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Replacing GB 6220-1986, GB 6221-1986

**Respiratory Protection -
Long Tube Breathing Apparatus**

呼吸防护 长管呼吸器

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Foreword

The Sub-clauses 5.2, 5.3, 5.4, and 7.2 in this Standard are mandatory, while the rest are recommended.

This Standard replaced GB 6220-1986 *Long Tube Respirators*; and GB 6221-1986 *Performance Test Methods of Long Tube Respirators*.

Compared with GB 6220-1986 *Long Tube Respirators*; and GB 6221-1986 *Performance Test Methods of Long Tube Respirators*, this Standard made the major changes as follows:

- Add the low flowrate warning requirements for the high-pressure air mask;
- Add the strength requirements for the structure and parts;
- Add the technical requirements and test methods of the high-pressure portion, warning device, pressure display device for the air-supply mask of the high-pressure cylinder, as well as the gas cylinder;
- Modify the technical requirements of the mask lens;
- Modify the test methods of breathing resistance;
- Add the test requirements for air-supply valve at different openings;
- Add the high and low temperature adaptability requirements and the test methods;
- Add the marking requirements.

This Standard was proposed by State Administration of Work Safety.

This Standard shall be under the jurisdiction of National Technical Committee on Personal Protective Equipment of Standardization Administration of China (SAC/TC 112).

Drafting organization of this Standard: Beijing Municipal Institute of Labor Protection.

Participating drafting organizations of this Standard: Institute of Chemical Defense; and MSA (China) Safety Equipment Co., Ltd.

Chief drafting staffs of this Standard: Yang Wenfen, Ding Songtao, Xiao Yiqing, Yao Haifeng, Chen Zhuowei, Zang Lanlan, Zhou Yunyun, and Luo Mufu.

The historical editions replaced by this Standard are as follows:

--- GB 6220-1986;

--- GB 6221-1986.

Respiratory Protection - Long Tube Breathing Apparatus

1 Scope

This Standard specifies the product classification and composition, technical requirements, test methods and marking of long tube breathing apparatus.

The products specified in this Standard are not suitable for fire-fighting and rescue sites.

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/T 1226 General Pressure Gauge

GB 2890-2009 Respiratory Protection - Non-Powered Air-Purifying Respirators

GB 5099 Seamless Steel Gas Cylinders

GB/T 16556-2007 Self-Contained Open-Circuit Compressed Air Breathing Apparatus

DOT-CFFC Basic Requirements for Fully Wrapped Carbon-Fiber Reinforced Aluminum Lined Cylinders

3 Terms and Definitions

For the purposes of this Document, the following terms and definitions apply.

3.1 Long tube breathing apparatus

The protective article that protects the wearer's respiratory organs from the surrounding air and transports clean air for breathing through long tubes.

NOTE: Long tube breathing apparatus is divided into: self-inhalation long tube breathing apparatus, powered long tube breathing apparatus, and long tube breathing apparatus with high pressure.

3.1.1 Self-inhalation long tube breathing apparatus

The long tube breathing apparatus that allows the wearer to breathe spontaneously to get fresh, clean air.

3.1.2 Powered long tube breathing apparatus

The long tube breathing apparatus that uses a fan or air compressor to deliver fresh, clean air to the wearer.

3.1.3 Long tube breathing apparatus with high pressure

The long tube breathing apparatus that uses compressed air or high-pressure gas cylinders to deliver clean air to the wearer.

NOTE 1: Also known as pressure demand long tube breathing apparatus.

NOTE 2: The long tube is a pressure-bearing component during gas transmission.

3.2 Breathing tube

The flexible and air-tight tube for connecting masks with long tube.

3.3 Straps

A ring or sleeve to secure a long tube to the waist of the wearer.

NOTE: The straps include a belt and a hanging ring.

3.4 Long tube

Air-tight, flexible and long breathing tube for conveying clean air.

3.5 Tight-fitting face masks

A mask that can cover the nose, mouth, and face, or a mask that can cover the eyes, nose, and mouth, and close to the head and face.

NOTE 1: The tight-fitting face mask is used to ensure the isolation of the working environment by the tight-fitting frame.

NOTE 2: Tight-fitting face mask are divided into full mask and half mask.

3.5.1 Full mask

A tight-fitting face mask that is tight-fitting the head, and covers the eyes, face, nose, mouth, and jaw.

3.5.2 Half mask

A tight-fitting face mask that is tight-fitting the head, and covers the mouth and nose, or covers the mouth, nose, and jaw.

3.6 Loose-fitting facepiece

The air introduction device for positive pressure breathing protection equipment covers only the eyes, nose and mouth, and tight-fitting the face.

