

Guideline No.F-07 (201510)



F-07 Air breathing apparatus

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Foreword

This Guideline is a part of CCS Rules, which contains technical requirements, inspection and testing criteria related to classification and statutory survey of marine products.

This Guideline is published and updated by CCS and can be found through <http://www.ccs.org.cn>.
Comments or suggestions can be sent by email to ps@ccs.org.cn.

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Air breathing apparatus

1 Application

1.1 The guideline applies to the positive-pressure fire-fighting air breathing apparatus used by the ship fireman to avoid the inhalation of harmful poison gas, smog, and noxious pollutant suspended in the air or used in the oxygen-deficient environment.

1.2 It does not apply to the oxygen air breathing apparatus, diving breathing apparatus, negative pressure ventilator and positive-pressure fire-fighting air breathing apparatus with air supplied externally.

2 Basis for approval and inspection

2.1 Chapter II-2 of 1974 SOLAS Convention, as 2000 Amended;

2.2 Chapter 3 of International Code for Fire Safety Systems (2001) ;

2.3 China public safety industry standards; GA 124-2004 Self-contained positive pressure air breathing apparatus for fire fighter;

3 Definitions

3.1 Positive-pressure fire-fighting air breathing apparatus: A type of air breathing apparatus or air storage cylinder which is carried by the fireman himself for inhaling the compressed air stored inside rather than the external air, with pressure in the mask more than the ambient pressure in any respiration cycle.

3.2 Static pressure

The pressure in the mask when the gas circuit of the system is balanced after the positive-pressure device of the air-supply valve is started.

3.3 High-pressure parts

The parts bearing the output pressure of the air cylinder directly during operation.

3.4 Medium-pressure airway tube

The airway tube bearing the output pressure of the pressure reducer during operation.

3.5 Inspiration resistance

Positive pressure in the mask during inspiration.

3.6 Expiration resistance

Positive pressure in the mask during expiration.

4 Plans and documents

4.1 The following plans and documents should be submitted to CCS for approval:

- (1) General assembly plan of the air breathing apparatus
- (2) Air cylinder valve diagram
- (3) Air supply valve diagram
- (4) Pressure reducing valve diagram
- (5) Frame carrier diagram
- (6) Technical product condition
- (7) Type test program

4.2 The following plans and documents should be submitted for information:

- (1) Nameplate diagram;
- (2) Test certificate sample;
- (3) Product operation instructions;

5 Materials and components

5.1 The materials and components of the product should be controlled as per relevant requirement of current regulations of CCS.

5.2 The air breathing apparatus should at least involve such products as the mask, air supply valve, exhalation valve, pressure reducer, safety valve, pressure display device, alarm, high-, medium- and low-pressure airway tube, air cylinder valve, air cylinder, and frame carrier.

5.3 The performance of all parts should match with each other, the manufacturer should formulate the inspection procedure and technical acceptance condition for each part, and the factory should test the valve, mask, pressure vessel, pipe fitting and alarm one by one according to the standard (or the technical acceptance condition on purchasing and delivery), and record the inspection result (which will be treated as the basic condition for CCS Surveyor's batch inspection).

5.4 The cylinder used for the air breathing apparatus should be interchangeable.

6 Site audit

6.1 The site audit involves the audit on product manufacturing management system and manufacturing process. For specific requirements, see CCS regulations.

6.2 The following points must be focused on during site audit:

6.3 Production equipment, test equipment and inspection equipment

6.3.1 Check whether the production equipment of the factory meet the production requirement, and the test conditions meet the type test (if it is carried out in the factory) and delivery inspection requirement on air breathing apparatus.

6.3.2 Check whether the inspection equipment of the factory is complete, whether the accuracy and range of the inspection instrument meet the type test requirement, or whether all the inspection instruments are within the valid identification period.

6.4 Factory quality control

6.4.1 Check the quality control on key processes during production as well as the operation status of the factory quality assurance system.

7 Type test

7.1 Type test program

The technical requirement and type test requirement of the air breathing apparatus can be proposed by CCS in the form of type test program and approved in written by the factory, or submitted by the applicant and approved by CCS. The program should at least include the test basis, item, determination rules (including the handling rules on type test failure), inspection method, department in charge of test, and schedule.

7.2 Sampling:

The samples (6 sets) used for type test should be selected from the products with delivery inspection certificate.

7.3 Test site:

The type test should be conducted by the full-time inspector of the manufacturer on the special inspection equipment within the validity of measurement that is approved by the CCS Surveyor at site, and the whole test process should be witnessed by the CCS Surveyor.

