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Machining centers - Safeguarding specification

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Table of Contents

Foreword

This Standard's Chapter 3, Article 4.7.3, Article 4.8.1, Article 4.8.3 and Article 4.8.4 are recommended, the rest are mandatory.

Formulated on the basis of GB 15760-1995 "Metal-cutting machine tools - General safeguarding specification", and combined with the structural characteristics of the machining center, this Standard is a supplement and realization to the aforementioned standard.

This Standard was written on the basis of GB/T 16755-1997 "Safety of machinery - Rules for drafting and presentation of safety standards".

This Standard was proposed by China Machinery Industry Federation.

This Standard shall be under the jurisdiction of China National Technical Committee for Standardization of Metal Cutting Machine Tool.

The drafting organization of this Standard: Beijing Machine Tool Research Institute.

Main drafters of this Standard: Zhang Wei and Li Xiangwen.

Machining centers - Safeguarding specification

1 Scope

This Standard specifies the technical requirements and safety measures on major hazards that shall be taken by machining centers.

This Standard is applicable to general-use machining centers.

2 Normative references

The following standards contain provisions which, through reference in this Standard, constitute the provisions of this Standard. At the time of publication, the editions indicated were valid. All standards shall be revised. The parties who enter into agreement based on this Standard are encouraged to investigate whether the latest versions of these standards are applicable.

GB 191-2000 Packaging - Pictorial marking for handling of goods (eqv ISO 780:1997)

GB 1251.1-1989 Ergonomics - Danger signals for public and work areas - Auditory danger (eqv ISO 7731:1986)

GB 1251.2-1996 Ergonomics - Visual danger signals - General requirements design and testing

GB 1251.3-1996 Ergonomics - system of auditory and visual danger and information signals

GB 2893-1982 Safety colors

GB 2894-1996 Safety signs (neq ISO 3864:1984)

GB/T 3168-1993 Numerical control of machine – Symbols (neq ISO 2972:1979)

GB 4053.1-1993 Safety requirements for fixed steel vertical ladders

GB 4053.2-1993 Safety requirements for fixed steel oblique ladders

GB 4053.3-1993 Safety requirements for fixed industrial protective railings

GB 4053.4-1983 Fixed steel industrial platform

GB/T 5226.1-1996 Safety of machinery - Electrical equipment of machines - Part 1: General requirements (eqv IEC 204-1:1992)

GB/T 6527.2-1986 General code of safety color (eqv ISO 3864:1984)

GB/T 6576-1986 Machine tools - Lubrication systems (neq ISO 5170:1977)

GB 7247-1995 Radiation safety of laser products equipment classification requirements and users guide (idt IEC 825:1984)

GB/T 7632-1987 Recommendations for the choice of lubricants for machine tools

GB/T 7932-1987 Pneumatic fluid power - General rules relating to systems (neq ISO 4414:1982)

GB 8196-1987 Safety requirement of guard on machinery

GB 8197-1987 Safety requirement of shield

GB 9969.1-1998 General principles for preparation of instructions for use of industrial products

GB 12265.1-1997 Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs

GB 12265.2-2000 Safety of machinery - Safety distances to prevent hazard zones being reached by the lower limbs

GB 12265.3-1997 Safety of machinery - Minimum gaps to avoid crushing of parts of the human body

GB/T 13379-1992 Principles of visual ergonomics - the lighting of indoor work places (neq ISO 8995:1989)

GB/T 14775-1993 Ergonomics requirements for controller

GB/T 14776-1993 Ergonomics - Principles for determining dimensions of work places in manufacturing areas and the dimensions

GB/T 15241.2-1999 Ergonomic principles related to mental workload - Part 2: Design principles (idt ISO 10075-2:1996)

GB/T 15706.1-1995 Safety of machinery - Basic concept, general principles for design - Part 1: Basic terminology, methodology

GB/T 15706.2-1995 Safety of machinery - Basic concepts, general principles for design Part 2: Technical principles and specifications

GB 15760-1995 Metal-cutting machine tools - General safeguarding specification

GB/T 16251-1996 Ergonomic principles in the design of work systems (eqv ISO 6385:1981)