3.7 Continuous flow valve

In an air-supply long tube breathing apparatus, a device that allows the wearer to adjust the amount of inspiratory air.

3.8 Low-resistance filters

In the self-inhalation long tube breathing apparatus, a large-pore filter device is installed at the inlet end of the long tube to prevent foreign matter from entering.

NOTE: This filter can prevent foreign matter above 0.15mm from passing through.

3.9 Demand valve

Air-supply valve

The valve controlled by the breathing action of the lungs, it opens when needed and supplies a breathable gas.

3.10 Warning device

A device that warns the wearer that respiratory protection is about to or has lost effective protection.

3.11 Static pressure

After the positive pressure device of the air supply valve is opened, the pressure in the mask cavity when the airway of the respirator is balanced.

3.12 High pressure

The absolute pressure with air pressure greater than or equal to 10 MPa.

3.13 Medium pressure

Pressures between 6kPa and 1MPa.

3.14 Low pressure

Pressures above atmospheric pressure and not exceeding 6kPa.

3.15 Dead space

The volume of gas re-inhaled from the previous exhalation.

NOTE: It is expressed by the volume fraction of carbon dioxide in the inhaled air.

4 Product Classification and Composition

The classification, composition, working environment, air supply source and pressure-bearing capacity of typical long tube breathing apparatus are shown in Table 1.

Table 1 -- Classification and Composition of Long Tube Breathing Apparatus

Type of long tube breathing apparatus	Major component and order of system composition					Air-supply source
Self-inhalation long tube breathing apparatus	Tight-fitting face mask ^a	Breathing tube ^a	Low pressure long tube ^a	Low-resistance filters ^a		Air ^a
Powered long tube breathing apparatus		Breathing tube ^a + continuous flow valve ^a	Low pressure long tube ^a	Filter ^a	Fan ^a Air compressor ^a	Air ^a
Long tube breathing apparatus with high pressure	Mask ^a	Breathing tube ^a + air-supply valve ^b	Medium pressure long tube ^b	High pressure reducer ^c	Filter ^c	High pressure air source ^c
Located environment	On-site working environment			Guaranteed working environment		
^a Bear the low-pressure components;						
^b Bear the medium-pressure components;						
^c Bear the high-pressure components.						

5 Technical Requirements

5.1 General requirements

5.1.1 Materials

5.1.1.1 Materials that are in direct contact with the head and face shall be harmless or non-allergenic, and the surface of metal parts shall be anti-corrosive.

5.1.1.2 The material shall have sufficient strength and elasticity, and shall not be damaged or deformed during normal service life.

5.1.1.3 The parts that may enter the work site shall be able to withstand the cleaning or disinfection treatment recommended by the manufacturer.

5.1.1.4 Long tubes shall be airtight and resistant to the penetration of external liquids.

5.1.2 Structure

5.1.2.1 Components shall not be prone to structural damage; and their design, composition and installation shall not cause any danger to users.

5.1.2.2 The headband shall be adjustable; and shall firmly fix the mask on the face; and there shall be no obvious compression or tenderness when worn.

5.1.2.3 The mask shall have a wide field of vision, and there shall be no distortion of the vision. The lens shall not be affected by fogging and other conditions that affect vision.

5.1.2.4 The breathing tube and air-supply mask shall not restrict the user's head movement or motion.

5.1.2.5 When the fan air-supply device stops working, it shall be able to switch to the backup air-supply device or change to the self-inhalation working mode and warn the guardian.

5.1.2.6 The length of the long tube shall be no greater than 80m.

NOTE: Long tube breathing apparatus longer than 80m shall be additionally tested in accordance with the manufacturer's instructions to ensure safe and comfortable use.

5.1.2.7 During normal operation, the breathing apparatus shall be designed so that each long tube can only supply one mask. Under special circumstances, each long tube can only supply a maximum of two masks.

5.1.2.8 Self-inhalation long tube breathing apparatus shall be provided with low-resistance filters to prevent foreign matter from entering.

5.1.2.9 Connections with different pressure ranges shall not be interchanged.

5.1.2.10 It is not allowed to design and install the air filter on the waist or mask.

5.1.3 Overall performance

5.1.3.1 The design of the mask shall avoid any tension or discomfort caused to the wearer by improper air velocity or distribution.

5.1.3.2 When the wearer is in a crouching position or working in a space-constrained environment, the long tube shall not hinder its movement.

5.1.3.3 In workplaces where a helmet is required, a long tube respirator mask shall not prevent the helmet from being worn.