If the inspection equipment of the manufacturer is not complete, the inspection capacity cannot be accepted by the Surveyor, or comparison identification is required, all or some of the type test items should be sent to the test and inspection agency specified by CCS for test or inspection.

7.4 Type test items

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No.	Item content	Technical requirement	Identification inspection	Test classification	
				Group A	Group B
1.	Structure, mark and package	Meet the requirement specified in 7.9.1.1, 7.9.1.2 7.9.1.3 and 7.9.1.4	◎	◎	
2.	Material flame retardation test	Meet the requirement specified in 7.9.2.3 and 7.9.2.4	◎		◎
3.	Wearing weight	Meet the requirement specified in 7.9.5	◎		◎
4.	Complete machine airtightness test	Meet the requirement specified in 7.9.6	◎	◎	◎
5.	Dynamic respiration resistance test	Meet the requirement specified in 7.9.7	◎	◎	◎
6.	High temperature resistance test	Meet the requirement specified in 7.9.8	◎		◎
7.	Low temperature resistance test	Meet the requirement specified in 7.9.9	◎		◎
8.	Static pressure test	Meet the requirement specified in 7.9.10	◎	◎	◎
9.	Alarm performance test	Meet the requirement specified in 7.9.11	◎	◎	◎
10.	Mask performance test	Meet the requirement specified in 7.9.12	◎		◎
11.	Reducing valve performance test	Meet the requirement specified in 7.9.13	◎		◎
12.	Safety valve performance test	Meet the requirement specified in 7.9.14	◎		◎

13.	Pressure gage test	Meet the requirement specified in 7.9.16	◎		◎
14.	High-pressure component strength test	Meet the requirement specified in 7.9.17	◎		◎
15.	Medium-pressure airway tube burst pressure test	Meet the requirement specified in 7.9.18	◎		◎
16.	Safety diaphragm burst pressure test	Meet the requirement specified in 7.9.19.3	◎		◎
17.	Air cylinder valve output terminal size determination	Meet the requirement specified in 7.9.19.4	◎		
18.	Personnel wearing performance test	Meet the requirement specified in 7.9.20	◎		◎

Note: Test classification description: “◎” indicates the test items.

Group A: Factory test.

Group B: The test (in addition to the factory test) that must be conducted when the new or old product transferred to another factory is subject to trial production and type approval, the raw material, design, process, or production equipment of the product produced normally is changed dramatically, the production of certain product is resumed after being discontinued for more than 1 year, or type test is required by the state quality supervision institutions.

7.7.5 Test record and report

The application unit should prepare the report based on the original record result, and the report should contain the test date, test item, name of the product inspected, location, model (specification), production unit, index, inspection basis, test method, inspection result, conclusion, compilation, audit, Surveyor verification, and inspection seal. The report (together with the proof materials on validity of the inspection equipment) should be submitted to the CCS Surveyor.

The original record of the type test should be signed by the Surveyor.

8 Issuing certificate

8.1 After such three determination conditions are evaluated comprehensively to be satisfactory, namely, the technical document is reviewed and approved by CCS, the type test result meets the requirements of relevant convention, regulation or standard, and the site audit and quality assurance system meets the product quality assurance requirement, CCS will issue type approval certificate to the applicant.

9 Technical requirement

9.1 Structure, mark and package

9.1.1 The air breathing apparatus should be arranged in such a way that the compressed air in the cylinder of the air breathing apparatus can pass through in sequence the air cylinder valve, pressure reducer, air supply valve, and mask for wearer's inspiration, and the expiration can be realized via the exhalation valve.

9.1.2 The air breathing apparatus features simple and compact structure, which can be worn and operated without assistance from another person, and should not be caught during passing of narrow passages.

9.1.3 The air breathing apparatus should be designed in such a way that the air supplied for respiration will not be interrupted when it is taken away from the wearer.

9.1.4 The air breathing apparatus should be provided with devices to filter impurities in the compressed air.

9.1.5 The cylinder valve should be installed in such a way that the wearer can open or close it easily.

9.1.6 The pressure gage should display the cylinder pressure, and should be installed in such a way that the wearer can observe the pressure easily.

9.1.7 The surface of the part that can be touched by the wearer should be free of sharp edges and corners.

9.1.8 The connection between the cylinder valve and the pressure reducer as well as the mask and the air supply valve should be reliably realized manually without any special tools. If any sealing element is adopted at the connection, it should not be fallen off or displaced.