GB 16754-1997 Safety of machinery - Emergency stop - Principles for design (eqv ISO/IEC 13850:1995)

GB/T 16769-1997 Metal-cutting machine tools - Measurement method of sound pressure level

GB/T 16855.1-1997 Safety of machinery - Safety related parts of control systems - Part 1: General principles for design

GB/T 16856-1997 Safety of machinery - Principles for risk assessment

GB/T 17161-1997 Machine tools - Direction of operation of controls (eqv ISO 447:1984)

GB/T 17454.1-1998 Safety of machinery Pressure sensitive protective device Part 1: General principles for the design and testing of pressure sensing mats and pressure sensing floors

GB 17888.1-1999 Safety of machinery - Permanent means of access to machinery - Part 1: Choice of a fixed means of access between two levels

GB 17888.2-1999 Safety of machinery - Permanent means of access to machinery - Part 2: Working platforms and walkways

GB 17888.3-1999 Safety of machinery - Permanent means of access to machinery - Part 3: Stairs stepladders and guard-rails

GB 17888.4-1999 Safety of machinery - Permanent means of access to machinery - Part 4: Fixed ladders

GB/T 18153-2000 Safety of machinery - Temperatures of touchable surfaces - Ergonomics data to establish temperature limit values for hot surfaces

GB 18209.1-2000 Safety of machinery - Indication, marking and actuation - Part 1: Requirements for visual, auditory and tactile signals (idt IEC 61310-1:1995)

GB 18209.2-2000 Safety of machinery - Indication, marking and actuation - Part 2: Requirements for marking (idt IEC 61310-2:1995)

JB/T 8356.1-1996 Machine Tools - Specification for Packing

JB/T 8356.2-1996 Machine Tools - Packing Box

JB/T 8356.3-1996 Inside-small Wood Box for Packing of Machine Tools

JB/T 9878-1999 Metal cutting machine tools - Determination of dust concentration

JB/T 9879-1999 Metal cutting machine tools - Determination method of oil mist concentration

JB/T 10051-1999 Hydraulic system general specifications for metal-cutting machine tools

3 Hazards of machine tool

3.1 Mechanical hazards

3.1.1 Crushing hazard

a) Crushing hazard between headstock and workbench;

b) Crushing hazard between workbench AND wall or other objects;

c) Crushing hazard between saddle (or sliding plate) AND wall or other objects;

d) Crushing hazard between cutting tool and cutting tool magazine;

e) Crushing hazard between cutting tool AND tool clamping mechanism or mechanical hand;

f) Crushing hazard between workpiece AND power workpiece clamping mechanism or workpiece movement (e.g. workpiece indexing);

g) Crushing hazard between mechanical chip conveyor's moving part and the fixed part;

h) Crushing hazard caused by operator's unexpected movement or observation during processing.

3.1.2 Shearing hazard

a) Shearing hazard between workbench and saddle;

b) Shearing hazard between saddle and machine body;

c) Shearing hazard between headstock and column (or sliding plate);

d) Shearing hazard between cutting tool and cutting tool magazine.

inconsistent with direction of human movement;

c) Hazard of unintended actions of machine tool caused by carelessness.

3.8 Hazards caused by energy supply disruption, damaged mechanical parts and other parafunction

3.8.1 Energy supply disruption of machine tool or control system

Hazard of power interruptions or fluctuations caused by malfunctions of machine tool. Hazard caused by automatic start of machine tool when it is switched on again after power interruption.

3.8.2 Accidental thrown out of machine tool parts and accidental ejection of pressure gas or liquid

a) Hazard of accidental thrown out or falling of cutting tool, workpiece during power interruption or loose connection;

b) Hazard caused by accidental ejection of pressure gas or liquid during power interruption or component damaging.

3.8.3 Failure or malfunction of control system

a) Hazard caused by moving part's malfunction, accidental start, runaway speed change and unstoppable movement;

b) Hazard caused by spindle overload and feed mechanism overload;

c) Hazard caused by unreliable function of control.

3.8.4 Assembly error

Hazard caused by assembly error of machine tool part, and wrong connection of catheter, cable, wire or hydraulic and pneumatic component.