5.1.3.4 The straps shall be able to fix the breathing tube or medium pressure tube behind or on the side of the wearer without affecting the operation. The width of the strap shall be no less than 40mm.

5.1.3.5 The parts of the breathing apparatus that need to be operated by the wearer shall be within reach and can be identified by touch. All adjustable parts shall not be accidentally changed during use.

5.1.3.6 Long tube shall be tested according to 6.2 and the tensile strength shall be greater than 1000N.

5.2 Performance requirements of low-pressure components

5.2.1 Test according to 6.3. When the continuous flow valve used for the tight-fitting face mask is on the minimum opening, the ventilation flow rate shall be greater than 30 L/min. When the continuous flow valve used for the loose-fitting facepiece is on the minimum opening, the ventilation flow rate shall be greater than 115 L/min.

NOTE: Bypass is allowed to ensure minimum flow. When bypass is used to ensure the flow, the continuous flow valve is allowed to close.

5.2.2 The leakage rate of tight-fitting face mask shall meet the requirements of 5.1.6 in GB 2890-2009.

5.2.3 Test according to 6.4. The respiratory resistance of the mask shall meet the requirements in Table 2.

Table 2 -- Respiratory Resistance Requirements

Test item	Air-supply mode		
	Self-inhalation	Continuous air-supply	Air-supply by high-pressure
Inhalation resistance/Pa	Inside pressure of the mask > -300	Inside pressure of the mask > -100	Inside pressure of the mask > 0
Exhalation resistance/Pa	<1000		

5.2.4 Test according to 6.5. The static pressure in the cavity of the mask shall be no greater than 500Pa.

5.2.5 The air tightness of the exhalation valve shall meet the requirements of relevant clauses of the mask exhalation valve in GB 2890-2009.

5.2.6 Test according to 6.6. The continuous operation performance of the blower shall be able to work normally without abnormal phenomena.

5.2.7 Test high and low temperature adaptability according to 6.7:

- a) It shall be free of stiffness, cracks, detached parts, and stickiness;
- b) The leakage rate shall meet the requirements of 5.2.2;
- c) Respiratory resistance shall meet the requirements of 5.2.3.

5.2.8 Test the air supply volume of the fan according to 6.8. The air volume at the inlet of the long tube shall be greater than 100 L/min; and the air pressure shall be greater than 1300Pa.

5.2.9 Test the minimum air supply volume according to 6.9. The minimum air supply volume at the inlet of the mask shall be greater than 30 L/min.

5.2.10 Test the strength of the straps according to 6.10. The straps shall be able to withstand 1000N tension without damage.

5.2.11 The dead space of the mask shall meet the requirements of 5.1.6 in GB 2890-2009.

5.2.12 The field of view of the mask shall meet the requirements of 5.1.7 in GB 2890-2009.

5.2.13 The observation window of the mask shall meet the requirements of 5.1.9 in GB 2890-2009.

5.2.14 The strength of the headband shall meet the requirements of 5.1.11 in GB 2890-2009.

5.2.15 Test the connection strength according to 6.12 in GB 2890-2009. All connection points shall not slip, break or plastically deform when they are subjected to an axial tensile force of 250N for 10s.

5.2.16 For the powered long tube breathing apparatus, the continuous flow valve shall meet the requirements of 5.2.3 at the maximum and minimum openings.

5.3 Performance requirements of medium-pressure components

Test according to 6.11. The pipeline (including connection parts) connected to the air supply valve shall be able to withstand 2 times the working pressure of the pressure reducer relief valve or at least 3MPa; take whichever is higher as the test pressure, keep it for 15min.

5.4 Performance requirements for high-pressure components

5.4.1 High-pressure tube joints shall not exceed 3 places.

5.4.2 The long tube breathing apparatus with high pressure shall be provided with a low-flow warning device. When the gas flow at the outlet of the long tube is lower than the set flow, a signal for help is sent to the monitor.

5.4.3 The anti-particle performance of the long tube breathing apparatus with high pressure shall meet the requirements of 5.12 in GB/T 16556-2007.

5.4.4 The air-tightness of the long tube breathing apparatus with high pressure shall meet the requirements of 5.23 in GB/T 16556-2007.

5.4.5 Test the pressure resistance of high-pressure parts according to 6.11. Metal parts that withstand high pressures bear at least 1.5 times the working pressure of gas cylinders, and non-metal parts that withstand high pressures bear at least twice the working pressure of gas cylinders.

5.4.6 Steel cylinders shall comply with the provisions of GB 5099; and composite cylinders shall comply with the provisions of DOT-CFFC.

