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**Entertainment robots - Safety requirements and testing
methods**

娱乐机器人 安全要求及测试方法

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Entertainment robots - Safety requirements and testing methods

1 Scope

This Standard specifies general principles of safety design, hazard identification and risk assessment, safety requirements, test conditions and requirements, test methods and safety marks, signs and descriptions for entertainment robots.

This Standard applies to the design, production, testing and maintenance of entertainment robots.

This Standard does not apply to large recreational facilities that come in contact with people.

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.

GB/T 2423.55-2006, *Environmental testing for electric and electronic products - Part 2: Test method - Test Eh: Hammer tests*

GB 2893, *Safety colors*

GB 4943.1-2011, *Information technology equipment - Safety - Part 1: General requirements*

GB/T 5169.11-2017, *Fire hazard testing for electric and electronic products - Part 11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end-products (GWEPT)*

GB/T 5169.21-2017, *Fire hazard testing for electric and electronic products - Part 21: Abnormal heat - Ball pressure test method*

GB 6675.1-2014, *Toys safety - Part 1: Basic code*

GB 6675.2-2014, *Safety of toys - Part 2: Mechanical and physical properties*

GB 6675.4-2014, *Safety of toys - Part 4: Migration of certain elements*

carried out in accordance with the strategies applicable to robots in Chapter 4 Risk assessment and risk reduction in GB/T 15706-2012.

6 Safety requirements

6.1 Safety protection function

6.1.1 Each time the robot is powered on or reset, the robot shall have self-checking and error reporting functions.

6.1.2 During abnormal operation or improper operation, the robot shall be able to ensure a safe state and have prompts such as alarms. It can still be used after it is released.

Example: If the user sets wrong operating parameters (it is considered to be improper operation), the robot will give an alarm or be in a protection state.

6.1.3 The moving parts that have the requirement to limit the operating range shall be provided with terminal limit or other limit methods as the final stroke limit measure, so as to prevent the moving parts from overshooting beyond the limit of the operating range.

6.1.4 The robot shall have an emergency stop function. After the emergency stop device is activated, the robot shall remain in a stopped state.

6.1.5 The robot shall have the function of sound and light alarm.

6.2 Material safety

6.2.1 The materials used by the robot shall comply with the national laws and regulations on products or prohibited dangerous substances in related fields such as electronic appliances and toys.

6.2.2 The migratory elements and plastic additives in the materials used by the robot shall meet the requirements for chemical properties of materials in 5.3 of GB 6675.1-2014.

6.3 Mechanical safety

6.3.1 Basic requirements

Under the foreseeable normal use state of the robot, there shall be no danger due to the design of its mechanical structure and strength.

In the foreseeable abnormal state of use, including reasonably foreseeable misuse, the

robot may be dangerous due to its mechanical structure and strength design. Warning instructions shall be provided.

Robots suitable for children under the age of 14 shall meet the requirements of GB 6675.2-2014 for mechanical and physical properties at different ages. Describe in the packaging or instruction manual.

6.3.2 Stability

The robot shall have sufficient static and dynamic stability. Under normal conditions of use, it shall not pose a danger to the user due to its lack of stability. Robots that are expected to be used on slopes shall be pre-planned to avoid overturning in scenarios where slopes are used. Explain in the instruction manual.

6.3.3 Structure

The structure of the robot shall have sufficient mechanical strength. It shall be able to withstand the foreseeable function of normal use without causing any danger. It shall be able to withstand foreseeable handling or loading and unloading operations.

The mechanical protective casing and internal parts shall be complete. Due to the occurrence of obstacles or other reasons, the moving parts of the robot cannot fall off and be thrown out. The parts that may be loose, separated or thrown out from the moving parts can be blocked or changed in direction.

6.3.4 Sharp edge

The accessible parts of the robot shall be free of sharp edges that can cause danger, including metal, glass, plastic edges and so on.

If the appearance of sharp edges cannot be avoided due to functional requirements, a warning statement shall be provided.

When the object of use includes children under 96 months, it shall meet the requirements of 4.6 in GB 6675.2-2014.

If the edges and corners of the robot may be dangerous to the operator due to the placement or use of the equipment, these edges or corners shall be rounded and polished. This requirement does not apply to edges or corners required for the normal functioning of the equipment.

6.3.5 Tip

The accessible parts of the robot shall be free from touchable tips that can cause danger. The tip part shall not be less than 60°, including metal, glass, plastic edges.

If the existence of sharp tips cannot be avoided due to appearance, function, corresponding protective devices or measures shall be provided. Warning instructions

The motor or motor system shall be enclosed by a separate mechanical shell. It shall not expose accessible sharp edges or sharp points, or other parts that could cause a hazard. Prevent the robot from causing dangerous injury under abnormal use.