3.8.5 Overturning and unexpected loss of machine tool stability

a) Hazard of overturning, falling or abnormal movement of machine tool and its accessories under unusual circumstances;

b) Hazard caused by component fracture of counterweight system.

3.9 Hazard caused by wrong safety measures, safety device error or incorrect positioning

3.9.1 Protective device

4 Safety requirements, measures and evaluation

4.1 General requirements

4.1.1 Carry out hazard identification, hazard analysis and hazard assessment of machine tool according to requirements of GB/T 16856.

4.1.2 The safety and protective measures adopted for machine tool shall comply with provisions of GB/T 15706.1, GB/T 15706.2 and Chapter 4 of GB 15760-1995.

4.2 Safety requirements, measures and assessment for mechanical hazard

4.2.1 Safety requirements, measures and assessment for crushing hazard

a) The headstock and workbench shall adopt safety measures to prevent crushing hazard.

   Assessment: visually inspect or information examination.

b) The minimum distance for squeezing between workbench and wall or other objects shall comply with provisions of GB 12265.3.

   Assessment: pattern or information check.

c) The minimum distance for squeezing between saddle (or sliding plate) and wall or other objects shall comply with provisions of GB 12265.3.

   Assessment: pattern or information check.

d) The cutting tool and cutting tool magazine are generally considered safe due to their positions, that is to say, if it can prevent to get close to cutting tool and cutting tool magazine from the ground around the machine tool or anywhere of platform or special operating platform, then it requires no protection; otherwise it shall adopt protective device to prevent crushing hazard.

   Assessment: visual inspection.

e) It shall adopt protective device to prevent crushing hazard in the working area between cutting tool and tool clamping mechanism.

   Assessment: visual inspection or information examination.

f) When the clamping moving distance between workpiece and power workpiece clamping mechanism exceeds 6 mm, it shall adopt safety

b) It shall take measures for rapid decline of headstock to prevent impacting hazard.

Assessment: functional inspection and information examination.

c) It shall take measures for mechanical hand's movement to prevent impacting hazard.

Assessment: visual inspection and information examination.

4.2.7 Safety requirements, measures and evaluation for stabbing or puncturing hazard

a) The exposed parts of machine tool shall be as flat and smooth as possible. There shall be no sharp edges, corners, projecting portions or openings that may hurt; otherwise it shall set alarm marks around.

Assessment: pattern check and visual inspection.

b) It shall take measures for console or suspended control cabinet to prevent bumping hazard.

Assessment: visual inspection and information examination.

4.2.8 Safety requirements, measures and evaluation for high pressure fluid ejection hazard

The cooling system, hydraulic system, pneumatic system and lubrication system of machine tool for transporting high pressure fluid shall be able to withstand the internal pressure and external pressure during normal operation to ensure that they shall not produce ejection hazard. The lubrication system shall comply with provisions of GB/T 6576. The pneumatic system shall comply with provisions of GB/T 7932. The hydraulic system shall comply with provisions of JB/T 10051.

Assessment: visual inspection and information examination.

4.2.9 Safety requirements, measures and evaluation for thrown out hazard of machine tool's parts or material / workpiece to be processed

a) The connection of machine tool's parts shall comply with provisions of 3.5 and 3.7.3 of GB/T 15706.2-1995.

- Motorized clamping device of workpiece shall comply with the following requirements:

1) When machine tool is working, the motorized clamping device of workpiece shall not move when machine tool is working;

Assessment: visual inspection.

b) The machine tool shall accommodate and effectively recover coolants, cutting fluids, liquid oils and lubricants, so as to prevent them from flowing to the ground around the machine tool and causing hazard due to spilling. If the protection in the processing area is not enough to protect the operator from spilling, it shall set additional protective shield. Or it shall prompt the user to add additional protective shield according to the shape and size characteristics of the workpiece.

Assessment: visual inspection and information examination.

c) When designing the work position, it shall give full consideration to personal safety on pedal and standing. When operating, if the working position of maintenance and adjustment is 2 m higher than the falling datum plane, then the platform for standing and fall protection railings, safety cages and protective shields shall be allocated. The designs of ladder, railing and platform shall comply with provisions of GB 4053.1~4053.4 and provisions of GB 17888.1~17888.4.