5.4.7 Test the gas delivery reliability of breathing tube and long tube according to 6.12. There shall be no restriction or obstruction of air flow. The reduction in gas flow shall not exceed 10% of the specified test air flow. After 10 min of the test, there shall be no observable distortion.

5.4.8 The gas cylinder valve shall meet the requirements of 5.15 in GB/T 16556-2007.

5.4.9 The pressure reducer shall meet the following requirements:

5.4.9.1 When a long tube breathing apparatus is provided with a pressure reducer, any adjustable part of the medium pressure section shall be firmly locked and appropriate sealing measures shall be taken to enable illegal adjustment to be observed.

5.4.9.2 When a downstream component of a long tube breathing apparatus cannot withstand the full pressure in the cylinder, a pressure relief valve shall be set.

5.4.9.3 For a long tube breathing apparatus with a pressure-reducer pressure relief valve, the pressure-reducer pressure relief valve shall be capable of passing a flow of 400 L/min at a pressure not exceeding 3MPa; after such valve is activated, the inhalation resistance and exhalation resistance shall be no greater than 2.5kPa.

5.4.10 A long tube breathing apparatus with high pressure shall be installed with a pressure gauge that complies with the provisions of GB/T 1226. The pressure gauge and its connecting tube shall meet the following requirements:

- a) The shell shall be equipped with a rubber protective sleeve. When the gas cylinder valve is opened, the pressure gauge should be able to read the pressure in the gas cylinder so that the single cylinder pressure or the equilibrium pressure can be measured separately;
- b) The position of the pressure gauge shall be easy to read the pressure value;
- c) The minimum value of the pressure gauge range is 0, the highest value shall be at least 5 MPa higher than the rated working pressure of the cylinder; the accuracy shall be less than Level-2.5; and the minimum division value shall be no greater than 1MPa;
- d) The pressure value on the pressure gauge shall be clearly readable in poor lighting conditions;
- e) Test according to 6.13. When the pressure gauge and connecting tube are removed from the long tube breathing apparatus, the leakage air flow under the pressure of 20MPa shall be no greater than 25 L/min.

5.4.11 The warning device shall meet the following requirements:

- a) In any case, the information provided by the warning device and pressure gauge (see 5.4.10) shall be complementary.
- b) Long tube breathing apparatus shall be provided with appropriate warning device, which shall alert the monitor when the cylinder pressure drops to a predetermined value.
- c) The warning device shall be activated automatically when the cylinder valve is opened.
- d) When the pressure in the cylinder drops to (5.5 ± 0.5) MPa, or when the remaining gas in the cylinder is at least 200L, the warning device should activate the alarm.
- e) After the warning device is activated, a continuous audible alarm or an intermittent audible alarm shall be issued. The sound intensity shall be no less than 90 dB (A), and the sound frequency range shall be between 2000 Hz and 4000 Hz. The duration of the continuous audible alarm shall be no less than 15s; the intermittent audible alarm response shall be no less than 60s. After that, the warning device shall continue to alarm until the cylinder pressure drops to 1 MPa.
- f) After the warning device is activated, the wearer shall be able to continue using the long tube breathing apparatus normally.
- g) Test according to 6.14. From the start of the pneumatic alarm to the pressure of

the cylinder dropping to 1MPa, the average gas consumption of the warning device shall be no greater than 5 L/min.

6 Test Methods

6.1 General of test conditions

6.1.1 The laboratory environment required in this Clause is: temperature $(20 \pm 2) ^\circ\text{C}$, humidity 30% ~ 70%.

6.1.2 The test head mold shall meet the requirements of 6.9.2.3 in GB 2890-2009.

6.1.3 The accuracy and precision requirements of the measuring instruments used in this Clause are as follows:

- a) Gas flowmeter: accuracy of Class-2.5, accurate to 0.2 L/min;
- b) Gasometer: accuracy of Class-2.5, accurate to 0.2L;
- c) Gas pressure gauge: accuracy of Class-1, accurate to 0.1 MPa or 1 Pa;
- d) thermometer: accuracy of Class-1, accurate to 0.1°C ;
- e) Timer: accuracy of Class-1, accurate to 0.1s.

6.2 Tensile strength of long tube

Take a long tube of appropriate length; one end is tied (bundled) with a 1000N weight, the other end is tied (bundled) on a loading fixture; and loaded at a speed of (100 ± 5) mm/min. When the weight is lifted, the long tube is considered to pass the test without failure or break.

6.3 Minimum flow test of continuous flow valve

Use a fan passing the test of 6.6 to supply air to the long tube. Connect the flow meter at the outlet of the continuous flow valve; adjust the continuous flow valve to the minimum; and take the reading of flow meter.