9.1.9 The dressing belt should be adjustable in length, which should not be slipped after being fastened.

9.2 Material requirement

9.2.1 The material of the air breathing apparatus should have sufficient mechanical strength and corrosion resistance capacity.

9.2.2 The material directly contacting the wearer's skin should be free of irritation or other harmfulness, and can be disinfected and washed.

9.2.3 The dressing belt and belt buckle should be free of melting with afterflame time of not more than 5 s after flame resistance test.

9.2.4 After flame resistance test, the mask, medium-pressure airway tube and air supply valve should still meet the requirement of 9.6 with afterflame time of not more than 5 s.

9.3 Mark

9.3.1 The manufacturer name or registered trademark should be provided on the airway tube, air supply valve, pressure reducer, mask, frame carrier, and air cylinder of each air breathing apparatus.

9.3.2 The following marks should be provided on the striking position of the packing box of the air breathing apparatus:

- (1) Name, address and registered trademark of the manufacturer.
- (2) Product name and model.
- (3) Production date and batch number.
- (4) Code of the product standard.
- (5) Number of the certification mark or approval document.

9.4 Package

9.4.1 Each air breathing apparatus should be provided with a specific packing box featuring shake-proofing and pressing resistance, and containing product instructions, packing list, certificate of inspection, spare parts and tools.

9.4.2 The product instructions should contain the following:

- (1) Usage and safety precautions.
- (2) Guidelines on maintenance, disinfection, storage and inspection.
- (3) Failure, causes and troubleshooting.
- (4) Description on air elements in the cylinder.
- (5) Description deemed to be necessary by the manufacturer.

9.5 Wearing mass

The wearing mass of the air breathing apparatus should not exceed 18 kg (when the air pressure in the cylinder is at the rated operating pressure).

9.6 Complete machine airtightness

After airtightness test, the drop of the pressure value indicated on the pressure gage of the air breathing apparatus should not exceed 2 MPa in 1 min.

9.7 Dynamic respiration resistance

9.7.1 When the air breathing apparatus operates in the range of rated operating pressure - 2 MPa with respiratory rate of 40 times/min and respiratory flow of 100 L/min, positive pressure should be maintained in the mask of the air breathing apparatus with inspiration resistance and exhalation resistance of not more than 500 Pa and 1000 Pa respectively.

9.7.2 When the air breathing apparatus operates in the range of 2 MPa - 1 MPa with respiratory rate of 25 times/min and respiratory flow of 50 L/min, positive pressure should be maintained in the mask of the air breathing apparatus with inspiration resistance and exhalation resistance of not more than 500 Pa and 700 Pa respectively.

9.8 High temperature resistance

After dry heat test, the components of the air breathing apparatus should be free of abnormal deformation, sticking or adhesive failure; when being operated with respiratory rate of 40 times/min and respiratory flow of 100 L/min, positive pressure should be maintained in the mask of the air breathing apparatus with exhalation resistance of not more than 1000 Pa.

9.9 Low temperature resistance

After low temperature test, the components of the air breathing apparatus should be free of crack, abnormal shrinking or embrittlement; when being operated with respiratory rate of 25 times/min and respiratory flow of 50 L/min, positive pressure should be maintained in the mask of the air breathing apparatus with exhalation resistance of not more than 1000 Pa.

9.10 Static pressure

The static pressure should not exceed 500 Pa or the opening pressure of the vent valve.

9.11 Alarm performance

9.11.1 When the pressure in the cylinder drops to (5.5 ± 0.5) MPa, the alarm should send out continuous or discontinuous sound alarm with duration of not less than 15 s or 60 s respectively and sound level of not less than 90 dB(A).

9.11.2 Starting from the alarm sending-out to the moment when the cylinder pressure is 1 MPa, the average gas consumption or total gas consumption of the alarm should not exceed 5 L/min and 85 L respectively.

9.12 Mask performance

9.12.1 The mask mass should be distributed symmetrically, and the head band or hood should be able to be adjusted freely according to wearer's head, and its sealing frame should fit wearer's face well without obvious pressing pain. The mask should be capable of removing the fog on the viewport.

9.12.2 The viewport is a type of one-piece facial visor, which should be made with colorless

transparent material with sound transparency and without visual distortion.

