SUPPLIED AIR RESPIRATORY PROTECTIVE DEVICES FOR RESCUE TEAMS - COMPRESSED AIR OPEN-CIRCUIT SELF-CONTAINED BREATHING APPARATUS

CFASDM 002 : 2013

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THE COUNCIL OF FIRE APPLIANCES STANDARD

FOR DISASTER MANAGEMENT

FOREWORD

This standard has been established by the Council of Fire Appliances Standard for Disaster Management (CFASDM) for which the Fire Equipment and Safety Center of Japan (FESC) acts as the Secretariat regarding the performance and testing methods for highly advanced fire equipment used by the rescue teams of fire departments at the time of special types of disasters, such as terrorism, as well as large-scale disasters, such as volcanic eruptions.

This standard has been established with reference to the relevant NIOSH (National Institute for Occupational Safety and Health) standards, EN (European standards), JIS and others. Whenever these reference standards are revised, this standard will accordingly be reviewed and revised if necessary.

It must be reminded that parts of this standard may infringe a patent with technical properties, patent on application after its laid-open disclosure, utility model patent or application for the registration of a utility model after its laid-open disclosure. Neither the Council of Fire Appliances Standard for Disaster Management nor the Fire Equipment and Safety Center of Japan shall be held responsible for the non-confirmation of such patent with technical properties, patent on application after its laid-open disclosure, utility model patent or application for the registration of a utility model after its laid-open disclosure.

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Supplied Air Respiratory Protective Devices for Rescue Teams – Compressed Air Open- Circuit Self-Contained Breathing Apparatus

1. Scope

This standard stipulates the minimum requirements regarding the structure-related demands and performance-related demands for the pressure-demand compressed air open-circuit self-contained breathing apparatus (hereinafter referred to as the "apparatus") among the supplied air respiratory protective devices used by rescue teams at the time of a special kind of disaster or a large-scale disaster.

Note : The apparatus stipulated in this standard does not assume its use in such situation as exposure to radiation, fierce fire, ignition by a chemical substance or high risk of explosion.

2. Normative references

The standards listed below shall form part of this standard when cited in this standard. When a cited standard is accompanied by the year of effectuation, the version established in that year alone shall form part of this standard and the provisions of subsequent revisions and supplementary provisions shall not form part of this standard.

JIS T 8001	:	1992	Glossary of terms for respiratory protective devices
JIS T 8155	:	1994	Compressed air open-circuit self-contained breathing apparatus
CFASDM 003	:	2004	Protective clothing for rescue teams for protection against chemicals

3. Definitions

The principal term used in this standard is defined as follows in addition to those definitions given in **JIS T 8001**, **JIS T 8155** and **CFASDM 003**.

a) **Permeation:** The phenomenon where a chemical substance in contact with a material surface is absorbed, diffused inside at the molecular level and departs through the rear surface.

4. Structure

The structure of the apparatus must meet the following requirements.

4.1 General

The apparatus shall have a structure which releases air from a compressed air cylinder to inside the facepiece via a supply valve, enables the wearer to inhale through the facepiece and discharges exhaled air to the outside via an exhalation valve, allowing the wearer to conduct work without

hindrance, shall have a pressure indicator and an alarm, shall be equipped with a pressure reduce valve, by-pass valve and medium-pressure hose if necessary and shall meet the following requirements.

a) The apparatus shall have a robust construction, be easy to use, as light weight as possible, durable for long use and reasonably resistant to breakdown or damage.

b) The apparatus shall be easy to operate and shall not create an abnormal feeling of oppression when worn.

c) The coupling at the coupling sections shall be secure with no prospect of leakage.

d) Any impact which is likely to occur as part of the handling of the apparatus shall not cause any hindrance to its use.

e) The apparatus shall have a mechanism which prevents its use when connection to a compressed air cylinder, the maximum filling pressure of which exceeds the maximum allowable working pressure, is attempted by means of allowing outward air discharge or other.

f) A compressed air cylinder shall have a carrying air capacity (capacity at the absolute pressure of 1 atm and 35 °C) of 1,200 L or more.