Assessment: visual inspection.

4.3 Safety requirements, measures and evaluation for electrical hazard

4.3.1 Safety requirements, measures and evaluation for hazard of electric shock

a) Live-parts protection shall comply with provisions of Chapter 6 of GB/T 5226-1-1996.

b) Insulation protection of electrical equipment shall comply with provisions of Chapter 5 of GB/T 5226.1-1996.

c) Grounding of electrical equipment shall comply with provisions of Chapter 8 of GB/T 5226.1-1996.

Assessment: a)~c) electrical design check, visual inspection, continuity test of protective grounding circuit, insulation resistance test.

4.3.2 Safety requirements, measures and evaluation for hazard of improper protection of electrical equipment

a) Overcurrent protection shall comply with provisions of 7.2 of GB/T 5226.1-1996.

b) Overload protection of electrical motor shall comply with provisions of 7.3 of GB/T 5226.1-1996.

order to prevent hazard of laser radiation, it shall take the following measures:

- The personal responsible for the use of laser products shall go through a certain level of trainings;

- Laser products shall be set with protective shield. After the protective shield is positioned (except laser window), it shall be able to prevent personal from contacting with laser radiation;

- In maintenance or during operation, the protective shields or protective enclosures of laser products shall be removable or removed, and it shall use interlocking protective device;

- If necessary, the user shall wear personal protective equipment.

Assessment: visual inspection and information examination.

4.7 Safety requirements, measures and evaluation for hazard produced by material and substance

4.7.1 Safety requirements, measures and evaluation for noxious liquid, gas, fog, smoke and dust

a) The selection and use of coolants shall make machine tool work as normal and protect human health.

Assessment: information examination.

b) The selection of liquid oil for machine tool shall comply with the provision of GB/T 7632. The selection and use of coatings and paints shall protect human health.

Assessment: information examination.

c) For the machine tool that generates harmful gas or amounts of oil mists during working, it shall take effective closure or set effective exhausting device or mist inhalation device. The measurement for oil mist concentration shall follow the provisions of JB/T 9879.

Assessment: actual testing and visual inspection.

d) For the machine tool that generates amounts of dusts, it shall take effective closure or set effective dust inhalation device The measurement for dust concentration shall follow the provisions of JB/T 9878.

Assessment: actual testing and visual inspection.

4.7.2 Safety requirements, measures and evaluation for fire and explosion

a) The installation position of lamps shall be able to prevent the hazard of explosion caused by spilt coolants; otherwise it shall use protective device.

Assessment: visual inspection.

b) The machine tool shall use fire resistant coolant and liquid oil. If flammable coolant, liquid oil or processing material is used, it shall take fireproof and explosion proof measures, e.g. fire extinguisher;

- Explosion proof device;

- Flammable limit device.

Assessment: information examination.

c) Fire protection for electrical equipment shall comply with the provisions of 7.4 and 14.3 of GB/T 5226.1-1996.

Assessment: visual inspection.

4.7.3 Safety requirements, measures and evaluation for organism and microorganism

The fuel tank, cooling box and cooling tank of machine tool shall be easy to clean. Usually, the fuel tank and the cooling box shall be put with covers to prevent foreign objects. It shall prompt the user to periodically replace the coolant and liquid oil.

Assessment: visual inspection and information examination.

4.8 Safety requirements, measures and evaluation for hazard produced by ignoring ergonomic principles

Manual control device and the design for its installation shall comply with human capabilities and limits (e.g. operating weight, distance to reach, strength, visibility and position), and relevant provisions of GB/T 16251 as well.

4.8.1 Safety requirements, measures and evaluation for unhealthy posture or excessive force

The designs for machine tool's hand wheel, handle and button station shall comply with the relevant provisions of GB/T 14775.

a) The operating force of machine tool’s hand wheel and handle within the range shall be even. The operating force of machine tool’s hand wheel and handle shall comply with the provisions of 7.10 of GB 15760-1995.