6.3.11 Wire

Except for the power cord for charging functions, the wires of the robot shall not be exposed outside the enclosure of the entertainment machine in any form.

6.4 Electrical safety

6.4.1 Safe use of power adapters

6.4.1.1 Overload

For robots powered by a power adapter, the power adapter shall have a short-circuit protection device. When the current exceeds the specified value, it shall automatically stop working.

6.4.1.2 Input current

For a robot powered by a power adapter, within the rated voltage range, under normal maximum working load and operating temperature, its steady-state input current shall not exceed 1.1 times its rated current.

6.4.2 Protection against accessible live parts

The protection of the robot for accessible live parts shall meet the requirements of 2.1 and 2.2 in GB 4943.1-2011.

6.4.3 Contact current

The design and construction of the robot shall ensure that there is no risk of electric shock from contact current.

When the robot is connected to the AC power grid, the contact current shall meet the requirements of 5.1 in GB 4943.1-2011.

6.4.4 Dielectric strength

The electric strength of the robot shall meet the requirements of 5.2 in GB 4943.1-2011.

6.4.5 Heating

Consider the heating of robot parts and the surface temperature requirements of accessible parts:

- a) Parts heating requirements: shall meet the temperature limit requirements of 4.5.2,

4.5.3 in GB 4943.1-2011 and alternative standards;

- b) Surface temperature requirements of accessible parts: the surface temperature of accessible parts shall not exceed 48°C. If the contact time is less than 1min, the surface temperature limit can be increased from 48°C to 51°C, but it needs to be explained in the instruction manual.

6.4.6 Heat and flame resistance

Thermoplastic parts directly mounted to parts carrying hazardous voltages shall be resistant to abnormal heat. The plastic parts are subject to the ball pressure test according to GB/T 5169.21-2017 to check whether they are qualified. If, according to the inspection of the physical properties of the material, it has been clearly shown that the material can meet the requirements of this test, this test need not be carried out.

The non-metallic housing material parts of the robot shall have sufficient resistance to ignition and flame spread. The shell material parts are subject to the glow wire test according to GB/T 5169.11-2017 to check whether they are qualified.

6.4.7 SELV circuit

The voltage presented by the SELV circuit of the robot under normal operating conditions and after a single fault shall still be a safe voltage that can be contacted. If no external load (open circuit) is applied to the SELV circuit, the SELV voltage limits shall not be exceeded. Check whether it meets the relevant requirements of 2.2 in GB 4943.1-2011 by inspection and related tests.

6.4.8 Abnormal working of motor

Robot motors shall not be in danger due to excessive temperature under overload, locked rotor and other abnormal conditions. It shall meet the requirements of 5.3.2 in GB 4943.1-2011.

6.4.9 Abnormal use of batteries and battery packs

The battery or battery pack of the robot shall have appropriate safety protection measures under abnormal human operation.

When the battery or battery pack has abnormal operations such as over-voltage charging, over-current charging, under-voltage charging, reverse polarity charging, forced discharge, external short circuit and drop, the battery or battery pack shall not cause fire, explosion or release of toxic and harmful gases or material phenomena.

NOTE: If the battery or battery pack has met the corresponding test requirements of GB 31241-2014, it can be considered to meet the requirements.

The response delay of the robot to the user's regular operation instructions shall be controlled within a reasonable range, so as to avoid the user's mis-operation caused by the long response delay.

6.7.8 Anti-collision

For robots with autonomous mobility, the body shall be equipped with obstacle avoidance and anti-collision detection sensors and corresponding control algorithms. If there is no obstacle avoidance or anti-collision function, the robot shall not cause damage to its mechanical structure and function after a collision.

6.8 Other safety

6.8.1 Noise

When the robot is running at rated load and maximum speed, the maximum sound pressure level of the external emission shall not be greater than 60dB(A).

6.8.2 Laser

The lasers and light-emitting diodes in the robot shall meet the requirements of Class I lasers in GB 7247.1-2012.

7 Test conditions and requirements

7.1 Technical documents

The following documents shall be prepared before testing:

- a) Test related design documents, drawings and interface descriptions;
- b) Product manual, operation manual, maintenance manual.

7.2 Test sample

Test samples shall meet the following requirements:

- a) The test samples are consistent with the submitted product information;
- b) The number of test samples meets the test requirements;
- c) The test samples for certification testing have quality inspection certificates such as enterprise qualification certificates.

7.3 Equipment and instrumentation

Instruments and equipment used for product testing shall be verified or calibrated and within the validity period. The test equipment used shall meet the intended use requirements. The measurement uncertainty or the maximum allowable error shall be less than 1/3 of the maximum allowable error of the measured parameter.

