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**Methods of environmental test for analytical
instruments**

分析仪器环境试验方法

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Methods of environmental test for analytical instruments

1 Scope

This standard specifies the general rules and methods of environmental test methods for analytical instruments.

This standard applies to the selection of the environmental test of instruments, which are required in the process of the research, development, design, manufacture, sale, of all analytical instruments (hereinafter referred to as instrument), for the purposes of ensuring the product quality, as well as in the process of developing product standards.

2 General

2.1 Applicability

This general rule applies to all instruments. It specifies the grouping of environmental condition, reference working conditions, test items, selection of grouping of environmental condition, test procedures, test sequence of the instrument.

2.2 Grouping of environmental condition

The instruments are divided into the following 4 basic groups, according to the conditions of use and transportation and circulation (see Table 1 for details):

Group I: The ambient temperature and humidity are controlled within the specified range, usually referring to a controllable environment, which has air-conditioning equipment. This group is applicable to precision instruments.

Group II: Only the ambient temperature is controlled within the specified range, usually referring to the indoor environment, which has general heat preservation, heating and ventilation. This group is applicable to laboratory instruments.

Group III: The ambient temperature and humidity are not controlled, usually referring to the indoor environment, which has no heat preservation, heating and ventilation. This group is applicable to industrial process instruments.

Group IV: The harsher environment where the ambient temperature and humidity are not controlled, usually referring to the outdoor environment with or without shelter. This group is applicable to outdoor use instruments.

2.3 Reference working conditions

Refer to Table 2, for reference values, ranges, tolerances of reference working conditions.

Under the conditions of no objection, it is allowed to carry out test, at a temperature of 15 °C ~ 25 °C, a relative humidity of 45% ~ 75%, an atmospheric pressure of 86 kPa ~ 106 kPa, a power supply voltage of 220 V ± 22 V, a power supply frequency of 50 Hz ± 0.5 Hz.

2.4 Test items

The test items include 16 items: power supply voltage and frequency test, low temperature test, high temperature test, temperature change test, constant damp heat test, alternating damp heat test, vibration test, magnetic field test, air pressure test, sand dust test, mildew test, salt spray test, low temperature storage test, high temperature storage test, drop test, collision test.

2.5 Selection of grouping of environmental conditions

2.5.1 For the product standards, it shall select the grouping of the environmental conditions in 2.2. If a certain influence quantity (generally only one) is not completely consistent with the environmental conditions of the specified group, it shall be specified separately in the product standard.

2.5.2 When it is not feasible to test the whole machine for a large product, the relevant standards shall provide for the test of those key parts or components.

2.5.3 The test items listed in Table 1 are the items that the instrument shall be subject to. In special circumstances, it shall be according to relevant standards OR negotiated by both the supplier and the buyer.

2.6 Test procedure

Each test usually includes the following contents (except for special items):

- a) Pretreatment (if necessary);
- b) Initial testing (if necessary);
- c) Condition test;
- d) Intermediate testing (if necessary);

Test the instrument according to relevant standards.

4.4.3 Condition test

4.4.3.1 Put the pre-processed instrument into the test box (chamber), at the normal position, in the non-powered and "ready-to-use" state. At this time, the temperature of the test box (chamber) is consistent with the temperature of the instrument.

4.4.3.2 The temperature of the test box (chamber) is reduced to the specified value, at a rate of change of not more than 1 °C/min (not more than the average value of 5 min). At this time, the instrument is powered on AND maintained for the specified test duration.

4.4.4 Intermediate testing

After the duration of the test is reached, the performance test shall be carried out immediately, in accordance with the relevant standards.

4.4.5 Recovery

After the testing, cut off the power supply of the instrument, to stop working. The temperature of the test box (chamber) is increased to the environmental conditions of the instrument during the pretreatment, at a rate of change of not more than 1 °C/min. After reaching the temperature, it will be restored for 1 h ~ 2 h.

4.4.6 Final testing

Test the instrument according to relevant standards.

4.5 Information to be given by relevant standards

When the relevant standards adopt this method, it shall give the following detailed rules as applicable as possible:

- a) Pretreatment;
- b) Initial testing items and requirements;
- c) The duration of test;
- d) Intermediate testing items and requirements;
- e) Final testing items and requirements;
- f) Any changes to the test procedure, as agreed by the supplier and the buyer.

The duration of the instrument temperature test shall be selected from the following:

2 h, 4 h, 8 h, 16 h.

5.4 Test procedure

5.4.1 Pretreatment

Place the instrument under normal (or reference) environmental conditions, to achieve temperature equilibrium.

5.4.2 Initial testing

Test the instrument according to relevant standards.

5.4.3 Condition test

5.4.3.1 Put the pre-processed instrument into the test box (chamber), at the normal position, in the non-powered and "ready-to-use" state. At this time, the temperature of the test box (chamber) is consistent with the temperature of the instrument.

