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NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA

ICS 13.220.10

C 84

GB 25972-2010

Gas fire extinguishing systems and components

Issued on: January 10, 2011

Implemented on: June 01, 2011

Issued by: General Administration of Quality Supervision, Inspection and Quarantine;

Standardization Administration of the People's Republic of China.

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Gas fire extinguishing systems and components

1 Scope

This standard specifies the terms and definitions, the method of formulating the model, the requirements, the test method, the inspection rules, the requirements for the preparation of the operating instructions, and the fire extinguishing agent filling requirements of the gas fire extinguishing system and its components.

This standard applies to heptafluoropropane (HFC227ea) fire extinguishing system, trifluoromethane (HFC23) fire extinguishing system, inert gas fire extinguishing system [including: IG01 (argon) fire extinguishing system, IG100 (nitrogen) fire extinguishing system, IG55 (argon, nitrogen) fire extinguishing system, IG541 (argon, nitrogen, and carbon dioxide) fire extinguishing system.

2 Normative references

The provisions in following documents become the provisions of this standard through reference in this standard. For the dated references, the subsequent amendments (excluding corrections) 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 150 Steel pressure vessels

GB 5099 Seamless steel gas cylinder (GB 5099-1994, neq ISO 4705:1983)

GB 5100 Welded steel gas cylinders (GB 5100-1994, neq ISO 4706:1989)

GB/T 8979 Pure nitrogen and high purity nitrogen and ultra-pure nitrogen

GB/T 9969 General principles for preparation of instructions for use of industrial products

GB 18614 Fire extinguishing agent - Heptafluoropropane (HFC227ea)

GB 20128 Inert fire extinguishing agent (GB 20128-2006, ISO 14520:2005, NEQ)

GA 61 General technical specifications of actuating and control devices of fixed extinguishing systems

3 Terms and definitions

The following terms and definitions apply to this standard.

3.1

System working pressure

Pressure at the outlet of the fire extinguishing agent cylinder group container valve.

Note: If the container valve on the fire extinguishing agent cylinder group does not have a decompression function, the working pressure of the system is the working pressure of the cylinder group.

If the container valve on the fire extinguishing agent cylinder group has a decompression function, the working pressure of the system is the pressure at the outlet of the container valve after decompression.

3.2

Filling density

The ratio of the mass of the fire extinguishing agent in the storage container to the volume of the container, in kilograms per cubic meter (kg/m^3).

3.3

Compressed inert gaseous fire extinguishing system

The fire extinguishing system in which the fire extinguishing agent in the extinguishing agent cylinder group is delivered by its own pressure.

3.4

Stored pressure gaseous fire extinguishing system

The fire extinguishing system in which the fire extinguishing agent is pressurized and stored in the cylinder group with inert gas, and the fire extinguishing agent in the cylinder group is delivered by the pressurized gas in the cylinder group when the system operates.

3.5

Storage pressure

For a compressed inert gaseous fire extinguishing system, it refers to the equilibrium pressure in an environment of $+20\text{ }^{\circ}\text{C}$ of the filled fire

other components.

5.1.2.3 All parts of the same system shall be fixed firmly and connected reliably, the parts are installed in the correct position, the overall layout is reasonable, and it is easy to operate, check and maintain.

5.1.2.4 The specifications of the same functional components in the system shall be the same (except for selection valves and nozzles). The volume, filling density or filling pressure of each fire extinguishing agent storage container shall be the same.

5.1.3 Appearance

5.1.3.1 The components of the system shall be free from obvious processing defects or mechanical damage. The external surfaces of the components shall be subject to anti-corrosion treatment. The anti-corrosion coating and plating shall be complete and uniform.

5.1.3.2 The name of the fire extinguishing agent shall be marked on the extinguishing agent storage container, the handwriting shall be clear and legible. The name of the filling gas shall be marked on the driving gas storage container.

5.1.3.3 Each manually operated part of the system shall be marked with text and graphic symbols to indicate the operation method.

5.1.3.4 The system nameplate shall be firmly set on the obvious part of the system, indicating: system name, model specification, implemented standard code, fire extinguishing agent filling total mass, working temperature range, production unit, product number, exit-factory date, etc.