9.12.3 The view field and carbon dioxide content (in volume) inhaled should meet the requirement of Table 1.

View field and carbon dioxide content (in volume) inhaled Table 1

Item		Requirement
View field	Total view field %	>70
	View field of both eyes %	>55
	Lower view field °	>35
Carbon dioxide content inhaled %		≤1

9.13 Pressure reducing valve performance

9.13.1 The output pressure of the pressure reducer should be within the design range in the range of rated operating pressure - 2 MPa.

9.13.2 Locking device should be provided at the output pressure adjustment part of the pressure reducer.

9.13.3 Safety valve should be provided at the output end of the pressure reducer with performance meeting the requirement of 9.14.

9.14 Safety valve performance

9.14.1 The opening pressure and total discharge pressure of the safety valve should be within (110~170)% of the designed max. output pressure of the pressure reducer.

9.14.2 The closing pressure of the safety pressure should not be less than the designed max. output pressure of the pressure reducer.

9.15 Air supply valve performance

The air supply valve should be provided with automatic positive-pressure mechanism.

9.16 Pressure gage

9.16.1 The pressure gage shell should be provided with elastomeric boot with shell diameter of not more than 60 mm.

9.16.2 The pressure measurement range should be (0~40) MPa with accuracy of not less than level 2.5 and min. scale interval of not more than 1 MPa.

9.16.3 Clear indication should be provided at the alarm pressure value section and the place of 30 MPa on the scale dial of the pressure gage.

9.16.4 The wearer should be able to read the indicated pressure value in dim or dark environment.

9.16.5 Water should not enter the pressure gage during waterproof performance test.

9.16.6 After the pressure gage is disconnected from the hose, the air leakage should not exceed 25 L/min when the pressure in the cylinder is 20 MPa.

9.16.7 Other performance of the pressure gage should meet the requirement of GB1226-2001.

9.17 High-pressure part strength

The high-pressure part should be free of leakage or abnormal deformation after water pressure test.

9.18 Medium-pressure airway tube

9.18.1 The airway tube should not affect the wearer's operation and head movement, or the connection of the air supply valve and mask;

9.18.2 The airway tube should not be blocked when it is bent or deformed due to wearer's movement;

9.18.3 The bursting pressure of the airway tube should not be less than 4 times the designed max. output pressure of the pressure reducer.

9.19 Air cylinder valve

9.19.1 The direction of the cylinder valve is anticlockwise after being opened.

9.19.2 Measures should be taken to guarantee that the cylinder valve will not be closed unintentionally after being opened. If the cylinder valve cannot be locked after being opened, it can only be closed after the opening hand wheel has been turned for at least 2 circles;

9.19.3 Safety diaphragm should be provided on the cylinder valve with bursting pressure of (37~45) MPa.

9.19.4 The output end thread of the cylinder valve should be internal thread with size of G5/8 and tolerance meeting the requirement of Table 1 of GB7307-2001.

9.20 Personnel wearing performance

It should make the wearer feel good without any insufficient air supply.

10 Test method and steps

10.1 Structure, mark and package inspection

Visual inspection should be adopted, and the result should meet the requirements of 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 on dressing belt and belt buckle materials

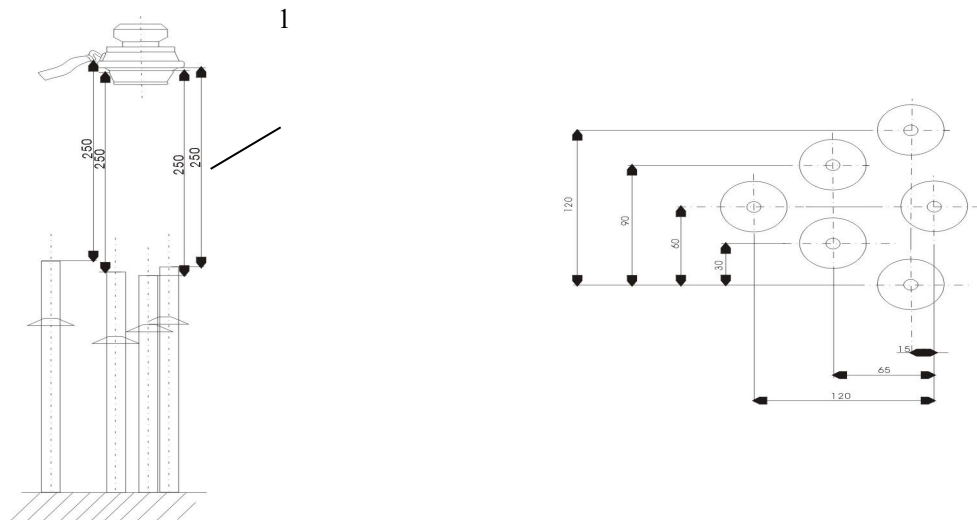
The flame height of the burner should be kept at 40 mm, and the temperature at the height of 20 mm above the flame should be kept at $(800\pm 50)^{\circ}\text{C}$ by adjusting the propane gas flow. The sample should be placed horizontally at the height of 20 mm above the flame for 12 s, and the result should comply with 9.2.3.



