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Fused Deposition Modeling Machines – Technical Requirements for Safeguarding

熔融沉积快速成形机床 安全防护技术要求

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Fused Deposition Modeling Machines – Technical Requirements for Safeguarding

1 Scope

This Standard specifies the safeguarding requirements, measures, usage information and other technical requirements for safeguarding of fused deposition modeling machines; and also stipulates the inspection requirements for safeguarding requirements.

This Standard applies to fused deposition modeling machines (hereinafter referred to as "machines").

2 Normative References

The provisions in following documents become the provisions of this Standard through reference in this Standard. For dated references, the subsequent amendments (excluding corrigendum) or revisions do not apply to this Standard, however, parties who reach an agreement based on this Standard are encouraged to study if the latest versions of these documents are applicable. For undated references, the latest edition of the referenced document applies.

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

GB 5226.1 Safety of machinery - Electrical equipment of machines--Part 1:General requirements (GB 5226.1-2002, IEC 60204-1:2000, IDT)

GB/T 14896.7-2004 Non-traditional machine tools - Terminology - Part 7: Rapid prototyping machines

GB/T 15706.1-1995 Safety of machinery - Basic concept, general principles for design - Part 1: Basic terminology, methodology (eqv ISO/TR 12100-1:1992)

GB/T 15706.2-1995 Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles and specifications (eqv ISO/TR 12100-2:1992)

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

GB/T 18569.1-2001 Safety of machinery - Reduction of risks to health from hazardous substances emitted by machinery - Part 1: Principles and specifications for machinery manufacturers (eqv ISO 14123-1:1998)

5.1.2 Risks shall be eliminated or reduced through design as much as possible, including the use of the following measures alone or in combination:

--- Choose appropriate design structures to avoid or reduce risks;

--- Reduce the need for operators to intervene in danger zones to limit their exposure to hazards.

5.1.3 For hazards that cannot be avoided or adequately limited by design, safeguarding devices shall be used to protect personnel.

5.1.4 The operator shall be informed through effective means of the remaining risks and certain hazards that are inconvenient to protect due to insufficient guards. If it can be stated in the product instruction manual, warning signs or plates shall also be set up at dangerous locations when necessary.

5.2 Mechanical hazards and safeguarding (see 7.2 for inspection)

5.2.1 The easily accessible parts of the machine shall not have sharp edges, sharp corners, sharp edges, etc. that can cause personal injury, so as to avoid the risk of punctures and cuts.

5.2.2 Under predetermined working conditions, the machine or its components shall not accidentally overturn.

5.2.3 Reliable limiting measures shall be taken for the reciprocating parts of the machine. Each motion axis shall be equipped with reliable electrical and mechanical double limit devices to prevent the risk of slipping.

5.2.4 The machining area of the machine shall be equipped with an interlocking protective cover. For machines with a closed structure in the working area, the molding chamber shall be equipped with an interlocking door.

5.2.5 When the interlocking guard is opened, the machine shall stop working or cannot be started; and it shall be ensured that it cannot be started before the guard is closed. If the door of the molding chamber is open, the machine cannot process to prevent the risk of collision when the nozzle runs at high speed.

5.2.6 The nozzle clamping device shall be safe and reliable to ensure that the nozzle does not fall or be thrown out during high-speed movement, causing a risk of projection.

5.2.7 Multiple different safeguarding devices shall be considered in greatly hazardous locations to avoid common cause failure. Such as high temperature protection measures, electrical and mechanical double limit devices for machine movement axis, etc.

5.3 Safeguarding device (see 7.3 for inspection)

5.3.1 Safeguarding devices are provided for the involved mechanical or other hazards. It shall

satisfy to:

--- Meet the required mechanical strength and stiffness, and have reliable performance;

--- Do not increase any additional hazards (such as causing pinching, shearing, etc.);

--- Can be fixed firmly and reliably.

5.3.2 Frequently disassembled guards shall be easy to assemble and disassemble, and their mass shall not exceed 6 kg. The opening force of the guards shall be no greater than 40 N.

