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F-0 7

AIR BREATHING APPARATUS

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Foreword

China Classification Society (hereinafter referred to as CCS) Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed service@ccs.org.cn.

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AIR BREATHING APPARATUS

1 Application

1.1 Self-contained positive-pressure fire-fighting air breathing apparatus for ships: used by shipboard firefighters during fire extinguishing and emergency rescue operations to prevent inhalation of harmful toxic gases, smoke, airborne harmful pollutants, and for use in oxygen-deficient environments.

1.2 The Guidelines do not apply to oxygen air breathing apparatuses, diving air breathing apparatuses, negative pressure air breathing apparatuses, or positive pressure fire-fighting air breathing apparatuses supplied from an external source.

2 Normative References

2.1 International Maritime Organization (IMO) *Amendments to the International Convention for the Safety of Life at Sea (SOLAS), 1974 (adopted 2000)* (II-Chapter 2);

2.2 International Maritime Organization (IMO) *International Code for Fire Safety Systems (FSS Code), 2001*, Chapter 3;

2.3 Public Security Industry Standards of China; GA124-2004 *Self-contained Positive Pressure Air Breathing Apparatus for Fire-fighter*;

3 Terms and Definitions

3.1 Self-contained positive pressure air breathing apparatus for fire-fighter: a type of air breathing apparatus in which firefighters carry their own compressed air cylinders and use the air inside the cylinder for breathing, without relying on ambient air. During any breathing cycle, the pressure inside the face mask remains higher than the ambient pressure.

3.2 Static Pressure

The pressure inside the face mask when the system air circuit is balanced after the positive pressure device of the air supply valve is activated.

3.3 High-pressure Components

Components that directly withstand the output pressure from the cylinder during operation.

3.4 Medium-pressure Air Duct

The air duct that withstands the output pressure of the pressure reducer during operation.

3.5 Inhalation Resistance

The positive pressure inside the face mask during inhalation.

3.6 Exhalation Resistance

The positive pressure inside the face mask during exhalation.

4 Drawings and Documents

4.1 The following drawings and documents shall be submitted to CCS for approval

(1) General Assembly Drawing of the Air Breathing Apparatus

(2) Cylinder Valve Drawing

(3) Air Supply Valve Drawing

(4) Pressure Reducing Valve Drawing

(5) Back Board Drawing

(6) Technical Specifications of Product

(7) Type Test Program

4.2 The following drawings and documents shall be submitted for information

(1) Nameplate Drawing;

(2) Sample of Test Certificate;

(3) Product Operating Instructions.

5 Materials and Components

5.1 Raw materials and parts and components of products shall be controlled in accordance with

the relevant requirements of our current specifications.

5.2 The air breathing apparatus shall include at least the following components: face mask, air supply valve, exhalation valve, pressure reducer, safety valve, pressure display device, alarm, and high-, medium- and low-pressure air ducts, cylinder valve, cylinder, and back board.

5.3 The performance of all components shall be compatible. The manufacturer shall formulate inspection procedures and acceptance technical requirements for each component. The factory shall inspect each valve, face mask, pressure vessel, pipe fittings, and alarm individually according to the relevant standards (or purchase and factory acceptance specifications), recording the survey results in a logbook, which shall serves as the basis for CCS surveyors to conduct batch inspections.

5.4 The cylinders used with the air breathing apparatus shall be interchangeable.

6 On-site Audit

6.1 The on-site audit covers both the product manufacturing management system and the manufacturing process. For the detailed requirements, refer to the CCS regulations.

6.2 Special attention shall be paid to the following items during the on-site audit:

6.3 Production equipment, testing equipment, and inspection equipment

6.3.1 Inspect whether the factory's production equipment meets the requirements of manufacturing; inspect whether the factory's testing environment meets the requirements for air breathing apparatus type test (if the type testing is conducted at the factory) and factory acceptance test.

6.3.2 Inspect whether the factory’s inspection equipment is complete, whether the accuracy and range of all testing instruments meet type test requirements, and whether all inspection instruments are within their valid calibration periods.