Fig.1 Schematic diagram for devices used for flame retardation test on dressing belt and belt buckle materials

10.2.2 Flame retardation test on mask, medium-pressure airway tube and air supply valve materials

Place the sample as per Fig. 2. Adjust the distance between the burner nozzle and the external surface of the sample to 250 mm, adjust the propane gas flow to keep the temperature at the center of the triangle formed by the top of the burner 250 mm away from the top of the burner at $(950\pm 50)^{\circ}\text{C}$, expose the sample in the flame for 5 s, and then conduct test as per 11.4. The result should meet the requirement of 9.2.4.



2



1. Sample

2. Burner nozzle

Fig. 2 Schematic diagram for devices used for flame retardation test on mask, medium-pressure airway tube and air supply valve materials

10.3 Wearing weight

It should be weighted with a scale, and the result should meet the requirement of 9.5.

10.4 Complete machine airtightness test:

Open the air supply valve when the cylinder pressure is not less than 90% of the nominal operating pressure, put the mask on the model head with good airtightness, open the air cylinder valve and then close it when the air channel of the system is filled with compressed air. After that, observe the pressure drop on the pressure gage of the air breathing apparatus within 1 min after the air cylinder is closed, and the result should meet the requirement of 9.6.

10.5 Dynamic respiration resistance test

10.5.1 Test device

Integrated test equipment for the air breathing apparatus.

10.5.2 Test steps:

Put the mask on the model head with good airtightness, connect the breathing interface with the artificial lung, set the respiratory rate and flow of the artificial lung to 40 times/min and 100 L/min respectively, open completely the air cylinder valve, start the artificial lung, and measure the respiratory resistance in the mask in the range of the rated operating pressure - 2 MPa of the cylinder; set the respiratory rate and flow of the artificial lung to 25 times/min and 25 L/min respectively, and measure the respiratory resistance in the mask in the operating pressure range of 2 MPa - 1 MPa of the cylinder. The result should meet the requirement of 9.7.

10.6 High temperature resistance test

Put the air breathing apparatus (adjust the pressure in the cylinder to 10 MPa) in the environment at $(60\pm 3)^{\circ}\text{C}$ for 4 h, then take it out and immediately connect it with the artificial lung; set the

respiratory rate and flow of the artificial lung to 40 times/min and 100 L/min respectively, open completely the air cylinder valve, start the artificial lung, and measure the respiratory resistance till the pressure in the air cylinder reaches 2 MPa. The result should meet the requirement of 7.9.8.

10.7 Low temperature resistance test

Put the air breathing apparatus (adjust the pressure in the cylinder to 30 MPa) in the environment at $(30\pm 3)^{\circ}\text{C}$ for 12 h, then take it out and immediately connect it with the artificial lung; set the respiratory rate and flow of the artificial lung to 25 times/min and 50 L/min respectively, open completely the air cylinder valve, start the artificial lung, and measure the respiratory resistance till the pressure in the air cylinder reaches 2 MPa. The result should meet the requirement of 7.9.9.

10.8 Static pressure test

Put the mask on the model head with good airtightness, connect the breathing interface with the artificial lung, open the air cylinder valve completely when the air supply valve is closed, start the artificial lung for respiration slowly for several times and then close it; record the mask pressure when the air channel of the system is balanced, and the result should meet the requirement of 9.10.

10.9 Alarm performance test

10.9.1 Start the air breathing apparatus and conduct respiration in the range of rated operating pressure - 2 MPa of the cylinder with respiratory rate and flow of 40 times/min and 100 L/min respectively, and in the range of 2 MPa - 1 MPa with respiratory rate and flow of 25 times/min and 50 L/min respectively. Read the alarm pressure of the alarm on the pressure gage of the air breathing apparatus and record the sound duration at the same time;

10.9.2 Measure the sound level at a place 1 m away from the alarm after the alarm sounds;

10.9.3 Connect the alarm output end with the flowmeter, change the alarm input end pressure, measure the alarm output end flow when the alarm sounds and the input end pressures are 4 MPa, 3 MPa, 2 MPa and 1 MPa respectively, and then calculate the average value. At the same time, record the duration from the time when the alarm sounds to that when the pressure is 1 MPa, and calculate the air consumption. The result should meet the requirement of 9.11.