Assessment: actual testing.

then safety measures shall be taken in the event of causing hazards. When the headstock is required to run but fails, it shall stop moving parts to move under any circumstances.

Assessment: visual inspection and information examination.

b) Generally, the moving parts that may be damaged by overload shall be set with overload safety device. If the overload is unable to be prevented due to structure, then the mark of which the extreme conditions of use are indicated shall be set on the machine tool.

Assessment: visual inspection, maximum load weight test, and load test.

c) The control device shall ensure that its functions are reliable, and it shall be able to withstand the expected workload and external influences. Logical mistakes shall not cause any hazard.

Assessment: functional inspection or certificate provided by supporting manufacturer that it complies with relevant standards, and information examination.

4.9.4 Safety requirements, measures and evaluation for assembly error

It shall prevent hazards caused by assembly or reassembly errors of some parts or line connection error, otherwise it shall:

- Indicate the direction of rotation on the moving parts and / or the shell;

- Indicate the marks on catheters, cables, wires, hydraulic fittings, pneumatic fittings and / or connectors.

The essential information shall be explained in the instructions for use.

Assessment: visual inspection, maximum load weight test, and load test.

4.9.5 Safety requirements, measures and evaluation for overturning and unexpected loss of machine tool stability

a) The machine tool and its accessories shall have sufficient stability under unusual circumstances. Machine tool's parts and connections shall be able to withstand all predictable operating forces to prevent the machine tool and its accessories from overturning, falling or abnormally moving.

If it is not able to assure the stabilities of the machine tool and its accessories by design (stable mass distribution), it shall take special safety measures. For example:

- Restrict the amount of exercise of machine tool's components and parts;

- The materials for protective cover, protective shield and protective railing, the maximum size of meshes and holes when adopting network structure, plate structure and fence structure as well as the minimum safety distance shall comply with the provisions of GB 8196 and GB 8197;

- The movable part of the protective device shall be easy to operate and move;

- The protective device that is regularly dismantled shall be easy to dismantle. Its weight shall not exceed 16 kg. For the protective device that is inconvenient to move with hands, it shall set lifting hole or lifting ring. And its weight (kg) shall be indicated on the protective device body or in machine tool's instructions for use;

- The transparent protective device for observation of machine tool's operation shall be easy to observe;

- The design for protective device shall try to avoid climbing;

- The design for protective device shall minimize the adverse psychological effects;

- The passage of the protective area shall make personnel exposed to the residual hazards (e.g. radiation), it shall set up warning marks at the entrance of the passage.

Assessment: pattern or information check, functional inspection and information examination.

b) It shall make observation, adjustment, maintenance and lubrication points located outside the hazardous zone, and reduce the need for the operator to enter the hazardous zone. Generally, the adjustment, maintenance, repair and cleaning shall be carried out when the machine tool is in the stationary state. If the operator needs to enter the hazardous zone when the machine tool is running as normal, it shall take safety measures.

Assessment: visual inspection and information examination.

4.10.2 Safety requirements, measures and evaluation for safety device

a) The interlocking device of the machine tool shall be reliable. Should the interlocking be unable to realize, then it shall set warning marks or signs near the control device and explain in the instructions for use.

Assessment: functional inspection and information examination.

b) The limit device of the machine tool shall comply with the following

5) Emergency visual signals shall be prior to any other visual warning signals;

6) Regularly check the effectiveness of visual signals of hazards. Whenever a new visual signal is started, it shall review the effectiveness of visual signals of hazards immediately.

- Sound warning signal device shall comply with the following requirements:

1) In the signal reception area, anyone shall identify and make the expected response to the signal;

2) Sound signals of hazards shall be prior to any other sound signals;

3) Emergency sound signals shall be prior to any other sound warning signals;

4) Regularly check the effectiveness of sound signals of hazards. Whenever a new sound signal is started or a new noise source appears, it shall timely review the effectiveness of sound signals

Assessment: visual inspection and functional inspection.

b) The safety use, adjustment and maintenance of the machine tool shall comply with the provisions of Chapter 5 of this Standard.