4.2 Structure of each component

4.2.1 Facepiece

The facepiece shall be a full facepiece which is easy to fit, shall have a headband which is sufficiently flexible, strong and adjustable and shall meet the following requirements.

a) The full facepiece shall cover the entire face of the wearer with a structure which prevents any leakage while the eyepiece shall be transparent, shall not cause distorted images which hinder the proper use of the apparatus and shall have a structure which prevents fogging. When tested by the method stipulated in **6.2.1 b)** after the test stipulated in **6.1.1**, the pressure after 1 min shall be between 1 kPa and 900 Pa.

b) The strength of the headband attaching sections shall be 100 N or higher when tested by the method stipulated in **6.1.2**.

4.2.2 Supply valve

The structure of the supply valve shall meet the following requirements.

a) The supply valve shall be sufficiently safe and gas-tight under the working pressure and shall hardly have any irregularity as a result of external impact.

b) The supply valve shall function sensitively in response to breathing.

c) The pressure demand valve shall function sensitively in response to the set positive pressure value.

4.2.3 Pressure demand-type exhalation valve

The exhalation valve shall have a structure which does not easily suffer from distortion or damage due to external pressure and shall open in a sensitive and assured manner in response to the set value or higher of positive pressure.

4.2.4 Pressure reduce valve

The pressure reduce valve shall meet the following requirements.

a) The pressure reduce valve shall be sufficiently safe under the working pressure and shall hardly have any irregularity as a result of external impact.

b) When a supply valve which does not have a function of a medium pressure safety valve in use, a medium pressure safety valve must be provided.

4.2.5 By-pass valve

The by-pass valve shall be capable of easily releasing air independently from the supply valve.

4.2.6 Pressure indicator

The graduations of the pressure indicator shall have explicit indication of the maximum filling pressure of the compressed air cylinder and the set pressure to actuate the alarm.

4.2.7 Alarm

The alarm shall be capable of clearly warning the wearer of low remaining air in an effective manner when the air pressure reaches the set value to actuate the alarm in use.

4.2.8 Harness

The harness shall have a structure which ensures the easy movement of the wearer who is carrying the apparatus on the back, shall have a robust construction, shall securely hold the compressed air cylinder and shall be adjustable to match the physical frame of the wearer.

4.2.9 Air supply hose

The air supply hose shall meet the following requirements.

a) The air supply hose shall not hinder the movement of the wearer.

b) When in use, the air supply hose shall be able to supply air without any hindrance even if it is pressed by the chin or an arm or subject to various kinds of bending.

c) The air supply hose attaching section shall not rupture when tested by the method stipulated in **6.1.3**.

d) The rupture pressure for a medium pressure hose shall be 5 times the standard working pressure or higher at the lower side of the pressure reduce valve .

4.2.10 Compressed air cylinder

The compressed air cylinder and stop valve used for the cylinder shall conform to the relevant provisions of 'Vessel Safety Regulations' based on 'High Pressure Gas Safety Law'.

5. Performance

The performance shall meet the following requirements.

5.1 Gas-tightness

The gas-tightness shall conform to the following provisions.

a) When the apparatus is tested by the method stipulated in **6.2.1 a)**, the pressure reduction shall not exceed 2 MPa per minute.

b) When the facepiece is tested by the method stipulated in **6.2.1 b)**, the pressure after 1 min shall be between -1 kPa and -900 Pa.

5.2 Leakage rate of apparatus

When the apparatus is tested by the method stipulated in **6.2.2**, the leakage rate shall be less than 0.03 %.

5.3 Pressure inside facepiece during inhalation

When tested by the method stipulated in **6.2.3**, the pressure inside the facepiece during inhalation shall be between +100 Pa and +600 Pa for no inhalation and between 0 Pa and +600 Pa for the inhalation gradually increased from 0 L/min to 300 L/min.

5.4 Pressure inside facepiece during exhalation

When tested by the method stipulated in **6.2.4**, the pressure inside the facepiece during exhalation shall be +700 Pa or less at 30 L/min and +1.5 kPa or less at 300 L/min.

5.5 Quantity of air released from by-pass valve

When tested by the method stipulated in **6.2.5**, the quantity of air released from the by-pass valve shall be 60 L/min or more at compressed air pressure of 3 MPa.

5.6 Actuation of alarm

When tested by the method stipulated in **6.2.6**, the pressure to actuate the alarm shall be between 100 % and 150 % of the set value.