10.10 Mask performance test

10.10.1 The test on the carbon dioxide content in the air inhaled should be conducted as per 6.5.3 of GA209-1999, and the result should meet the requirement of 10.12.3.

10.10.2 View field test

The view field test should be conducted as per GB2891-2009, and the result should meet the requirement of 9.12.3.

10.11 Pressure reducing valve performance test

Install the pressure gage at the output pressure end of the pressure reducer, open the air cylinder

valve, and measure the output pressure of the pressure reducer in the range of the rated operating pressure - 2 MPa of the cylinder. The result should meet the requirement of 9.13.

10.12 Safety valve performance test

10.12.1 Connect the input end of the safety valve with the air source, rise the pressure slowly and uniformly with a rate of not more than 0.01 MPa / s, and then measure the opening pressure of the safety valve;

10.12.2 Continue to raise the pressure till the safety valve reaches the full exhaust status, and then measure the full exhaust pressure of the safety valve;

10.12.3 Reduce the pressure slowly and uniformly till the safety valve is closed, and then measure the closing pressure of the safety valve.

The result should meet the requirement of 10.14.

10.13 Pressure gage test

10.13.1 Measure the shell diameter of the pressure gage with a vernier caliper. The result should meet the requirement of 9.16.

10.13.2 Immerse the pressure gage into the clear water with temperature of not less than 5°C for 24 h. The result should meet the requirement of 9.16.

10.13.3 When the pressure in the cylinder is 20 MPa, remove the pressure gage, install the flowmeter, open the cylinder valve completely, and measure the air leakage of the pressure gage airway tube. The result should meet the requirement of 9.16.

10.14 High-pressure part strength test

Apply water pressure that is 1.5 times the cylinder operating pressure at the input end of the high pressure part for 2 min. The result should meet the requirement of 9.17.

10.15 Medium-pressure airway tube burst pressure test

Connect the medium-pressure airway tube with the special water pressure testbed, exhaust the gas in the pipe, and raise the pressure slowly till it bursts. The result should meet the requirement of 9.18.

10.16 Safety diaphragm burst pressure test

Connect the air cylinder valve with safety diaphragm to the water pressure testbed, close the air cylinder valve, and raise the pressure slowly till it bursts. The result should meet the requirement of 9.19.3.

10.17 Air cylinder valve output terminal size determination: The result should meet the requirement of 9.19.4.

10.18 Personnel wearing performance test

10.18.1 Test condition

It should be conducted at normal temperature, normal pressure, and specified simulated environmental conditions.

10.18.2 Wearer's subjective sensation

- (1) Wearing comfort;
- (2) Dressing belt buckle adjustability;
- (3) Whether the pressure gage is accessible and visible;
- (4) Sight definition of the mask viewport;
- (5) Whether the mask is capable of removing the fog on the viewport;
- (6) Air supply valve opening status;
- (7) Air supply status;
- (8) Sound transmission status;
- (9) Alarm status;
- (10) Other matters found by the wearer.

10.18.3 Ask two persons to wear fire control work clothes and air breathing apparatus respectively and then walk on the flat ground at 6 km/h for 30 min. After that, ask them their feelings. The result should meet the requirement of 9.20.

10.18.4 Adaptability test in the simulated environment

Ask two persons to wear fire control work clothes and air breathing apparatus respectively and then conduct the test as per the following sequence for 30 min. After that, ask them their feelings. The result should meet the requirement of 9.20.

- (1) Carry a 13 kg earth bag to walk for 15 m, and then put it on the plate wall of 2 m in height;
- (2) Climb over plate walls of 0.4 m, 1 m, 1.2 m and 2 m respectively with an interval of 7 m;
- (3) Climb over the wall corner of the fire training building;

- (4) Climb up/down the 12 m high fire ladder for three times respectively;
- (5) Climb up/down the 12 m high ladder with 460 mm square holes for one time respectively;
- (6) Wind and unwind one fire hose; climb over one pore channel with length of 3.7 m and diameter of 0.7 m and another one of 3.7 m (L) X 0.9m (W) X 0.6m(H) respectively;
- (7) Rest for 5 min, check the blood pressure, electrocardio and heart rate, and then replace the air cylinder;
- (8) Run on the flat ground at 6 km / h till the end of the test.