6.4 Factory Quality Control

6.4.1 Assess the quality control of key stages in the production process and review the operation of the factory's quality assurance system.

7 Type Test

7.1 Type Test Program

The technical requirements and type test requirements for air breathing apparatus may either be proposed by CCS in the form of a type test program, to be confirmed in writing by the manufacturer, or submitted by the applicant and then approved by CCS. The program shall include at least the test basis, test items, evaluation criteria (including procedures for handling type test failures), inspection methods, responsible departments, and the test schedule.

7.2 Sampling:

Samples for the type test shall be randomly selected from products that have passed the factory survey, with a total of six units.

7.3 Test Site:

The type test shall be conducted by full-time inspectors of the manufacturer unit on dedicated inspection equipment with valid calibration confirmed by the CCS attending surveyor; the entire testing process must be witnessed by a CCS surveyor.

If the manufacturer's inspection equipment is incomplete, if the testing standards are not accepted by the surveyor, or if comparison/verification is required, all or specified test items shall be performed at a test or verification agency designated by CCS.

7.4 Type Test Items

S/N	**Test Item Description**	**Technical Requirements**	**Appraisal inspection**	**Test Classification**	
				Group A	**Group B**
1.	Construction, Marking, and Packaging	Complies with 7.9.1.1 and 7.9.1.2 7.9.1.3 and 7.9.1.4	◎	◎	
2.	Material Flame Retardation Test	Complies with 7.9.2.3 7.9.2.4	◎		◎
3.	Wearing Weight	Complies with 7.9.5	◎		◎
4.	Whole apparatus airtightness test	Complies with 7.9.6	◎	◎	◎
5.	Dynamic Breathing Resistance Test	Complies with 7.9.7	◎	◎	◎
6.	High Temperature Resistance Test	Complies with 7.9.8	◎		◎
7.	Low Temperature Resistance Test	Complies with 7.9.9	◎		◎
8.	Static Pressure Test	Complies with 7.9.10	◎	◎	◎
9.	Alarm Performance Test	Complies with 7.9.11	◎	◎	◎

10.	Face Mask Performance Test	Complies with 7.9.12	◎		◎
11.	Pressure Reducing Valve Performance Test	Complies with 7.9.13	◎		◎
12.	Safety Valve Performance Test	Complies with 7.9.14	◎		◎
13.	Pressure Gauge Test	Complies with 7.9.16	◎		◎
14.	High-pressure Component Strength Test	Complies with 7.9.17	◎		◎
15.	Medium-pressure Air Duct Burst Pressure Test	Complies with 7.9.18	◎		◎
16.	Safety Diaphragm Burst Pressure Test	Complies with 7.9.19.3	◎		◎
17.	Measurement of Cylinder Valve Outlet Dimensions	Complies with 7.9.19.4	◎		
18.	Personnel Wearing Performance Test	Complies with 7.9.20	◎		◎

Note: Test Classification Explanation: "◎ " indicates an survey item

Group A: refers to factory test

Group B: refers to the trial production and type approval of new products or those transferred from other factories; When there are significant changes in raw materials, design, processes, or production equipment for existing products; when production resumes after a suspension of over one year; or when a type survey is required by the national quality supervision authority. In these cases, in addition to routine factory tests, this test must also be conducted.

7.7.5 Test Records and Reports

The applicant shall prepare a report based on the original test records. The report shall include the test date, test items, product name, location, model (specification), manufacturer, indicators, inspection basis, testing method, test results, conclusions, preparation, review, surveyor verification, and inspection seal. Valid calibration certificates for the inspection equipment shall be attached and submitted to the chief surveyor of CCS.

The original records of the type test shall be signed by the surveyor.

8 Certification

8.1 After the technical documents have been reviewed and approved by CCS, the type test results have met the requirements of relevant conventions, specifications, or standards, and the on-site audit has confirmed that the quality assurance system meets product quality requirements—meaning all three evaluation criteria are satisfactorily met after comprehensive assessment—CCS will issue a type approval certificate to the applicant.