5.7 Heat resistance of apparatus

When the apparatus form which the compressed air cylinder and stop valve are detached is tested by the method stipulated in **6.2.7**, the test results shall meet the requirements under **5.1 Gas-tightness, 5.3 Pressure inside facepiece during inhalation** and **5.4 Pressure inside facepiece during exhalation**.

5.8 Flame resistance of apparatus

The flame resistance of the facepiece, the components connected to the facepiece (air supply hose and pressure demand valve) and the harness (strap and buckle) shall be one of the classes shown in **Table 1** when tested by the method stipulated in **6.2.8**.

Table 1 Classification of flame resistance

Class	Duration of exposure	Required performance
3	Steady placement of the test piece in flames for 5 s	• No damage is caused which results in abnormality of the structure or performance. • No molten droplets are generated. • Burning does not continue for more than 5 s after after removing the flame.
2	Steady placement of the test piece in flames for 1 s	
1	Passing of the test piece through a flame	

5.9 Cold resistance of apparatus

When the apparatus detached the compressed air cylinder and stop valve is tested by the method stipulated in **6.2.9**, the test results shall meet the requirements under **5.1 Gas-tightness, 5.3 Pressure inside facepiece during inhalation** and **5.4 Pressure inside facepiece during exhalation**.

5.10 Permeation resistance of facepiece

The permeation resistance of the facepiece shall meet the following requirements.

5.10.1 The face contact area and eyepiece of the facepiece shall not cause obvious discolouration of the detector paper when tested by the method stipulated in **6.2.10**.

5.10.2 When used with a gas-tight chemical protective suit with a breathing air supply that is independent of the ambient atmosphere worn outside the suit (Type 1b) of which the structure makes the facepiece act as the primary barrier between the ambient atmosphere and the wearer, the face contact area and eyepiece of the facepiece shall meet the requirements under **5.10.1** above and also the requirements under **6.3.3 Facepiece for respiratory protective devices in CFASDM 003** Chemical protective clothing for rescue teams.

6. Tests

The tests shall be structural tests and performance tests.

6.1 Structural tests

The following structural tests shall be conducted.

6.1.1 Impact test on eyepiece

After alternatively placing the eyepiece attached to the facepiece in thermostatic chambers of -10°C and 40°C five times each for 30 min each time, the facepiece shall be attached to a dummy head or similar with the central part of the eyepiece in a level position. A steel ball of 22 mm in diameter and some 45 g in mass shall then be freely dropped on to the central surface of the eyepiece from a height of 1.3 m and any occurrence of a gas-tightness defect due to damage to the eyepiece, etc. shall be checked by the method stipulated in **6.2.1 b)**. In this case, the steel ball may be dropped through a pipe (with an inner diameter of approximately double the diameter of the steel ball in question) which allows the free fall of the steel ball.

6.1.2 Strength test of headband and its attaching part

The headband for testing of which one end is attached to the facepiece (or a suitable part) and the other end consists of the end of the headband in question (opposite end of the headband from the end attached to the facepiece) shall be mounted to a tensile tester and shall be pulled at a speed of 20 cm/min to measure the load when either the headband or headband attaching section ruptures.

6.1.3 Strength test of air supply hose attaching part

Using a suitable place of the facepiece and a component connected to the air inlet side of the air supply hose as the two ends, the air supply hose shall be pulled with a force of 150 N to check if any rupture occurs.

6.2 Performance tests

The following performance tests shall be conducted.

6.2.1 Gas-tightness test

The gas-tightness test shall be conducted in the following manner.

a) Apparatus

A fully filled compressed air cylinder shall be attached to the apparatus and the facepiece shall be mounted to the dummy head shown in **Fig. 1**. The stop valve shall then be opened and the supply valve shall be placed in the state of pressure demand. After confirmation of the stoppage of the rising pointer of the pressure indicator of the apparatus, the stop valve shall be closed, followed by checking of any decline of the reading by the pressure indicator for a duration of 1 min.

Notes

(1) When connection is made to a high pressure pipeline instead of a compressed air cylinder, the connecting section to the said high pressure pipeline shall have the same configuration as the connecting section of the stop valve with the high pressure capacity being equal to the capacity of the stop valve.