5.1.3.5 The system warning sign shall be firmly set in the obvious part of the system. The content of the warning sign for the inert gas fire extinguishing system is that "The nozzle will emit high-pressure gas when the system is in operation"; for the heptafluoropropane fire extinguishing system and the trifluoromethane extinguishing system, the content of the warning sign is that "The system will decompose and produce a certain amount of hydrogen fluoride gas when it extinguishes fire". The contents of the warning sign shall be clearly readable under the general lighting conditions at a distance of 3 m from the sign.

5.1.4 System quasi-working status

The working positions of the operating parts of the system, the control and monitoring functions of the control panel shall all be in the normal quasi-working state; the leak detection devices of each cylinder group shall be in normal working condition, and the filling mass of the medium in the cylinder group (filling pressure) shall be consistent with the nominal value on the cylinder group.

group shall not be loose, fall off or damaged. After the test, the air tightness of the fire extinguishing agent cylinder group shall comply with the provisions of 5.2.4, the container valve shall be able to open normally in case of automatic and manual startup.

5.2.9 Siphon

For fire extinguishing agent cylinder group with siphons, the siphon shall be made of a metal material that can resist corrosion by the fire extinguishing agent.

5.2.10 Incorrect discharge protection device

The fire extinguishing agent cylinder group shall have a protective device at the container valve outlet for preventing the accidental discharge of the fire extinguishing agent during the transportation, loading and unloading, and storage. The opening on the protective device shall enable the fire extinguishing agent to be uniformly sprayed without generating excessive recoil force. And shall not be charged out.

5.2.11 Gas sampling requirements

Fire extinguishing agent cylinder group (on container or container valve) shall be equipped with fire extinguishing agent sampling port, and the fire extinguishing agent shall be able to be drawn from the cylinder group without opening the container valve or fully opening the container valve (it can still be closed after the sampling of fire extinguishing agent).

5.2.12 Fire extinguishing agent release time

At the maximum filling density or filling pressure of the fire extinguishing agent cylinder group, the discharge time of the fire extinguishing agent from the container valve shall be not more than 80% of the system discharge time as specified in 5.1.1.3.

5.2.13 Fire extinguishing agents and pressurized gas requirements

Heptafluoropropane fire extinguishing agent shall meet the requirements of GB 18614.

The inert gas extinguishing agent shall meet the requirements of GB 20128.

Other fire extinguishing agents shall be products announced by the public security department of the State Council.

The pressurized gas shall be pure nitrogen and shall meet the requirements of GB/T 8979.

5.2.14 Signs

5.5.10.1 Salt spray corrosion resistance

The salt spray corrosion test shall be carried out in accordance with the method specified in 6.9, the container valve and its accessories shall not have obvious corrosion damage. After the test, the sealing performance of the container valve shall comply with the provisions of 5.5.5. When the working reliability is tested in accordance with the provisions of 6.6.1, it shall be able to open accurately and reliably.

5.5.10.2 Stress corrosion resistance

The stress corrosion test shall be carried out in accordance with the method specified in 6.11. The container valve and its accessories shall not be cracked or damaged. The strength of the container valve after the test shall comply with the provisions of 5.5.4.

5.5.10.3 Sulfur dioxide corrosion resistance

Sulfur dioxide corrosion test shall be carried out in accordance with the method specified in 6.10. The container valve and its accessories shall not have obvious corrosion damage. After the test, the container valve sealing performance shall comply with the provisions of 5.5.5. When the working reliability is tested in accordance with the provisions of 6.6.1, it shall be able to open accurately and reliably.

5.5.11 Manual operation requirements

The container valve shall have a mechanical emergency startup function. Perform an emergency manual startup operation test in accordance with the method specified in 6.16. The following requirements shall be met:

- a) The manual operating force shall not exceed 150 N;
- b) The finger pulling operation force shall not exceed 50 N;
- c) The finger pushing operation force shall not exceed 10 N;
- d) All manual operation displacement shall not exceed 300 mm;
- e) The operating torque for rotary opening the container valve shall not exceed $10 \text{ N} \cdot \text{m}$ and the rotation angle shall not exceed 27° .

5.5.12 Structural requirements

A one-way needle valve should be installed at the pressure monitor mounting port for the container valve which is equipped with the pressure display.

5.6 Nozzle

The test pressure is the maximum working pressure of the system and the pressure holding time is 5 mm.

5.7.6 Working reliability requirements

The working reliability test is carried out in accordance with the method specified in 6.6.1. The selection valve and its auxiliary control drive shall be flexible and reliable, and shall not cause any failure or structural damage (except for parts that are allowed to be damaged during normal operation).