5.4.3.2 The temperature of the test box (chamber) is increased to the specified value, at a rate of change of not more than 1 °C/min (not more than the average value of 5 min). At this time, the instrument is powered on AND maintained for the specified test duration.

5.4.4 Intermediate testing

After the duration of the test is reached, the performance test shall be carried out immediately, in accordance with the relevant standards.

5.4.5 Recovery

After the testing, cut off the power supply of the instrument, to stop working. The temperature of the test box (chamber) is reduced to the environmental conditions of the instrument during the pretreatment, at a rate of change of not more than 1 °C/min. After reaching the temperature, it will be restored for 1 h ~ 2 h.

5.4.6 Final testing

Test the instrument according to relevant standards.

5.5 Information to be given by relevant standards

When the relevant standards adopt this method, it shall give the following

temperature of each part of the inner wall of the test box (chamber) AND the specified test temperature, shall not exceed the following values: 3% at high temperature, 8% at low temperature (calculated by Kelvin (K) temperature). The instrument shall not be exposed to direct radiation, from any heating and cooling elements, that do not meet the above requirements.

6.3.1.4 The air in the test box (chamber) shall be fully circulated. Forced air circulation can be used, to keep the temperature uniform.

6.3.1.5 The volume of the test box (chamber) shall be greater than 3 times the volume of the instrument.

6.3.2 Requirements for the instrument

When the working space of the test box (chamber) is not enough for the whole machine test, if the instrument allows, the test can be carried out separately, in the form of extension set.

6.3.3 Test duration

The duration of the two temperatures of the instrument (t_1) shall be selected from the following:

1 h, 2 h, 3 h.

6.4 Test procedure

6.4.1 Pretreatment

Place the instrument under normal (or reference) environmental conditions, to achieve temperature equilibrium.

6.4.2 Initial testing

Test the instrument according to relevant standards.

6.4.3 Condition test

6.4.3.1 Put the pretreated instrument into the test box (chamber), in the normal position. At this time, the temperature of the test box (chamber) is consistent with the temperature of the instrument.

6.4.3.2 Start the instrument. After normal operation, the temperature of the test box (chamber) is reduced to the specified value T_A , at a rate of change of not more than 1 °C/min (not more than the average value of 5 min). After the temperature is stable, keep the test duration t_1 . Immediately test the instrument, at this temperature, in accordance with relevant standards.

7.3.1.7 The volume of the test box (chamber) shall be greater than 3 times the volume of the instrument.

7.3.2 Requirements for instrument

When the working space of the test box (room) is not enough for the whole machine test, if the instrument allows, the test can be carried out separately, in the form of extension set.

7.3.3 Test duration

The duration of the instrument test shall be selected from the following:

4 h, 8 h, 12 h.

7.4 Test procedure

7.4.1 Pretreatment

Place the instrument under normal (or reference) environmental conditions, to achieve a temperature and humidity balance.

7.4.2 Initial testing

Test the instrument according to relevant standards.

7.4.3 Condition test

7.4.3.1 Put the pre-processed instrument into the test box (chamber), in the normal position, under the non-powered and "ready-to-use" state. At this time, the temperature and humidity of the test box (chamber) are consistent with the temperature and humidity of the instrument.

7.4.3.2 The temperature of the test box (chamber) is increased to the specified value, at a rate of change of not more than 1 °C/min (not more than an average value of 5 min), to preheat the instrument. After the temperature is stable, humidify it, to reach to the specified value, within 2 h, to avoid condensation on the instrument. After the temperature and humidity are stable, keep the test duration.

Note: If the relevant standards stipulate that the instrument is energized when the condition test is started, then proceed as stipulated. Other methods remain unchanged.

7.4.4 Intermediate testing

After the test duration is reached, start the instrument AND carry out testing, according to the relevant standards.

The duration of the instrument test is 24 h per cycle. There are two test cycles.

8.4 Test procedure

8.4.1 Pretreatment

Place the instrument under normal (or reference) environmental conditions, to achieve a temperature and humidity balance.

8.4.2 Initial testing

Test the instrument according to relevant standards.

8.4.3 Condition test

8.4.3.1 Put the pre-processed instrument into the test box (chamber), in the normal position, under the non-powered, "ready-to-use" state.

8.4.3.2 Under the conditions of a temperature of $25\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ and a relative humidity of 45% ~ 75%, make the test instrument's temperature be stable. After that, raise the humidity in the working space to not less than 95%, within 1 h.

8.4.3.3 According to the requirements of Figure 2, make the temperature in the working space change cyclically, within 24 hours.