(2) When the structure of the pressure demand valve is designed to function to maintain a positive pressure through the release of a tiny quantity of air, this quantity of air released shall not be deemed to constitute air leakage.

(3) A measure to prevent air leakage from the contact area between the facepiece and dummy head may be applied.

b) Facepiece

The facepiece shall be mounted to the dummy head shown in **Fig. 1**. The connecting port of the supply valve shall be plugged and the exhalation valve shall be moistened. The hollow area of the facepiece and the dummy head shall be reduced pressure by 1 kPa and observation shall be conducted for the duration of 1 min.

Note

(1) A measure to prevent air leakage from the contact area between the facepiece and the dummy head may be applied.

6.2.2 Leakage rate test on apparatus

The facepiece shall be properly mounted to the dummy head. A test contaminant shall be supplied to the test chamber shown in **Fig. 2** and a breathing simulator shall be used to simulate breathing of 24 times/min at a rate of 40 L/min. After 3 min, part of the exhaled air suctioned to the exhaled air circuit shall be sampled for measuring of the contaminant concentration Ci by the detector for a duration of 1 min or longer.

In addition, air containing the test contaminant shall be sampled from the test chamber and the contaminant concentration Co shall be measured for a duration of 1 min or longer.

The leakage rate shall be determined by the following expression based on the Ci and Co values established by the test.

$$\text{(air leakage rate)} = \frac{C_I}{C_0} \times 100$$

Note : The test contaminant to be used in this test shall be NaCl particles, sulphur hexafluoride gas, isoamilacetate or an equivalent chemical substance.

6.2.3 Test on pressure inside facepiece during inhalation

Either the facepiece or a test facepiece with the same specifications shall be mounted to a dummy head and sealing shall be applied to achieve an air leakage from the contact area between the facepiece and the dummy head of 0.1 L/min or less when the pressure inside the facepiece is 600 Pa. A supply valve shall then be attached to this facepiece and air with the maximum working pressure (0 ~ 2 MPa) of the apparatus and 3 MPa shall be supplied to the connecting port of the facepiece to the compressed air cylinder. This shall be followed by measuring of the pressure inside the facepiece (for a facepiece with a nose cup, the pressure outside the nose cup) when the inhalation is none and when the inhalation is gradually increased from 0 L/min to 300 L/min.

6.2.4 Test on pressure inside facepiece during exhalation

The facepiece of the apparatus shall be mounted to a dummy head and air shall be supplied at a rate of 30 L/min and 300 L/min, then the pressure difference between the inside and outside of the facepiece shall be measured.

6.2.5 Test on Operation of by-pass valve

An air pressure of 3 MPa shall be applied to the high pressure area and the by-pass valve shall be opened, then the quantity of air released shall be measured.

6.2.6 Test on actuation of alarm

An air pressure of 200 % of the set value or higher shall be applied to the high pressure area and either the supply valve or the by-pass valve shall be operated to reduce the air pressure, then the level of pressure required to actuate the alarm shall be measured.

6.2.7 Heat resistance test on apparatus

The apparatus detached the compressed air cylinder and stop valve shall be suspended in a thermostatic chamber of 70±2 °C. After 6 h of heating, the apparatus shall be removed from the chamber and stood at room temperature for 1 h or longer and shall undergo **6.2.1 Gas-tightness test**, **6.2.3 Test on pressure inside facepiece during inhalation** and **6.2.4 The test on pressure inside facepiece during exhalation**.

6.2.8 Flame resistance test on apparatus

The flame resistance test on the facepiece, the components connected to the facepiece (air supply hose and pressure demand valve) and the harness (strap and buckle) shall be conducted by checking for any sustained damage, melting and/or burning of any component which is exposed to ambient atmosphere when the apparatus is worn. In this test, each component shall pass through burner flames of 800±50 °C only once at a speed of 60 ± 5 mm/sec. The details of this test are shown in **Fig. 3**.

Note

(1) The above method of testing shall apply to components of Class 1 resistance to flame. In the case of Class 2 and Class 3 resistance to flame components, each component moving at a speed of 60±5 mm/sec shall stop in the flames for the stipulated duration of time before resuming steady movement.