5.7.7 Local resistance loss

The local resistance loss of the selection valve of the heptafluoropropane fire extinguishing system and the trifluoromethane fire extinguishing system is expressed by the equivalent length of the connected pipeline. The difference between the equivalent length of the selection valve measured by the test method specified in 6.8.1 and the published value in the manufacturer's instructions shall not exceed 10% of the published value in the operating instructions.

The local resistance loss of the inert gas fire extinguishing system is represented by the pressure loss curve. The difference between the pressure loss curve measured by the test method specified in 6.8.2 and the published value in the production unit's instruction manual shall not exceed 10% of the published value in the instruction manual.

5.7.8 Corrosion resistance

5.7.8.1 Salt spray corrosion resistance

The salt spray corrosion test shall be carried out in accordance with the method specified in 6.9. The selection valve and its accessories shall not have obvious corrosion damage. After the test, the sealing performance of the selection valve shall comply with the provisions of 5.7.5. When the working reliability is tested in accordance with the provisions of 6.6.1, it shall be able to open accurately and reliably.

5.7.8.2 Stress corrosion resistance

The stress corrosion test is performed in accordance with the method specified in 6.11. The valve and its accessories shall not be cracked or damaged. The strength of the selection valve after the test shall comply with the provisions of 5.7.4.

5.7.8.3 Resistance to sulfur dioxide corrosion

The sulfur dioxide corrosion test shall be carried out in accordance with the method specified in 6.10. The selection valve and its accessories shall not have

group and the pressure holding time is 5 minutes.

The one-way valves have the same forward and reverse strength requirements.

5.8.5 Forward sealing requirements

The airtightness test shall be carried out in accordance with the method specified in 6.4.3. The one-way valve shall be free from air leakage. The test pressure is the maximum working pressure of the cylinder group and the pressure holding time is 5 min.

5.8.6 Backward sealing requirements

The one-way valve used on the flow channel of the fire extinguishing agent shall be tested for backward airtightness in accordance with the method specified in 6.4.3. The bubble leakage shall not exceed 20 bubbles per minute at the maximum working pressure of the cylinder group.

The one-way valve which is used along the driving gas control pipeline shall not produce air bubble leakage under the maximum working pressure.

5.8.7 Working reliability requirements

The working reliability test shall be carried out in accordance with the method specified in 6.6.2. The one-way valve shall be able to withstand 100 times "open-close" action tests. The opening and closing actions shall be flexible and accurate and shall not cause any failure or structural damage.

5.8.8 Opening pressure requirements

The test is carried out in accordance with the method specified in 6.22, the opening pressure of the one-way valve shall not exceed the published value of the production unit's instruction manual.

5.8.9 Local resistance loss

The local resistance loss of the one-way valve of the heptafluoropropane fire extinguishing system and the trifluoromethane fire extinguishing system is expressed in terms of the equivalent length of the connected pipeline. The difference between the equivalent length of the one-way valve measured by the test method specified in 6.8.1 and the published value in the manufacturer's instruction manual shall not exceed 10% of the published value in the instruction manual.

The local resistance loss of the one-way valve of the inert gas fire extinguishing system is represented by the pressure loss curve. The difference between the pressure loss curve measured by the test method specified in 6.8.2 and the published value in the manufacturer's instruction manual shall not exceed 10%

The stress corrosion test shall be carried out in accordance with the method specified in 6.11. The safety venting device shall not be cracked or damaged. The discharge pressure range of the safety venting device after the test shall comply with the provisions of 5.11.1.

5.11.2.3 Resistance to sulfur dioxide corrosion

Sulfur dioxide corrosion test shall be carried out in accordance with the method specified in 6.10. The safety venting device shall not have obvious corrosion damage. The discharge pressure range of the safety venting device after the test shall comply with the provisions of 5.11.1.

5.11.3 Temperature cycling resistance

After the temperature cycling test in accordance with the method specified in 6.13, the discharge pressure range of the safety venting device installed on the cylinder group shall comply with the provisions of 5.11.1.

5.12 Drive device

The performance of the drive system of the system shall comply with the provisions of GA 61, where the working temperature range shall comply with the requirements of 5.1.1.1.