9 Technical Requirements

9.1 Structure, marking, and packaging

9.1.1 The air breathing apparatus shall be designed so that the compressed air in the cylinder sequentially passes through the cylinder valve, pressure reducer, and supply valve, then enters the face mask to provide inhalation for the wearer, while exhaled air is discharged through the exhalation valve to the outside of the face mask.

9.1.2 The air breathing apparatus shall have a simple and compact structure that allows the wearer to don and use it without assistance. When passing through narrow passages, the air breathing apparatus shall not be snagged or impede movement.

9.1.3 The air breathing apparatus shall ensure that the air supply for breathing is not interrupted when it is removed from the wearer.

9.1.4 The air breathing apparatus shall be equipped with an installation that prevents impurities in the compressed air.

9.1.5 The installation position of the cylinder valve shall be convenient for the wearer to open or close the valve.

9.1.6 The pressure gauge shall indicate the cylinder pressure and be installed in a position easily visible to the wearer.

9.1.7 Components that may be touched by the wearer shall have no sharp edges.

9.1.8 The cylinder valve shall be connected to the pressure reducer, and the face mask shall be connected to the air supply valve reliably, without the need for special tools—hand assembly only. If a seal is used at the connection, it shall not detach or be displaced.

9.1.9 The harness shall be adjustable in length and shall not slip after fastening.

9.2 Material Requirements

9.2.1 The materials used for the air breathing apparatus shall possess adequate mechanical strength and corrosion resistance.

9.2.2 Materials in direct contact with the wearer’s skin shall be non-irritating, free from other hazards, and capable of being disinfected and washed.

9.2.3 After testing for flame resistance, the harness and buckle shall not exhibit melting and the after flame time shall not exceed 5 s.

9.2.4 After flame resistance testing of the face mask, medium-pressure air duct, and air supply valve, the after flame time shall not exceed 5 s, and they shall still comply with the requirements specified in Clause 9.6.

9.3 Marking

9.3.1 The manufacturer's name or registered trademark must be displayed on the air duct, air supply valve, pressure reducer, face mask, back board, and cylinder of each air breathing apparatus.

9.3.2 The following label information shall appear in a prominent location on each air breathing apparatus packaging box:

(1) Manufacturer name, address, and registered trademark.

(2) Product name and model.

(3) Date of manufacture and batch number.

(4) Identification code for the applicable product standard.

(5) Certification mark or approval document number.

9.4 Packaging

9.4.1 Each air breathing apparatus shall be provided with a dedicated packaging box that offers shockproof and compression-resistant features. The box shall include the product manual, packing list, certificate of conformity, spare parts, and tools.

9.4.2 The product operation manual must contain the following information:

(1) Operating instructions and safety precautions.

(2) Guidance on maintenance, disinfection, storage, and inspection procedures.

(3) Faults, fault causes and troubleshooting methods.

(4) Description of the air composition inside the cylinder.

(5) Any additional instructions and descriptions considered necessary by the manufacturer.

9.5 Wearing Quality

The weight of the air breathing apparatus while worn shall not exceed 18kg (when the gas pressure in the cylinder is at the rated working pressure).

9.6 Whole Apparatus Airtightness Performance

After the air breathing apparatus passes the airtightness test, the pressure drop indicated by its pressure gauge shall not exceed 2MPa within 1 minute.

9.7 Dynamic Breathing Resistance

9.7.1 Within the range from the rated working pressure of the gas cylinder down to 2 MPa, at a breathing rate of 40 breaths/min and a ventilation volume of 100L/min, the face mask of the air breathing apparatus shall always maintain positive pressure. The inhalation resistance shall not exceed 500 Pa, and the exhalation resistance shall not exceed 1000 Pa.

9.7.2 Within the range from 2 MPa to 1 MPa, at a breathing rate of 25 breaths/min and a ventilation volume of 50L/min, the face mask of the air breathing apparatus shall still maintain positive pressure. The inhalation resistance shall not exceed 500 Pa, and the exhalation resistance shall not exceed 700 Pa.