6.2.9 Cold resistance test on apparatus

The apparatus form which the compressed air cylinder and stop valve are detached shall be suspended in a thermostatic chamber of -20±2 °C. After 3 h, the apparatus shall be removed from the chamber and stood at room temperature for 1 h or longer and shall undergo **6.2.1 Gas-tightness test**, **6.2.3 Test on pressure inside facepiece during inhalation** and **6.2.4 Test on pressure inside facepiece during exhalation**.

6.2.10 Permeation resistance test on facepiece

The permeation resistance test on the facepiece shall be conducted in the following manner.

a) From the areas of the face contact area and eyepiece of the facepiece which are in contact with ambient atmosphere (when in actual use), test pieces of 15 mm × 15 mm in size shall be cut from the thinnest parts of those areas where test pieces of the said size can be cut.

b) Detector paper (designated by a test institution which is stipulated separately from this standard) of 10 mm x 10 mm in size shall be closely adhered to the back (face side of the facepiece) of each test piece. Each test piece shall be placed on a glass plate with the detector paper side facing down and the area between the edges of the test piece and glass plate shall be sealed with paraffin.

c) The test piece shall be placed in a level position and 0.02 mL of β-chloroethyl ethyl sulphide (CAS: 693-07-2) shall be dripped on to the surface of the test piece.

d) The specimen in the state described in **c)** shall be placed inside a thermostatic chamber of 30 ±1 °C and any discolouration of the detector paper shall be examined 6 h later.

7. Inspection

The following items shall be inspected by means of sampling inspection and shall be complied with all the requirements under each item.

(1) Apparatus

- **a)** Gas-tightness
- **b)** Pressure inside facepiece during inhalation
- **c)** Pressure inside facepiece during exhalation
- **d)** Quantity of air released from by-pass valve
- **e)** Actuation of alarm

(2) Unit Facepiece

- **a)** Gas-tightness

b) Pressure inside facepiece during exhalation [(1)]

Note [(1)] This inspection shall be conducted when the facepiece is equipped with (an) exhalation valve(s).

8. Marking

The following information shall be marked in Japanese on the apparatus in easily visible places.

a) Name of standard

b) Model number (number given by a test institution which is stipulated separately from this standard)

c) Name of manufacturer or its code

d) Date of manufacture or its code

e) Resistance to flame class

f) Special performance (applicability to Level A - Protective clothing for rescue teams for protection against chemicals (Type 1b))

g) Prohibited use of a compressed oxygen cylinder

h) Names of components and their product numbers (may be listed in the manual as an alternative)

9. Manual

The apparatus shall be accompanied by a manual which explains the following matters in Japanese.

a) Important notes for use

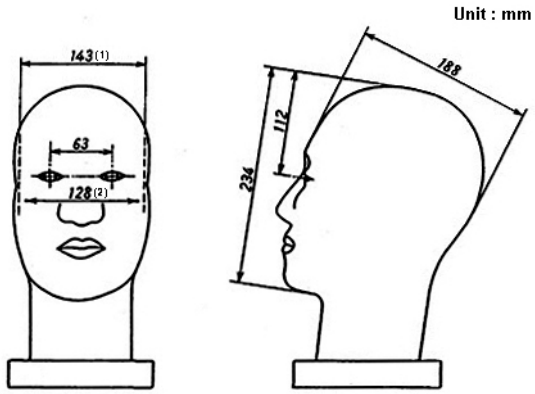
b) Method of use (donning and doffing methods, use for emergency response and others)