Assessment: visual inspection and information examination.

c) Generally, the hydraulic pressure, lubrication, cooling pump (or tank) and other oil storage of the machine tool shall be set with level monitoring device. Check if the monitoring level is lower than the minimum limit.

Assessment: visual inspection.

4.10.6 Safety requirements, measures and evaluation for energy supply cut-off device

The safety requirements for energy supply cut-off device shall comply with the provisions of 6.2.2 of GB/T 15706.2-1995.

Assessment: visual inspection and residual voltage test.

4.10.7 Safety requirements, measures and evaluation for emergency stop device

An emergency stop control device shall be set in each working or operating position. It shall be set at least in the following positions:

b) The hydraulic system shall be set with safety valve to prevent overpressure or relief valve to adjust the pressure change;

c) Each component of hydraulic system shall be able to withstand the maximum work pressure specified by the design;

d) The pressure safety device shall be adjusted to the values specified in the instructions for use;

e) The internal leakage of hydraulic system shall not cause hazards;

f) When the power source is disconnected, the accumulator shall be automatically released, otherwise it shall provide reliable isolation measures. If the accumulator still needs to maintain the pressure, it shall illustrate the instructions for safe use on the accumulator or in a conspicuous place nearby. The instructions shall contain words such as “Be Careful (or Caution), Pressure Vessel”. These instructions shall be also shown on the drawing of oil circuit. On the accumulator, the following marks shall be indicated:

1) Manufacturing date;

2) Capacity (L);

3) Rated pressure;

4) Allowable temperature (°C);

5) Mark of conformity.

Assessment: a)~f) pattern check, visual inspection, functional inspection and information inspection.

4.14. Safety requirements, measures and evaluation for hazard caused by lubrication system of machine tool

Safety requirements for lubrication system of machine tool shall comply with the provisions of GB/T 6576 and the followings:

a) The oil level indicator shall be set in a safe place where it is easy to observe.

b) The manual lubrication point on the machine tool and accessories shall be set with marks for easy operation;

c) It shall prevent the accidental mixing of coolant, cutting fluid and lubricant.

Assessment: a)~c) pattern check, visual inspection, functional inspection and

may only reduce the throwing hazards instead of completely eliminating the hazards";

c) The recommendation of keeping windows transparency, especially the effects of clean wiping, heat and chemical action;

d) The maximum length, the greatest diameter, the maximum weight of the cutting tool;

e) Fixed and reliable cutting tool replacement;

f) Fixed, reliable replacement and use of clamping device provided by random; the maximum permissible speed; the maximum permissible speed or working capability after change;

g) Use of additional devices and reliable connection method of machine tool;

h) The maximum speed, the maximum feed rate, the maximum workpiece weight it bears, and the maximum clamping force;

i) Process of numeric-control operation, e.g. cutting tool correction, entering of work mode, selection of work mode, etc.;

j) Reset method;

k) Treatment of hot cutting tool or hot chips to prevent hazards caused by them;

l) Reminder of moving area where one shall directly get close to the platform through the fence.

5.4.3 The instructions for use shall give safety warnings on contents related to safety. The warnings shall be indicated by a larger font size or a different font, or emphasized by special symbols or colors.

5.5 Signs, symbols (image figures) and text warning shall comply with the provisions of 5.4 of GB/T 15706.2, 10.3 of GB/T 5226.1-1996 and GB 18209.2. Their positions, contents and forms shall be eye-striking.

Safety warnings of high and moderate hazards shall be reliably placed on the prominent position of the machine tool. Therefore, the user shall see the warnings from the use positon during normal use of the product. The instructions for use shall point out the positions of safety warning marks in order to attract user's attention.

5.6 For best results, the writing on the discussion about safety and safety warnings shall consider the followings:

- Maintaining under safe operation.

6.5 The user shall be responsible for his own safety when he adds clamps, tooling and auxiliary equipment by himself, as well as his safety after he changes or modifies the original machine tool, tooling and auxiliary equipment.

6.6 The user shall be responsible for the hazards caused by his failure to follow the instructions for use of the machine tool on operation, adjustment, maintenance, installation and transport.

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