9.8 High Temperature Performance

After high-temperature testing, all parts of the air breathing apparatus shall be free from abnormal deformation, adhesion, delamination, and similar defects. At a breathing rate of 40 breaths/min and a ventilation volume of 100L/min, the face mask of the air breathing apparatus shall maintain positive pressure, and the exhalation resistance shall not exceed 1000 Pa.

9.9 Low Temperature Performance

After the air breathing apparatus has undergone low temperature testing, all components shall remain free of cracking, abnormal shrinkage, brittleness, or similar defects. With a breathing rate of 25 breaths per minute and a breathing flow rate of 50L/min, the air breathing apparatus's face mask shall maintain positive pressure, and the exhalation resistance shall not exceed 1000Pa.

9.10 Static Pressure

The static pressure shall not exceed 500Pa and must not exceed the opening pressure of the exhalation valve.

9.11 Alarm Performance

9.11.1 When the pressure inside the cylinder drops to (5.5±0.5) MPa, the alarm shall emit a continuous or intermittent audible signal. The continuous alarm duration shall not be less than 15 seconds, the intermittent alarm duration shall not be less than 60 seconds, and the sound level shall not be less than 90dB(A).

9.11.2 From the time the alarm is activated until the cylinder pressure reaches 1MPa, the average gas consumption of the alarm shall not exceed 5L/min, and the total gas consumption shall not exceed 85L.

9.12 Face Mask Performance

9.12.1 The mass of the face mask shall be evenly distributed; the headband or hood must be freely adjustable to fit the wearer's head, and the sealing frame must fit snugly against the wearer's face without causing noticeable pressure discomfort. The face mask shall have an anti-fog function for the viewport.

9.12.2 The viewport shall be a large viewing window, made of colorless, transparent material with excellent light transmittance, and shall not cause visual distortion.

9.12.3 The field of view and the carbon dioxide concentration (by volume) in the inhaled gas shall comply with the requirements specified in Clause Table 1.

Field of View and Carbon Dioxide Concentration in Inhaled Gas Table 1

Item		**Requirements**
Field of view	Total field of view %	＞70
1	Binocular field of view %	＞55
1	Lower field of view °	＞35
Carbon dioxide concentration in inhaled gas %		≤1

9.13 Pressure Reducing Valve Performance

9.13.1 Within the range from the rated working pressure of the gas cylinder down to 2 MPa, the output pressure of the pressure reducer shall remain within the design value range.

9.13.2 The output pressure adjustment component of the pressure reducer shall be equipped with a locking device.

9.13.3 A safety valve shall be installed at the output end of the pressure reducer; its performance shall comply with the requirements specified in Clause 9.14.

9.14 Safety Valve Performance

9.14.1 The opening pressure and full discharge pressure of the safety valve shall be within 110% to 170% of the maximum design output pressure of the pressure reducer.

9.14.2 The closing pressure of the safety valve shall not be less than the maximum design output pressure of the pressure regulator.

9.15 Performance of Air Supply Valve

The air supply valve shall be equipped with an automatic positive pressure mechanism.

9.16 Pressure Gauge

9.16.1 The pressure gauge casing shall be fitted with a rubber protective cover, and the case diameter shall not exceed 60 mm.

9.16.2 The pressure measurement range shall be (0–40) MPa, the accuracy shall not be lower than grade 2.5, and the minimum scale division shall not exceed 1 MPa.

9.16.3 The alarm pressure segment and the 30 MPa mark on the pressure gauge dial shall be clearly indicated.

9.16.4 The wearer shall be able to read the pressure indication in dim or dark environments.

9.16.5 After the pressure gauge undergoes the waterproof performance test, no water shall enter the gauge.

9.16.6 When the pressure gauge is disconnected from the hose, with the cylinder pressure at 20 MPa, the leakage shall not exceed 25L/min.