- a) Heating stage: within $3\text{ h} \pm 0.5\text{ h}$, increase the temperature is continuously increased to $40\text{ }^{\circ}\text{C}$ (or $55\text{ }^{\circ}\text{C}$). Heating rate shall be limited to the shaded range in Figure 2. At this stage, except for the last 15 minutes, wherein the relative humidity shall not be less than 90%, the relative humidity of the rest of the time shall not be less than 95%, so that the test instrument will produce condensation (excessive condensation shall not be produced, for large-scale testing equipment);
- b) High temperature and high humidity constant stage: Maintain the temperature of the working space within the range of $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ (or $55\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$). Count from the beginning of the heating phase, until reaching to $12\text{ h} \pm 0.5\text{ h}$. In this stage, except for the initial and last 15 min, wherein the relative humidity is not less than 99%, it is $93\% \pm 3\%$ for the rest time;
- c) Cooling stage: Reduce the temperature of the working space, from $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ (or $55\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$) to $25\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$, within $3\text{ h} \sim 6\text{ h}$. The cooling rate shall be limited to the shaded range, which is specified in Figure 2. It shall be noted that, the cooling rate within 1.5 h after the beginning of the temperature reduction, is the temperature reduction rate, at which the temperature is reduced from $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ (or $55\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$) to $25\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$, within $3\text{ h} \pm 15\text{ min}$. In this stage, except that the relative humidity

It is performed according to product standards.

11.2.4 Test duration

It is selected from the following time:

10 min, 2 h, 4 h.

In the absence of requirements, the duration of the constant low pressure test is 2 h. The duration of the air pressure change test is 10 min.

11.3 Test procedure

11.3.1 Pretreatment

Place the instrument under normal (or according to relevant standards) environmental conditions, to achieve temperature equilibrium.

11.3.2 Initial testing

Test the instrument according to relevant standards.

11.3.3 Condition test

11.3.3.1 Put the pre-processed instrument into the test box (chamber), in the normal position, under the non-powered and "ready-to-use" state. At this time, the temperature of the test box (chamber) is consistent with the temperature of the instrument.

11.3.3.2 Reduce the air pressure of the test box (chamber) to the specified value. The average rate of pressure change shall not exceed 10 kPa/min. After the air pressure reaches the specified value, start the instrument AND maintain the specified test duration.

11.3.3.3 When the air pressure change test is performed, the instrument is started immediately after being placed in the test box (chamber). After the air pressure rises (falls) to the specified value, maintain the specified test duration, respectively. THEN, perform the test according to the relevant requirements.

11.3.4 Intermediate testing

After the duration of the test is reached, the performance test shall be carried out immediately, in accordance with the relevant standards.

11.3.5 Recovery

After the test is over, turn off the instrument and stop working. The average rate of pressure change of the test box (chamber) is restored to normal pressure, at

no more than 10 kPa/min; the recovery time is 1 h ~ 2 h.

11.3.6 Final testing

Test the instrument according to relevant standards.

11.4 Information to be given by relevant standards

When the relevant standards adopt this method, it shall give the following detailed rules as applicable as possible:

- a) Pretreatment;
- b) Initial testing items and requirements;
- c) The duration of the test;
- d) Intermediate testing items and requirements;
- e) Final testing items and requirements.

12 Sand dust test

12.1 Applicability

This method is suitable for evaluating the applicability of the instrument, for use and storage in a dusty environment.

12.2 Test conditions

12.2.1 La: Test of dust resistance of enclosure

12.2.1.1 Purpose

It is used to test the sealing performance of the instrument's enclosure.

12.2.1.2 Requirements for test box (chamber)

- a) It can provide a non-laminar dust-carrying vertical circulating airflow;
- b) It shall have the function of recycling dust;
- c) It shall have good airtightness;
- d) It shall be able to observe the circulation status of dust, during the test;
- e) The inner wall shall be smooth and anti-static;
- f) The volume of the test box (chamber) shall be more than 3 times the

volume of the instrument.

12.2.1.3 Test dust

Dry talc powder, that can pass through a square-hole sieve, which has an aperture of 75 μm and a wire diameter of 50 μm .

12.2.1.4 Dust concentration

The dust concentration in the test box (chamber) (working chamber and pipe passage) is 2 kg/m^3 .

12.2.1.5 Air velocity

It can ensure that the test dust settles on the test sample evenly and slowly, but the maximum value shall not exceed 2 m/s.

12.2.1.6 Temperature and relative humidity

During the test, the temperature in the test box (chamber) is 15 °C ~ 35 °C; the relative humidity is 45% ~ 75%.

12.2.1.7 Duration

The duration of the test is 8 h.

12.2.2 Lb: Test of free dust fall

12.2.2.1 Purpose

It is used to test the ability of the instrument, in an environment where the dust settles freely AND there is no obvious air flow.

12.2.2.2 Requirements for test box (chamber)

- a) It shall be possible to expose the instrument to dust-filled air, so that the dust can settle freely on the instrument;
- b) It shall have the ability to blow in dust intermittently;
- c) The dust used for testing shall be blown in, at one-fifth of the working height near the top of the test box (chamber);
- d) It shall have good airtightness;
- e) The inner wall shall be smooth and anti-static;
- f) The effective space shall be not less than 8 m^3 ; the ratio of height to side length is 2:5:1.

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