

ICS 23.020.30

CCS J 74



**NATIONAL STANDARD OF THE  
PEOPLE'S REPUBLIC OF CHINA**

**GB 28053-2011**

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**[GB/T 28053-2011] Composite cylinders for breathing apparatus**

呼吸器用复合气瓶

**(English Translation)**

**Issued on: December 30, 2011**

**Implemented on: December 1, 2012**

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

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### 1 Scope

This standard specifies the types and parameters, technical requirements, test methods and qualification standards, inspection rules and markings, packaging, transportation and storage requirements of fully wrapped carbon-fiber reinforced aluminum liner composite cylinders for breathing apparatus (hereinafter referred to as gas cylinders).

This standard applies to the design and manufacture of gas cylinders which have a nominal working pressure not greater than 30 MPa, a nominal volume of not greater than 12 L, an ambient temperature of use of -40 °C ~ 60 °C, is refillable of breathing gas.

### 2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this standard.

GB 191 Packaging - Pictorial marking for handling of goods

GB/T 192 General purpose metric screw threads - Basic profile

GB/T 196 General purpose metric screw threads - Basic dimensions

GB/T 197 General purpose metric screw threads - Tolerances

GB/T 228.1 Metallic materials - Tensile testing - Part 1: Method of test at room temperature

GB/T 230.1 Metallic materials - Rockwell hardness test - Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)

GB/T 231.1 Metallic materials - Brinell hardness test - Part 1: Test method

GB/T 1458 Test method for mechanical properties of ring of filament -  
Winding reinforced plastics

GB/T 3191 Extrusion rods and bars of aluminum and aluminum alloys

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GB/T 3246.1 Inspection method for structure of wrought aluminum and aluminum alloy products - Part 2: Inspection method for microstructure

GB/T 3246.2 Inspection method for structure of wrought aluminum and aluminum alloy products - Part 2: Inspection method for macrostructure

GB/T 3362 Test methods for tensile properties of carbon-fiber multifilament

GB/T 3880.1 ~ 3880.3 Wrought aluminum and aluminum alloy plates, sheets and strips for general engineering

GB/T 3934 Specification of gauges for general purpose screw threads

GB/T 4437.1 Aluminum and aluminum alloy extruded tubes - Part 1:  
Seamless tubes

GB/T 4612 Plastics - Epoxy compounds - Determination of epoxy equivalent

GB/T 6519 Process for ultrasonic inspection of wrought aluminum alloy products

GB/T 7690.3 Reinforcements - Test method for yarns - Part 3: Determination of breaking force and breaking elongation for glass fiber

GB/T 9251 Methods for hydrostatic test of gas cylinders

GB/T 9252 Method for pressure cycling test of gas cylinders

GB/T 12137 Method for leakage test of gas cylinders

GB/T 13005 Terminology of gas cylinders

GB/T 15385 Method for hydraulic burst test of gas cylinder

GB/T 20975 (all parts) Methods for chemical analysis of aluminum and aluminum alloys

YS/T 67 Wrought aluminum and aluminum alloy columniform ingots

TSG R7002 Rules for type test of gas cylinder

### 3.1 Terms and definitions

The terms and definitions as established in GB/T 13005 as well as the following terms and definitions apply to this document.

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The testing method shall comply with the provisions of GB/T 20975.

5.1.1.2 The material of the liner shall meet the requirements of the corresponding standards. The ingot shall be in accordance with YS/T 67; the extruded bar shall be in accordance with GB/T 3191; the plate shall be in accordance with GB/T 3880.1 ~ 3880.3; the tube shall be in accordance with

GB/T 4437.1. The grain size of the ingot shall not be lower than the grade 2.

The test method of grain size conforms to the provisions of GB/T 3246.2.

5.1.1.3 The liner material shall have the product quality certificate of the material manufacturer. It can be used only after passing the re-inspection by the gas cylinder manufacturer.

5.1.1.4 The chemical composition re-inspection shall be conducted according to the material's furnace number. The content of Pb and Bi may be confirmed according to the data of the product quality certificate.

5.1.1.5 The ingot shall be ultrasonically tested. The ultrasonic testing shall be carried out according to the  $\phi 2$ mm equivalent flat-bottomed hole. The testing method shall meet the requirements of GB/T 6519.

#### 5.1.2 Liner design

##### 5.1.2.1

Shoulder and bottom shall adopt convex structure.

##### 5.1.2.2

The thickness of the shoulder and bottom shall meet the requirements of the hydraulic burst test and fatigue test of the gas cylinder.

##### 5.1.2.3 In order to obtain a reasonable stress distribution, the shoulders and

bottom shall use the gradually-changed thickness design; the cylinder and shoulders, cylinder and bottom shall be smoothly transitioned.

5.1.2.4 The designed wall thickness of the liner shall be verified by stress analysis.

5.1.2.5 The thickness of the bottleneck shall ensure that it will not deform when subjected to the additional external force of valve installation. The valve installation torque shall comply

with the provisions of Appendix A.

5.1.2.6 The thread of the bottle opening shall be straight thread and penetrate through the opening. The thread length shall be not less than 6 pitches; the safety factor of shear stress under hydraulic test pressure shall be at least 10.

The calculation method of the safety factor of the thread's shear stress is as shown in Appendix B.

### **5.1.3 Manufacturing of liner**

#### **5.1.3.1**

It shall meet the requirements of design drawings and relevant technical

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The strength of the material shall meet the minimum value of the performance requirements of the gas cylinder manufacturer.

The testing method shall comply with the provisions of GB/T 7690.3.

### **5.2.1.3 Resin matrix**

It shall use epoxy resin or modified epoxy resin. The material shall meet the requirements of the corresponding standards and have a quality certificate. The material shall be suitable for the fiber wrapping process and meet the performance requirements of the gas cylinder manufacturer. The determination method of epoxy equivalent shall comply with the provisions of GB/T 4612.

### **5.2.2 Design of gas cylinder**

#### **5.2.2.1**

The hydraulic test pressure shall be  $5/3$  times the nominal working pressure.

#### **5.2.2.2**

The minimum burst pressure shall be 3.4 times the nominal working pressure.

#### **5.2.2.3**

The design service life of the gas cylinder is 15 years.

#### **5.2.2.4**

Stress analysis shall use finite element technology and establish an appropriate model, to calculate the maximum stress in the liner and the wrapping layer and the stress distribution at each point under zero pressure, working pressure, test pressure and minimum burst pressure after auto-fretting.