c) Checking, maintenance and storage methods before and after use

d) Disinfection method for facepiece

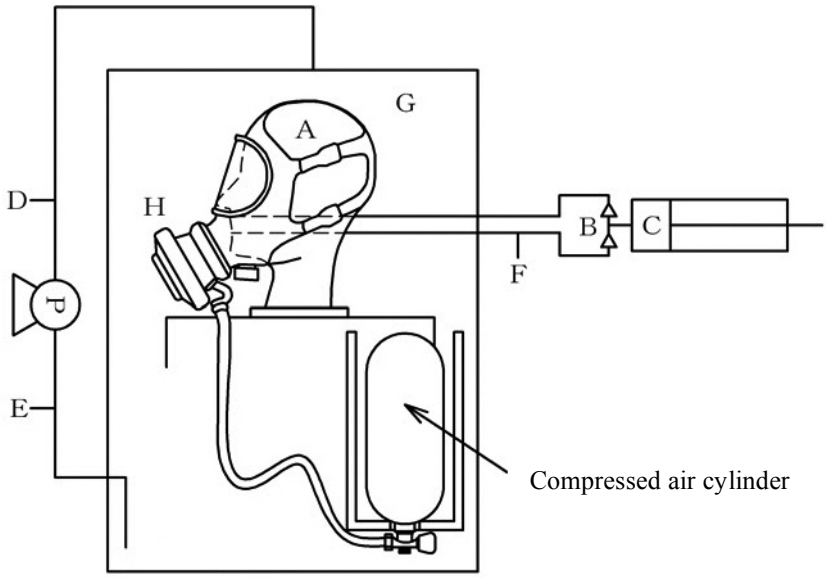
e) Prospect of use in an environment exceeding the atmospheric pressure and important notes if such use is feasible

f) Compatible model of protective clothing against chemicals



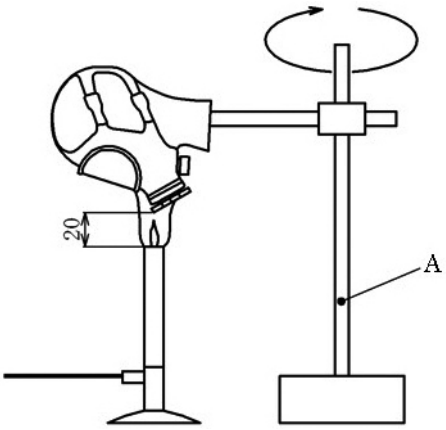
Notes
1) Distance between the antilobia
2) Width of the zygomatic arch

Fig. 1 Dummy head for testing

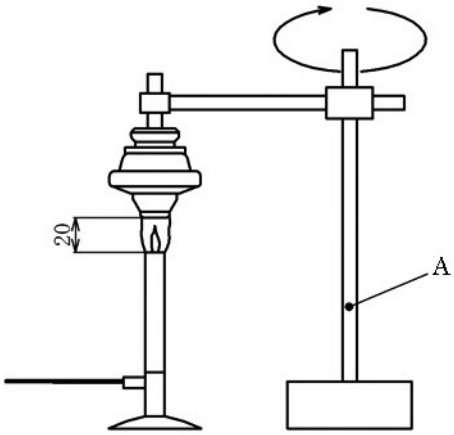


A : Dummy head
B : Three way valve
C : Breathing simulator
D : Inflow port of contaminant
E : Sampling port for air inside the chamber
F : Sampling port for air inside the apparatus
G : Test chamber
H : Sample (the apparatus)

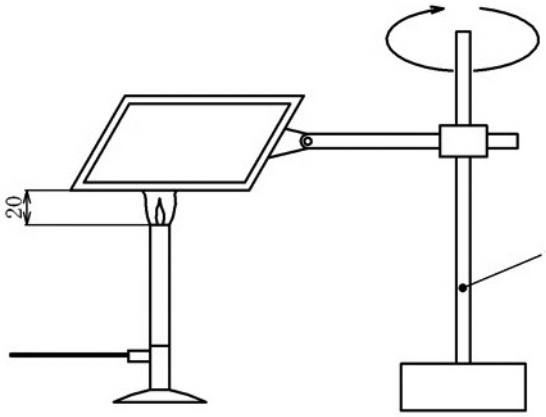
Fig. 2 Leakage rate test



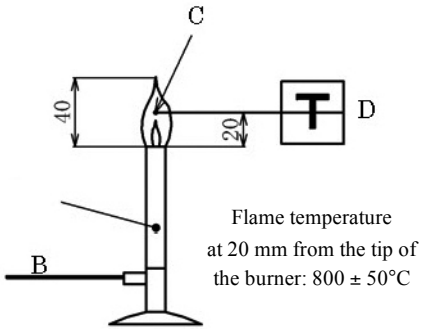
(1) Flame resistance test on facepiece



(2) Flame resistance test on components connected to facepiece



(3) Flame resistance test on harness (strap and buckle)



(4) Adjustment of burner

A : Rotator
B : Height adjustable burner
or burner stipulated in ISO6941: 1987/AMD1: 1992
C : Thermocouple
D : Thermometer

Fig. 3 Flame resistance test methods

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