5.4 Control systems and devices (see 7.4 for inspection)

5.4.1 The control and manipulation system of the moving parts of the machine (referred to as the control system) shall be functionally reliable and ensure that all functions do not interfere with each other. It shall be able to withstand the expected workload and external influences, control interruption and damage to the information carrier, and shall not lead to the emergence of dangerous situations.

5.4.2 When setting up control devices, additional hazards caused by mis-operation shall be taken into consideration. Control devices prone to mis-operation shall be designed with fault tolerance in mind.

5.4.3 The machine shall be equipped with a working state selection switch for each control function, and each position is only allowed to correspond to one control method or working state (such as automatic control or adjustment, inspection). Other methods (such as code control) can also be used to select working state.

5.4.4 A "stop" control device shall be set near each "start" control device. Each operating position of the machine shall be equipped with an emergency stop device. Emergency stop devices shall comply with the relevant provisions of GB 5226.1.

5.4.5 The installation height of instruments for frequent observation of readings is generally 0.7 m~1.7 m. The installation height of instruments whose readings are not frequently observed is allowed to be 0.3 m~2.5 m.

5.5 Electrical hazards and safeguarding (see 7.5, 7.11 for inspection)

5.5.1 The protection level of the electrical box (cabinet) shall comply with the relevant provisions of GB 5226.1.

5.5.2 The machine shall be reliably grounded, the grounding insulation resistance shall be no less than 1 MΩ, and meet the continuity requirements of the protection circuit.

5.5.3 The electrical equipment (including components) in the machine molding chamber shall be electrical products with additional requirements for heat resistance (see the relevant provisions of GB 5226.1).

5.5.4 Other safeguarding requirements for machine electrical equipment shall comply with the relevant provisions of GB 5226.1.

5.6 High temperature safeguarding requirements (see 7.6, 7.12 for inspection)

5.6.1 The nozzle heating system shall adopt a reliable temperature control device that can automatically adjust the nozzle temperature. Thermal protection measures (such as installing a protective cover made of heat-insulating material) shall be taken on the outside of the nozzle and the heating system of the nozzle to prevent the risk of burns.

5.6.2 For machines heated in the molding chambers, the following safeguarding measures shall be taken:

--- Use reliable temperature control device to control the heater temperature and prevent the temperature from being too high;

--- When the temperature of the molding chamber reaches the specified temperature, the machine is given a processing instruction, and the machine shall prompt the operator for confirmation.

5.6.3 The door of the molding chamber shall be interlocked with the nozzle heating system. The door cannot be opened when the nozzle is heating and processing.

5.6.4 The precise range of nozzle temperature and forming chamber temperature required for different molding materials shall be indicated in the machine instruction manual.

5.7 Exhaust system requirements (see 7.7 for inspection)

If the molding chamber is equipped with an exhaust device, the flow rate shall meet the cooling requirements and shall be interlocked with the molding chamber heater. That is, when the molding chamber is heated, the exhaust device is disconnected; when the molding chamber is not heated, the exhaust device is connected.

5.8 Hazardous gas safeguarding requirements (see 7.13 for inspection)

5.8.1 In accordance with the principles stipulated in GB/T 18569.1-2001, considering that the discharged substances may cause hazardous risks to health, measures for the suppression and emission of harmful gases shall be proposed in the instructions for use.

5.8.2 The determination method of hazardous substance concentration shall be in accordance with the provisions of GB/T 18569.2~2001.

5.9 Noise (see 7.8 for inspection)

5.9.1 The noise sound pressure level of the entire machine shall not exceed 60 dB(A). The measuring method of noise pressure level of machines shall comply with the provisions of GB/T 16769-1997.

6.3.1 General

The safety requirements in the instruction manual shall be comprehensive and specific, clearly reminding the operator of the hazards that may be faced during operation, and describing hazard safeguarding measures and methods. For the safety content of the instruction manual, see 6.3.2 ~ 6.3.7. The instruction manual carrier shall ensure durability.

6.3.2 Transportation, handling and storage information of machines

---Safe storage conditions for machines;

--- The size, mass and center of gravity of the machine;

--- Machine handling instructions (such as the force application points of lifting equipment);

--- Packaging safeguarding requirements and packaging icons for machines.