7.4 Test environment requirements

Unless otherwise specified in this document or the detail specification, all tests shall be carried out under the following conditions:

- a) Temperature: indoor 0°C ~ 40°C; outdoor temperature shall be within the working temperature range specified by the manufacturer;
- b) Relative humidity: 20%~90%;
- c) Air pressure: 86kPa~106kPa.

7.5 Test interruption and recovery

If the following situations occur during the test, the test shall be interrupted and resumed.

- a) The test interruptions are as follows:
 - The key indicators of the test sample are unqualified;
 - The test sample does not work properly due to malfunction and cannot be repaired.
- b) Supplementary tests shall be carried out according to the situation when the following situations occur during the test:
 - Individual test items failed, and the cause has been identified and corrected;
 - The original design has been changed during maintenance and adjustment;
 - Replace the components or assemblies that affect the technical performance of the test sample.

For robots with a mass greater than or equal to 5kg, no tipping will occur when it is 10° relative to the normal vertical position in the power-off state.

8.3.2.2 Dynamic stability test

Place the robot on the most unfavorable support surface for expected use, including the horizontal surface and the inclined surface with the most unfavorable angle. Then, start the robot and let the robot move on the support surface for at least 10min. Check that the robot moves normally and does not tip over.

When the robot falls, consider whether the fall will cause harm to the user. The degree of damage can be divided into high, medium and low. When the robot is dumped, it is also necessary to consider whether the dumping will cause damage to the function of the robot. The degree of damage can be divided into high, medium and low.

NOTE: This clause applies only to robots with locomotion capabilities. When the damage to the user and the function of the robot is low after the robot falls, this test can also be considered as not applicable.

8.3.3 Structural test

Operate and control the moving parts of the robot when it is turned off and on. When necessary, the robot can be turned on to move continuously for not less than 5h within the maximum designed range of motion. Observe and record.

8.3.4 Sharp edge test

Use a sharp edge test device to test the possible sharp edges of the robot by rubbing back and forth once through TFE tape that can simulate human skin. Observe whether the TFE tape is scratched.

8.3.5 Tip test

Check that the robot has the sharp tip required for the function. Check for a prominent warning instruction sign near the tip. For any tip part that is not required for the function and possible, measure it through a suitable protractor with a resolution of not less than 0.5°.

8.3.6 Clearance test

Use the test finger that conforms to Test tool B of Figure 2 in GB/T 16842-2016 to test the clearance part of the robot. The clearance shall not be penetrated by the test tool.

For robots that can be used for children under the age of 14, the test finger that conforms to Test tool 18 of Figure 12 in GB/T 16842-2016 shall also be used for testing. The clearance shall not be penetrated by the test tool.

For robots that can be used for children less than 36 months old, the test finger that

rated voltage. If the robot has one or more rated voltage ranges, the input current shall be measured at each terminal voltage within each rated voltage range. The test voltage is $\pm 10\%$ fluctuation range of the rated voltage. Take the voltage value that is most unfavorable to the robot.

For DC-powered robots, the test is to be carried out in the charging state. The test time shall include from the low battery protection state specified by the manufacturer to the fully charged state. For AC-powered robots, the tests are carried out under power-on and normal load conditions.

If the rated current indication is a single value, the higher input current measured in the relevant voltage range shall be used to determine. If two input current values are marked and separated by a short line, the two values measured in the relevant voltage range shall be taken for determination. In each case, wait for the input current to stabilize before taking the reading. If the current varies during the normal duty cycle, the steady-state current shall be read from the average indication of the measured ammeter over a representative period of time.

8.4.2 Test of protection against accessible live parts

Check the structural layout of the robot. Carry out the following tests:

- a) Visually check whether the housing structure of the robot is sufficiently airtight.
- b) Use the test finger that conforms to Test finger of Test tool B of Figure 2 in GB/T 16842-2016 to carry out the test. During the test, first remove the operator's detachable parts. Open the accessible doors, covers. Then, insert the test finger into the opening in the shell. Live parts shall not be touched.
- c) Use the test pin that conforms to Test tool 13 of Figure 9 in GB/T 16842-2016 to test. When the test pin is inserted into the opening of the outer electrical protective enclosure, the test pin shall not touch exposed parts with dangerous voltage. During the test, operator-removable parts, including fuse holders and lamps, shall remain in place. Accessible doors and covers shall be closed.

8.4.3 Contact current test

For DC-powered robots, the test is performed when the charging current is at its maximum. For AC-powered robots, the test is carried out under the condition of power-on and normal load.

Measure the rms value of the contact current between any pole of the robot power supply and the accessible metal part connected to the metal foil. The measurement method is carried out according to the measurement network in Figure 4 in GB/T 12113-2003. The test voltage is $\pm 10\%$ fluctuation range of the rated voltage. Take the most unfavorable voltage value. The test time is 60s.

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