6.4 Respiratory resistance

6.4.1 Test equipment

- a) Artificial lung: breathing frequency 20 times/min; respiratory flow (40 ± 1) L/min; sine wave airflow;
- b) Pressure measuring device: dynamic pressure measuring device; record the

curve; read the maximum and minimum values.

6.4.2 Test procedure

Wear the mask on the test head mold; and adjust the rest to the working state. The breathing interface is connected to the artificial lung. The artificial lung is started. Measure the pressure within the mask, which is the respiratory resistance.

NOTE 1: The high-pressure system shall be tested from the highest working pressure to 1MPa.

NOTE 2: For systems with continuous flow valves, the maximum and minimum opening conditions shall be tested separately.

6.5 Static pressure test

6.5.1 Powered long tube breathing apparatus

Wear the mask and the breathing tube on the test head mold; and use the fan or the air compressor equipped to the product, which are tested according to 6.6 to supply air to the long tube; adjust the continuous flow valve to the maximum opening; and use a pressure gauge to measure the pressure inside the mask under stable air flow; whichever is greater.

6.5.2 Long tube breathing apparatus with high pressure

Wear the mask and the breathing tube on the test head mold; turn on the automatic positive pressure mechanism; and use a pressure gauge to measure the pressure inside the mask under stable air flow; whichever is greater.

Wear the mask and the breathing tube on the test head mold; open the forced air supply (flushing) mechanism to the maximum opening; and use a pressure gauge to measure the pressure inside the mask under stable air flow; whichever is greater.

6.6 Test of continuous working performance of blower

Wear the mask on the test head mold; use a blower to supply air to the mask through a long tube; adjust the continuous flow valve to the minimum opening; and work continuously for 24h.

6.7 High and low temperature adaptability

Take the samples containing the long tube and place them in $(50 \pm 2) ^\circ\text{C}$ and $(-20 \pm 2) ^\circ\text{C}$ environment for 3h; then take the corresponding test within 5min after taking out.

6.8 Test of air output

Use a fan that has passed the test of 6.6; and connect a flow meter in series at the

outlet of the fan or the air compressor provided to the product to take the reading of flow meter.

Use a fan that has passed the test of 6.6; and connect a hose of an appropriate length at the outlet of the fan or air compressor provided to the product. The opening of the hose is placed 130mm below the water surface, and air bubbles shall be generated.

6.9 Minimum air output

Use a fan that has passed the test of 6.6 to supply air to the long tube; adjust the continuous flow valve to the minimum opening; and connect a flow meter in series with the air outlet of the breathing tube to take reading of the flow meter.

6.10 Tension of strap

Place the waistband and the strap on the test chucks, respectively; and apply a tension of (1000 ± 10) N to the two test chucks for 5 min.

NOTE: When loading, the test sample shall not be impacted.

6.11 Pressure resistance

The pressure loading device is installed at one end of the tee; and the remaining two ends of the tee are connected in series in the pipeline. All valves of the pressurized component are opened, and the load is slowly applied. The loading medium is oil or water. Load to the specified pressure, keep for 15min then unload.

6.12 Reliability of air transmission

Connect the flow meter at the air outlet of the breathing tube; and supply air at the air inlet of the long tube; and adjust the flow to the use flow rate specified by the manufacturer or (100 ± 2) L/min. Complete the following tests:

- a) Wrap the long tube and breathing tube for 3 laps on a log with diameter of 30mm; and take the reading of the flowmeter.
- b) Clamp the long tube between wooden boards with length of 500mm; apply 1000N pressure; and take the reading of the flowmeter.

NOTE: The use flow rate specified by the manufacturer shall be preferred.

6.13 Leakage of pressure gauge

Adjust the upstream air supply pressure of the pressure gauge to 20 MPa. Remove the pressure gauge and replace it with a flow meter to measure at least 5 min.

6.14 Air consumption of warning device

Adjust the upstream air supply pressure of the warning device to the highest working pressure of the high-pressure air source ~ 1 MPa. Connect the rear end of the alarm whistle to the flow meter. Measure one point for each 5 MPa reduction and take the average value.

7 Marking

7.1 The product shall have a permanent marking and instruction manual.

7.2 The permanent marking shall include:

- a) The name of the product;
- b) Standard number;
- c) The manufacturer's logo;
- d) Model or size (if applicable).

7.3 The instruction manual shall include the following:

- a) The name of the product;
- b) Manufacturer information;
- c) The type of mask;
- d) Standard number;
- e) Production date or batch number;
- f) Use method;
- g) The shelf life;
- h) Cleaning and maintenance recommendations;
- i) Storage conditions;
- j) Certification mark.

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