5.13 Control panel

5.13.1 Power requirements

The power supply shall meet the following requirements:

- a) When the AC supply voltage varies within the range of 187 V ~ 242 V and the frequency is 50 Hz $\pm$ 1 Hz, the control panel shall be able to work reliably;
- b) The standby power supply capacity of the control panel shall be capable of continuous operation for 24 h under normal monitoring conditions, during which the system shall be reliably started;
- c) Main and standby power supply shall have working instructions.

5.13.2 Alarm function

The control panel shall be able to receive the fire alarm signal from the fire detector and the fire alarm triggering device, and emit an audible and visual alarm signal. At rated working voltage, at 1 m away from the control panel, the sound pressure levels (A weighting) of the internal and external audio components shall be 65 dB (A) and 85 dB (A) above and 115 dB (A) below, respectively.

units or trademarks, product name models, product numbers, date of exit-factory, etc.

5.14 Leak detection device

5.14.1 Weighing device

5.14.1.1 Alarm function

The weighing device installed in the fire extinguishing system shall have an upper leakage alarm function. When the leakage of the filled media in the cylinder group reaches 5% of the filling mass, it shall be able to be reliably alarmed. The light alarm signal shall be yellow, in the general lighting conditions, it shall be clearly visible from a distance of 3 m; the sound pressure level (A weighting) of sound alarm signal at rated voltage at a distance of 1 m shall not be less than 65 dB (A).

5.14.1.2 High and low temperature resistance

After the weighing device is placed in the maximum working temperature and minimum working temperature environment specified in 5.1.1.1 for 8 h, its alarm function shall meet the requirements of 5.14.1.1.

5.14.1.3 Overload requirements

The weighing device is subjected to a static load of 2 times the mass of the cylinder group (calculated in accordance with the maximum filling density of the medium in the cylinder group) and maintained at 15 min, and shall not be damaged. The alarm function after the test shall comply with the provisions of 5.14.1.1.

5.14.1.4 Corrosion resistance

5.14.1.4.1 Salt spray corrosion resistance

The salt spray corrosion test shall be carried out in accordance with the method specified in 6.9. The weighing device shall not have obvious corrosion damage. The alarm function after the test shall comply with the provisions of 5.14.1.1.

5.14.1.4.2 Resistance to sulfur dioxide corrosion

Sulfur dioxide corrosion test shall be carried out in accordance with the method specified in 6.10. The weighing device shall not have obvious corrosion damage. The alarm function after the test shall meet the requirements of 5.14.1.1

5.14.1.5 Signs

The obvious part of the device is marked with: production unit or trademark,

the provisions of 5.14.3.1.

5.14.3.4 Signs

The obvious part of the device shall be marked with: production unit or trademark, product model specifications, measurement range, etc.

5.15 Signal feedback device

5.15.1 Working pressure

The working pressure of the signal feedback device shall not be less than the maximum working pressure of the system.

5.15.2 Action pressure

The action pressure setting of the signal feedback device shall not exceed 0.5 times the minimum working pressure of the system. When the signal feedback device is installed behind the decompression device, its action pressure setting value shall not exceed 50% of the pressure behind the decompression device. The action pressure deviation of the signal feedback device shall not exceed 10% of the set value.

The signal feedback device shall have a self-locking function that can only be manually reset after the action.

5.15.3 Working reliability requirements

It is tested in accordance with the method specified in 6.36, the signal feedback device shall be operated 100 times reliably under the pressure greater than or equal to the action pressure without any failure and structural damage. The contact resistance of the signal feedback device contact after the test shall meet the requirements of 5.15.9.

5.15.4 Strength requirements

Perform the hydraulic strength test in accordance with the method specified in 6.3. The signal feedback device shall not be damaged.

The test pressure is 1.5 times the maximum working pressure of the system and the pressure holding time is 5 min.

5.15.5 Sealing requirements

The airtightness test shall be carried out in accordance with the method specified in 6.4.2. The signal feedback device shall not have air bubble leakage.

The test pressure is the maximum working pressure of the system, and the pressure is maintained for 5 minutes.

5.16 1 Decompression device

5.16.1 Working pressure

The working pressure of the inert gas extinguishing system decompression device shall comply with the provisions of 5.1.1.2.

5.16.2 Strength requirements

The hydraulic strength test shall be carried out in accordance with the method specified in 6.3. The pressure relief device shall not leak, deform or be damaged.

The test pressure is 1.5 times the maximum working pressure of the system and the pressure holding time is 5 minutes.