9.16.7 Other performance parameters of the pressure gauge shall conform to the requirements specified in GB1226-2001.

9.17 Strength of high-pressure components

High-pressure components shall exhibit no leakage or abnormal deformation after hydrostatic pressure testing

9.18 Medium-pressure air duct

9.18.1 The air duct shall not impede the wearer's work or free head movement, nor interfere with the connection between the demand valve and the face mask;

9.18.2 The air duct shall not impede airflow, even if wearer movement causes the duct to bend or deform;

9.18.3 The burst pressure of the air duct shall not be less than four times the maximum design output pressure of the pressure reducer.

9.19 Cylinder Valve

9.19.1 The cylinder valve shall open counterclockwise.

9.19.2 Once opened, the cylinder valve shall be protected against inadvertent closure. If the cylinder valve cannot be locked after being opened, the opening handwheel shall be rotated at least two full turns to reach the closed position;

9.19.3 The cylinder valve shall be fitted with a safety diaphragm with a burst pressure of (37–45) MPa.

9.19.4 The outlet of the cylinder valve shall have an internal thread, size G5/8, with tolerances as specified in Table 1 of GB7307-2001.

9.20 Wearer Performance

The wearer shall experience satisfactory comfort and no inadequate air supply.

10 Test Methods and Procedures

10.1 Structure, Marking, and Packaging Inspection

When visually inspected, the results shall comply with the requirements specified in Clause 9.1.1, 9.1.2, 9.1.3, and 9.1.4.

10.2 Material Flame Retardation Test

10.2.1 Flame Retardation Test for Harness and Buckle Materials

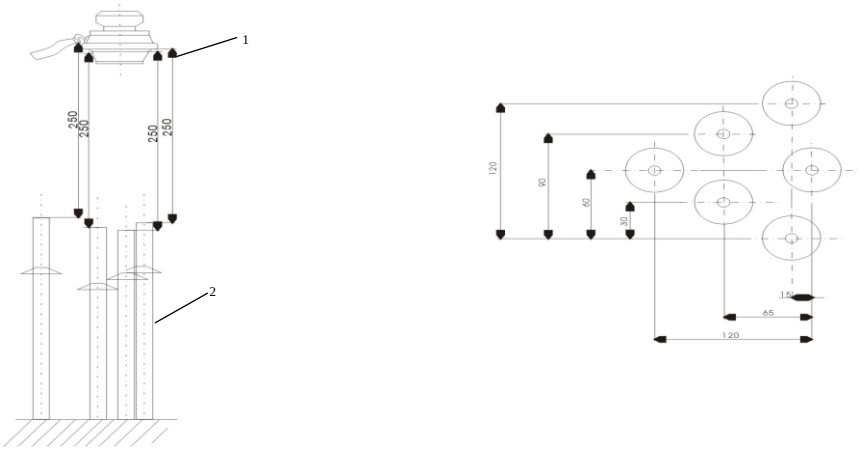
By adjusting the flow rate of propane gas, set the burner flame height to 40 mm, and ensure the temperature at a position 20 mm from the flame is (800±50) ℃. Place the specimen horizontally at a position 20 mm above the flame for 12 seconds. The result must conform to Clause 9.2.3.

1. Specimen 2. Burner nozzle

Figure 1 Schematic Diagram of the Flame Retardation Test Installation for Harness and Buckle Materials

10.2.2 Flame Retardation Test for Face Mask, Medium-Pressure Air Duct, and Air Supply Valve Materials

Arrange the specimen as shown in Figure 2. Adjust the distance between the burner nozzle and the outer surface of the specimen to 250 mm, and adjust the propane gas flow rate so that the temperature at the center of the triangle formed by the top of the burner, situated 250 mm from the burner top, is (950±50) ℃. Expose the specimen to the flame for 5 seconds, then carry out the test as specified in Section 11.4. Results shall comply with the requirements specified in Clause 9.2.4.



1. Specimen 2. Burner nozzle

Figure 2 Schematic diagram of the flame-retardant performance test apparatus for face mask, medium-pressure air duct, and air supply valve materials

10.3 Wearing weight

Weigh the item using a scale. The result shall comply with the requirements specified in Clause 9.5.

