

ICS 23.020.30

CCS J 74

NB

**ENERGY INDUSTRY STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

NB/T 47011-2022

Replacing NB/T 47011-2010

Zirconium pressure vessels

锆制压力容器

Issued on: November 4, 2022

Implemented on: May 4, 2023

Issued by: National Energy Administration of the PRC

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Foreword

This document was issued on 4 November 2022 by the National Energy Administration of the PRC and takes effect on 4 May 2023.

It is a NB/T standard: recommended rather than compulsory, but it is the text a Chinese reviewer applies when assessing a submission.

It is classified under ICS 23.020.30, Chinese classification J 74.

It replaces NB/T 47011-2010, which is superseded.

This document has been drafted in accordance with the rules given in GB/T 1.1-2020, Directives for standardization - Part 1: Rules for the structure and drafting of standardizing documents.

This document replaces NB/T 47011-2010, Zirconium pressure vessels. In addition to structural adjustments and editorial changes, the following main technical changes have been made with respect to NB/T 47011-2010.

- a) The scope of application has been revised: the main body of the standard now applies to single layer welded pressure vessels (including tubular shells) whose shells are made entirely of zirconium material (see Clause 1).
- b) The indispensable normative references have been adjusted as required by the main body of the document (see Clause 2).
- c) Supplementary requirements have been introduced for GB/T 21183 standard zirconium plate used for the fabrication of pressure retaining components (see 5.2.2).
- d) Penetrant testing requirements have been introduced for zirconium forgings used for the fabrication of pressure retaining components (see 5.4.3).
- e) Penetrant testing requirements have been introduced for zirconium bars used for the fabrication of pressure retaining components (see 5.5.2).
- f) Requirements for externally purchased finished zirconium parts and components have been added (see 7.1.1.2).
- g) Requirements relating to risk prevention and control during the fabrication of zirconium vessels have been added (see 7.1.5 and 7.1.6).
- h) Requirements for the re-inspection of materials have been added (see 7.2.1).
- i) The requirements of the welding clauses have been revised and supplemented (see 7.4).
- j) The requirements of the heat treatment clauses have been revised and supplemented (see 7.5).
- k) The requirements of the clauses on test coupons and test specimens have been revised and supplemented (see 7.6).
- l) The requirements of the non-destructive testing clauses have been revised and supplemented (see 7.7).
- m) The requirements of the clauses on pressure tests and leak tests have been revised and supplemented (see 7.8).
- n) The requirements of the clauses on the hot gas cycling test have been revised and supplemented (see 7.9).
- o) The normative annex Zirconium clad plate pressure vessels and zirconium lined pressure vessels has been added (see Annex D).
- p) The informative annex Material properties of zirconium for pressure vessels has been revised (see Annex E).
- q) The informative annex Welded joint structures of zirconium clad plate vessels and zirconium lined vessels has been revised (see Annex F).

Attention is drawn to the possibility that some of the content of this document may involve patents. The issuing body of this document assumes no responsibility for identifying patents.

This document was proposed by and is under the jurisdiction of the National Technical Committee on Boilers and Pressure Vessels of Standardization Administration of China (SAC/TC 262).

Drafting organizations of this document: Hefei General Machinery Research Institute Co., Ltd.; China Special Equipment Inspection and Research Institute; Nanjing Baose Co., Ltd.; Sinopec Engineering Construction Co., Ltd.; CNNC Baoti Zirconium Industry Co., Ltd.; Xi'an You'nai Special Vessel Manufacturing Co., Ltd.; Zhejiang University of Technology; Hefei General Special Material and Equipment Co., Ltd.; China Huanqiu (Wuhuan) Engineering Co., Ltd.; Baoti Group Co., Ltd.; Western Titanium Industry Co., Ltd.

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The successive editions of this document and of the document it replaces are as follows: first issued in 2010 as NB/T 47011-2010; this is the first revision.

1 Scope

NB/T 47011-2022 governs pressure vessels made of zirconium and zirconium alloys, replacing the 2010 edition. Zirconium is the material of last resort for the most aggressive chemical duty - hot concentrated sulphuric, hydrochloric and organic acids, and urea service - where even titanium and high nickel alloys corrode, and it is expensive enough that a vessel is normally built as zirconium clad on steel or as a thin loose liner. Almost every rule follows from the metal's behaviour: it absorbs oxygen, nitrogen and hydrogen readily at temperature and embrittles, it ignites as fine swarf, and it is ruined by contact with iron. The standard sets the permitted grades and their allowable stresses against temperature, together with zirconium-clad plate and the requirements on the bond. It covers general requirements and design conditions, the design of shells, heads, openings, nozzles and flanges, and wall thickness with the corrosion allowance appropriate to the service. Fabrication is treated at length - forming and its temperature limits, cutting, the cleanliness and complete segregation from ferrous tooling, welding procedure and welder qualification with the inert gas shielding and trailing shields required, the control of weld colour as evidence of shielding, heat treatment and weld inspection. Testing, marking and the documentation delivered with the vessel close the document. It applies to the design, manufacture, inspection and acceptance of zirconium pressure vessels in China.

1.1 This document specifies the requirements for the materials, design, fabrication, inspection and acceptance of zirconium pressure vessels. It applies to single layer welded

pressure vessels (including tubular shells) whose shells are made entirely of zirconium material.

1.2 This document applies to zirconium pressure vessels with a design pressure not greater than 35 MPa.

1.3 The design temperature range covered by this document is determined by the service temperature permitted for the zirconium material.

1.4 The design and calculation methods given in this document apply to pressure retaining components made entirely of zirconium material. Those parts of a zirconium pressure vessel that are made of non-zirconium materials shall be designed and calculated in accordance with the relevant product standard for the material concerned.

1.5 This document does not apply to the following pressure vessels.

- a) Vessels with a design pressure lower than 0.1 MPa and a degree of vacuum lower than 0.02 MPa.
- b) Vessels governed by the Regulation on Safety Technology Supervision for Transportable Pressure Vessels.
- c) Pressure vessels used in military equipment, nuclear facilities, aerospace craft, railway locomotives, offshore installations and ships, and underground mines.
- d) Pressure retaining chambers that form an integral part of, or are a component of, rotating or reciprocating mechanical equipment, such as pump casings, compressor casings, turbine casings, hydraulic cylinders and papermaking rolls.
- e) Vessels heated directly by flame.
- f) Plate heat exchangers, spiral plate heat exchangers, air cooled heat exchangers and cooling coils.
- g) Vessels whose volume (the geometric volume excluding the permanent internals) is less than 0.03 cubic metres, or whose inside diameter (for non-circular cross sections, the largest geometric dimension of the inner boundary of the cross section) is less than 150 mm.
- h) Vessels for which a fatigue analysis is carried out.

1.6 Definition of the boundaries of the vessel.

1.6.1 Connections between the vessel and external piping are bounded as follows: a) the end face of the groove of the first circumferential joint for a welded connection; b) the end face of the first threaded joint for a threaded connection; c) the sealing face of the first flange for a flanged connection; d) the first sealing face for a special connector or pipe fitting connection.