5.16.3 Sealing requirements

The airtightness test shall be carried out in accordance with the method specified in 6.4.5. The pressure relief device shall be free of air bubbles.

The test pressure is the maximum working pressure of the system and the pressure holding time is 5 min.

5.16.4 Decompression characteristics

In accordance with the test method specified in 6.38, the difference between the decompression characteristics of the decompression device measured at the specified flow rate and the published values in the operating instructions of the production unit shall be no more than 10% of the value declared in the operating instruction.

5.16.5 Signs

The obvious parts of the decompression device shall be marked with: production unit or trademark, model specification, medium flow direction, etc.

5.17 Low venting high close valve

5.17.1 Setting requirements

The low venting high close valve shall be installed on the header pipe of the combined distribution system.

Low venting high close valve shall be installed on the driving gas control pipeline.

5.17.2 Materials

The low venting high close valve and its internal mechanical parts shall be made

a) Ambient temperature: + 15 °C ~ + 35 °C;

b) Relative humidity: 45 % ~ 75 %;

c) Atmospheric pressure: 86 kPa ~ 106 kPa.

6.2 Appearance, material inspection

6.2.1 With reference to the design drawings and related technical documentation, visually check or using a general-purpose instrument to check the sample structure, size, extinguishing agent and pressurized gas, the volume and diameter of the storage container, and the material of the part to see if they are in accordance with the provisions of Clause 5.

6.2.2 Use visual inspection to check the contents of component signs, fixing methods, and cylinder group composition.

6.2.3 Check the consistency of the sample process, visually inspect whether there are processing defects, surface coating defects, mechanical damage and other defects, whether it meets the provisions of the corresponding provisions and design requirements.

6.3 Hydraulic strength test

6.3.1 The hydraulic source for the hydraulic strength test device shall have a voltage regulator function to eliminate pressure pulses. The accuracy of the pressure measuring instrument shall not be lower than class 1.6. The rate of pressure increase of the test device shall be adjustable within the range of service pressure.

The hydraulic strength test of pressure display can also be performed on a piston pressure tester.

6.3.2 Connect the inlet of the sample to be tested to the hydraulic strength tester, remove the air from the connection pipeline and the sample cavity, close all the outlets of the sample. Slowly pressurize to the test pressure at a rate of no more than 0.5 MPa/s. Relieve the pressure after holding for 5 min. Examine the sample and record the test results.

The pressurizing rate of connection pipeline strength test is not less than 0.5 MPa/s.

6.4 Airtightness test

6.4.1 Test requirements

The air pressure sealing test device uses nitrogen or compressed air, the accuracy of the pressure measuring instrument is not less than level 1.6. The

and the sample cavity, close all the outlets of the sample. The pressure is gradually increased to the test pressure at a pressure increase rate of not more than 0.5 MPa/s. After 5 minutes, the pressure is released. The samples are examined and the test results are recorded.

6.6 Working reliability test

6.6.1 Working reliability test of container valve and selection valve

6.6.1.1 The working reliability test of the container valve and selection valve is performed on a special test device. Compressed air or nitrogen is used as the gas source; the volume of the special test container and the working state of the driver shall meet the requirement that the tested valve is fully opened after starting, and the outlet of the tested valve shall be connected to the straight pipe with the same nominal diameter as the outlet and not exceeding 0.5 m in length, as well as a nozzle with an equivalent bore diameter of not less than 3 mm.

6.6.1.2 Install the tested valve on the special test container, connect the control drive components, make it work under the specified conditions. Follow the following procedures:

- a) Pressurize the inlet end of the tested valve to the cylinder storage pressure p , for the gas fire extinguishing system selection valve whose container valve itself is equipped with the decompression device, the value p is the pressure at the outlet side of the container valve, the pressure holding time is not less than 5 s;
- b) Start the control drive component to open the tested valve (the drive force applied by the drive component to the tested valve shall be the drive force of the drive component at the corresponding temperature);
- c) When the pressure in the special test container drops below 0.5 MPa, close the tested valve;
- d) Pressurize the test valve again and continue the next cycle.

Parts that are subject to damage during normal operation of the tested valve are replaced after each cycle of testing.