6.3.3 Information on delivery and commissioning of machines

--- Requirements for machine fixation;

--- Assembly and installation requirements: installation space requirements, etc.;

--- Connection instructions for machine power sources (including requirements for grounding devices);

--- Allowed environmental conditions: such as ambient temperature, humidity and vibration requirements.

6.3.4 Information about the machine itself

--- Noise data generated by machines;

--- Description and diagrams of safety functions.

6.3.5 Machine usage information

--- Preparation and inspection before use;

--- Description of safety warnings, safety safeguarding, and warning signs before and during use;

--- Operating procedures, methods, precautions during startup and operation, as well as common mis-operations and preventive measures;

--- Hazardous situations that may occur during operation;

--- Monitoring and recording of safety conditions during operation.

6.3.6 Maintenance information of machine

Safety technical requirements for maintenance personnel to perform maintenance shall be put forward.

6.3.7 Hazardous gas emission information

The installation and use of relevant accessories that emit hazardous gases shall be explained; the emission of exhaust gases shall comply with relevant national environmental protection provisions.

7 Inspection of Safeguarding Requirements

The safeguarding requirements of machines can be tested through inspections, tests, etc. Inspection can be carried out through visual inspection, manual inspection and measurement, etc. Test is based on a certain method and using instruments to measure corresponding index data and draw qualitative and quantitative conclusions (the test can include inspection content).

7.1 General inspection (see 5.1 for safeguarding requirements)

Check whether the machine tool meets the safety design requirements and whether the safety measures are reasonable through safety assessment and design safety analysis.

7.2 Inspection of mechanical hazards and safeguarding (see 5.2 for safeguarding requirements)

7.2.1 Whether the easily accessible parts of the machine are flat and whether there are sharp edges, corners, burrs, etc.

7.2.2 Whether the machine or its components are stable after installation.

7.2.3 Whether reliable limit measures are taken for reciprocating moving parts; whether reliable mechanical limit measures are taken for each moving axis (electric) in addition to electrical limit measures.

7.2.4 Whether an interlocking protective cover is installed in the machining area of the machine, or whether an interlocking door is installed in the molding room.

7.2.5 Whether the interlocking of the interlocking guard is effective and reliable. According to the design requirements, the interlocking function is tested for three times.

7.2.6 Whether the nozzle clamping device is reliable.

7.2.7 Whether various safeguarding measures have been taken at the greatly hazardous parts.

7.3 Inspection of safeguarding devices (see 5.3 for safeguarding requirements)

7.8 Noise inspection (see 5.9 for safeguarding requirements)

Check whether the noise pressure level is ≤60 dB(A), and whether there are any screams or impact sounds from the machine.

7.9 Lighting inspection (see 5.10 for safeguarding requirements)

7.9.1 Whether the required lighting device or corresponding interface is provided on the machine.

7.9.2 Whether the electrical safety of the lighting device on the machine complies with the relevant standards.

7.10 Usage information inspection (see Clause 6 for safeguarding requirements)

7.10.1 Whether the signals, warning devices, signs and symbols of the machine are complete.

7.10.2 Whether the signs and symbols of the machine are firm and clearly visible.

7.10.3 Whether the instruction manual clearly explain the hazards, protective measures and environmental protection requirements of the machine.

7.10.4 Whether the instruction manual carrier is durable.

7.10.5 Whether the nozzle temperature and molding chamber temperature range for different molding materials are provided in the instruction manual.

7.11 Electrical safety test (see 5.5 for safeguarding requirements)

Machines shall undergo the following tests in accordance with the provisions of GB 5226.1:

a) Continuity test of protective grounding circuit

The continuity test of protective grounding circuit shall be carried out in accordance with the relevant provisions of GB 5226.1.

b) Insulation resistance test

The insulation resistance test shall be carried out in accordance with the relevant provisions of GB 5226.1.

c) Withstand voltage test

The withstand voltage test shall be carried out in accordance with the relevant provisions of GB 5226.1.

7.12 Heating system control test (see 5.6 for safeguarding requirements)

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