10.4 Whole apparatus airtightness test:

When the cylinder pressure is not less than 90% of the nominal working pressure, open the air supply valve, securely and hermetically wear the face mask onto the headform, open the cylinder valve, close the cylinder valve after the system air circuit is filled with compressed air, and observe the pressure drop indicated by the air breathing apparatus's gauge within 1 minute after closing the cylinder valve. The result shall comply with the requirements specified in Clause of 9.6.

10.5 Dynamic breathing resistance test

10.5.1 Test apparatus

Integrated air breathing apparatus tester.

10.5.2 Test procedures:

Securely and hermetically wear the face mask onto the headform, ensuring an airtight seal. Connect its breathing port to the artificial lung. Set the artificial lung to a breathing frequency of 40 cycles/min with a breathing flow rate 100L/min. Fully open the gas cylinder valve, start the artificial lung, and measure the mask's breathing resistance when the cylinder's operating pressure is at 2MPa. Next, set the artificial lung to a breathing frequency of 25 cycles/min with a breathing flow rate 25L/min. Measure the mask's breathing resistance as the cylinder pressure decreases from 2MPa to 1MPa. The results shall comply with the requirements specified in Clause 9.7.

10.6 High Temperature Resistance Test

Place the air breathing apparatus (with cylinder pressure adjusted to 10MPa) in an environment at (60±3)℃ for 4 hours. Remove it and immediately connect the air breathing apparatus to the artificial lung. Set the artificial lung to a breathing frequency of 40 cycles/min with a breathing flow rate 100L/min. Fully open the cylinder valve, start the artificial lung, and measure the breathing resistance until the cylinder pressure drops to 2MPa. The results shall comply with the

requirements specified in Clause 7.9.8.

10.7 Low Temperature Resistance Test

Place the air breathing apparatus (with the cylinder pressure adjusted to 30 MPa) in an environment of (30 ± 3) °C for 12 h. Immediately connect the air breathing apparatus to the artificial lung after removal. Set the artificial lung to a breathing rate of 25 breaths/min and a tidal volume of 50 L/min. Fully open the cylinder valve, start the artificial lung, and measure the breathing resistance until the cylinder pressure drops to 2 MPa. The results shall comply with the requirements specified in Clause 7.9.9

10.8 Static Pressure Test

Securely and hermetically wear the face mask onto the headform, with its breathing interface connected to the artificial lung. With the gas supply valve closed, fully open the cylinder valve. Start the artificial lung and perform several slow breaths, then shut off the artificial lung. When the system air circuit is balanced, record the pressure inside the mask. The results must meet the requirements specified in Clause 9.10.

10.9 Alarm Performance Test

10.9.1 Start the breathing apparatus. Within the cylinder's rated working pressure down to 2 MPa, operate at a breathing rate of 40 breaths/min and a tidal volume of 100 L/min; from 2 MPa to 1 MPa, operate at a breathing rate of 25 breaths/min and a tidal volume of 50 L/min. Read the alarm activation pressure value from the air breathing apparatus's pressure gauge and simultaneously record the duration of the alarm sound;

10.9.2 When the alarm sounds, measure the sound pressure level at a distance of 1m from the alarm;

10.9.3 Connect the alarm output end to a flow meter, vary the pressure at the alarm input end, and measure the flow rate at the alarm output end when the alarm activates, as well as when the input end pressure is 4 MPa, 3 MPa, 2 MPa, and 1 MPa; then calculate the average flow rate. Simultaneously, record the time from alarm activation until the pressure drops to 1 MPa, and calculate the corresponding air consumption. The results shall conform to the requirements specified in Clause 9.11.

10.10 Face Mask Performance Test

10.10.1 The test for carbon dioxide content in inhaled air shall be conducted in accordance with 6.5.3 of GA209-1999, and results shall meet the requirements specified in Clause 10.12.3.

10.10.2 Visual Field Test

The visual field test shall be performed in accordance with GB2891-2009, and the results shall comply with the requirements specified in Clause 9.12.3.