6.6.1.3 At room temperature ($+20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$), the above cyclic test is repeated 100 times. The test device and the sample are transferred into the temperature test chamber, the test is performed 10 times at the lowest and highest working temperatures. Before the test, the sample is left in the test environment for a period of not less than 2 h for the first test. The rest of the test shall allow the temperature of the sample to fully balance with the temperature in the test chamber.

suspended in the middle of the working space of the test chamber in accordance with its normal use position. The temperature of the working space is controlled at $+35\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$. Drops of solution from the tested sample cannot be recycled. Salt mists shall be collected in the working space from at least two areas to adjust the spray rate during the test and the concentration of the test salt solution. Collection is made continuously for 16 h from every 80 cm^2 collection area, 1.0 mL ~ 2.0 mL of saline solution shall be collected every hour. The concentration shall be 19% ~ 21% (mass fraction).

The test period is 10 days and ensure continuous spray. After the end of the test, the sample is rinsed with clean water and allowed to dry naturally for 7 days at a temperature of $+20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ and a relative humidity of less than 70%. The corrosion of the sample is checked and recorded.

6.10 Sulfur dioxide corrosion test

The test is conducted in a chemical gas corrosion test device. In the working chamber, 1% sulfur dioxide gas is added every 24 h in accordance with the volume fraction. Inject enough distilled water into the bottom flatware at the bottom of the working chamber to volatilize naturally to form a humid environment. The temperature in the working chamber is maintained at $+45\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

After the sample is removed of oil stain, suspend it in the middle of the working chamber at the normal position of use. Drops of condensed liquid at the top of the working chamber shall not drip on the sample.

The test period is 16 days, when the test is performed for 8 days, take out the sample, use clean water to rinse it, place it back into the working chamber again, continue test for another 8 days. At the end of the test, place the sample in a temperature of $+20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ and a relative humidity of not more than 70% to dry it for 7 d, check the corrosion conditions of the sample and make records.

The sulfur dioxide gas used in the test can also be produced daily in the working chamber by reacting $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ solution with diluted sulfuric acid.

6.11 Stress corrosion test

6.11.1 Selection of stress corrosion test methods

The components using the copper alloy which contains more than 15% zinc as materials are subject to the stress corrosion test as specified in 6.11.2.

The components using the austenitic stainless steel as materials are subject to the magnesium chloride stress corrosion test specified in 6.11.3.

6.11.2 Ammonia stress corrosion test

The minimum scale of weighing equipment shall not be greater than 2/10000.

When using pressure loss as a judgment, the precision pressure measuring instrument for inspection shall be installed (or replaced) on the sample. The sample to be tested is placed in a constant temperature chamber, the temperature is controlled at $+25\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$. After 24 hours, the pressure value of the cylinder group to be tested is read. For the sample judged by the mass loss, record only the weighing value, and there is no constant temperature requirement.

The test is carried out on a vibratory bench with an amplitude of 0.8 mm and a frequency of 20 Hz. The sample is vibrated for 2 h along three mutually perpendicular axis X, Y and Z, respectively.

After the vibration test, the pressure values of the cylinder group are read. The requirements for weighing are the same as those before the vibration. The cylinder group is started automatically and the cylinder group is weighed to calculate the filling amount of the fire extinguishing agent.

6.12.2 Control panel vibration test

The test is carried out on a vibratory bench. The sample is fixed on the bench in accordance with the working position and tested in accordance with the following procedure:

- a) In a frequency range of 5 Hz ~ 60 Hz ~ 5 Hz, perform a frequency sweep cycle at a rate of 1 octave per minute and an amplitude of 0.19 mm, observe and record the found resonance frequency;
- b) When no resonance frequency is found, perform the fixed-frequency vibration test with an amplitude of 0.19 mm and a duration of $10\text{ min} \pm 0.5\text{ min}$ at a frequency of 60 Hz;
- c) When the resonance frequency is found to be no more than four, at each resonance frequency, perform the fixed frequency vibration test with an amplitude of 0.19 mm and the duration of $10\text{ min} \pm 0.5\text{ min}$;
- d) When the resonant frequency is found to exceed four, perform two frequency sweep cycles with an amplitude of 0.19 mm in the frequency range of 5 Hz ~ 60 Hz ~ 5 Hz at a rate of 1 octave per minute.

The above tests are performed sequentially on the three axis X, Y, and Z of the sample.

6.13 Temperature cycling leakage test

The test is conducted in a temperature chamber. The requirements for reading and weighing the pressure of the cylinder group before the test are the same

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