10.11 Pressure Reducing Valve Performance Test

Mount a pressure gauge at the outlet of the pressure regulator. Open the cylinder valve and measure the regulator's output pressure within the range from the cylinder's rated working pressure down to 2 MPa. The results shall comply with the requirements specified in Clause 9.13

10.12 Safety Valve Performance Test

10.12.1 Connect the inlet of the safety valve to the pressure source and increase the pressure slowly and uniformly at a rate not exceeding 0.01 MPa/s. Measure the opening pressure of the safety valve;

10.12.2 Continue increasing the pressure until the safety valve reaches full discharge, and measure its full discharge pressure;

10.12.3 Slowly and uniformly decrease the pressure until the safety valve closes, and measure its closing pressure.

The results shall comply with the requirements specified in Clause 10.14

10.13 Pressure Gauge Test

10.13.1 Measure the outer diameter of the pressure gauge case using a vernier caliper. The results shall comply with the requirements specified in Clause 9.16

10.13.2 Immerse the pressure gauge in clean water at a temperature no less than 5 ℃ for 24 hours. The results shall comply with the requirements specified in Clause 9.16.

10.13.3 When the pressure inside the gas cylinder reaches 20 MPa, remove the pressure gauge, install the flow meter, fully open the cylinder valve, and measure the leakage rate of the pressure gauge's vent tube. The result shall comply the requirements specified in Clause 9.16.

10.14 High-pressure component strength test

Apply hydraulic pressure to the input end of the high-pressure component at 1.5 times the working pressure of the gas cylinder for 2 minutes, and the result must meet the requirements specified in Clause 9.17.

10.15 Medium-pressure air duct burst pressure test

Connect the medium-pressure air duct to a dedicated hydraulic test stand, evacuate the air from the tube, and then slowly increase pressure until rupture occurs. The result shall comply the requirements specified in Clause 9.18.

10.16 Safety diaphragm burst pressure test

Connect the gas cylinder valve fitted with a safety diaphragm to the hydraulic test stand, close the cylinder valve including the live valve, and then slowly pressurize until rupture. The result must meet the requirements specified in Clause 9.19.3.

10.17 Measurement of cylinder valve outlet dimensions: The structure must comply with the requirements specified in Clause 9.19.4.

10.18 Personnel wearing performance test

10.18.1 Test conditions

The test shall be conducted under normal temperature, atmospheric pressure, and specified simulated environmental conditions.

10.18.2 Subjective perceptions of the wearer:

(1) Wearing comfort;

(2) Adjustability of the harness buckle;

(3) Accessibility and visibility of the pressure gauge;

(4) Clarity of the face mask visor;

(5) Whether the face mask has an anti-fogging feature for the visor;

(6) Status of air supply valve operation;

(7) Air supply condition

(8) Voice transmission condition

(9) Alarm condition

(10) Any other issues perceived by the wearer.

10.18.3 Two test personnel, wearing fire-fighting protective clothing and air breathing apparatuses, walk on level ground at a speed of 6 km/h for 30 minutes. After the test, the wearers are interviewed regarding their subjective perceptions. The results shall comply with the requirements specified in Clause 9.20.

10.18.4 Adaptability test in a simulated environment

Two test personnel, wearing fire-fighting protective clothing and air breathing apparatuses, perform the test for 30 minutes in the following sequence. After the test, they are interviewed regarding their subjective perceptions. The results shall comply with the requirements specified in Clause 9.20.

(1) Carry a 13 kg sandbag, walk 15m, and place the sandbag on a 2 m high board wall;

(2) Climb over board walls with heights of 0.4 m, 1 m, 1.2 m, and 2 m, each spaced 7 m apart;

(3) Climb the corner wall of the fire training building;

(4) Ascend and descend a 12 m fire ladder three times;

(5) Ascend and descend once on a ladder with 460 mm square openings; ladder height: 12 m;

(6) Deploy and retrieve one fire hose; traverse one passage measuring 3.7m in length with a diameter of 0.7m, and one passage measuring 3.7m in length, 0.9m in width, and 0.6m in height;

(7) Rest for 5 minutes, measure blood pressure, ECG, and heart rate, and replace the air cylinder;

(8) Run at a speed of 6 km/h on level ground until the test is complete.