ASME PVHO-1–2023
(Revision of ASME PVHO-1–2019)

Safety Standard for Pressure Vessels for Human Occupancy

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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FOREWORD

Early in 1971, an ad hoc committee was formed by action of the ASME Codes and Standards Policy Board to develop design rules for pressure vessels for human occupancy. The importance of this task was soon recognized, and the ASME Safety Code Committee on Pressure Vessels for Human Occupancy (PVHO) was established in 1974 to continue the work of the ad hoc committee. Initially, this committee was to confine its activity to the pressure boundary of such systems. It was to reference existing ASME Boiler and Pressure Vessel Code (BPVC) Sections, insofar as practicable, adapting them for application to pressure vessels for human occupancy. The common practice hitherto had been to design such chambers in accordance with ASME BPVC, Section VIII, Division 1; however, a number of important considerations were not covered in those rules. Among these were requirements for viewports and the in-service use of pressure relief valves, and special material toughness requirements. This Standard provides the necessary rules to supplement that Section and also ASME BPVC, Section VIII, Division 2. The user is expected to be familiar with the principles and application of ASME BPVC Sections.

ASME BPVC criteria furnish the baseline for design. In ASME PVHO-1, design temperature is limited to 0°F to 150°F (−18°C to 66°C). Supporting structure and lifting loads are given special attention. Certain design details permitted by Section VIII are excluded. A major addition is the inclusion of design rules for acrylic viewports (Section 2). The formulation of rules for these vital and critical appurtenances was one of the reasons for establishing the PVHO Committee. Finally, all chambers designed for external pressure are required to be subjected to an external pressure hydrostatic test or pneumatic test.

The 2007 edition was completely rewritten and reformatted from the 2002 edition. Section 1, General Requirements, is intended to be used for all PVHOs, regardless of use. The rules for external pressure design were expanded to include unstiffened and ring-stiffened cylinders, in addition to spheres. Other additions included Sections pertaining to application-specific PVHOs. Sections were included for medical hyperbaric systems, diving systems, submersibles, and quality assurance. The Piping Systems Section was expanded. Where possible, Mandatory Appendices were incorporated into the body of the Standard. All forms were revised to reflect the document (PVHO-1), an abbreviation denoting the corresponding section (e.g., GR for General Requirements), and the form number within that Section. An example is PVHO-1 Form GR-1.

The 2012 edition included expansions made to the General Requirements, Viewports, and Diving Systems Sections.

The 2016 edition included additional expansions made to the General Requirements, Viewports, Medical Hyperbaric Systems, and Diving Systems Sections. It included a new Nonmandatory Appendix for preparing PVHO performance-based Cases for flexible chambers. There is continuing work being accomplished by the subcommittees in the areas of PVHOs using nonstandard materials, including nonmetallic PVHOs. A companion document (ASME PVHO-2) that covers in-service guidelines for PVHOs has been published.

The 2019 edition of ASME PVHO-1 continued to address complete PVHO systems and PVHOs made from nonstandard materials. In support of this work, definitions in Mandatory Appendix II and various forms were added or updated to reflect the differences in approach to documenting the entire PVHO system as a whole rather than as single or multiple pressure vessels/chambers. Additionally, changes were made to clarify several design standards and requirements for easier understanding and implementation by all users of this Standard.

The 2023 edition includes revisions to Section 1, specifically the addition of PVHO systems integrator documentation and marking requirements for PVHO systems in which the PVHO systems integrator differs from the PVHO manufacturer. Additionally, this edition develops a nomenclature list for Section 2 based on ASME PVHO-1–2016. Code Case 22 (Alternative Long-Term Proof Pressure Test Under PVHO-1) has been integrated into a new para. 2-11.5.2. Paragraph 4-9.4 has been revised and adds requirements for gauge scale, accuracy, calibration, and calibration verification. The subcommittee has decided to cite the requirements of ASME B40.1 and ASME B40.7 rather than summarizing and repeating the information. As required by para. 4-9.3, current monoplace chambers do not have hull valves. Additionally, hyperbaric evacuation units (HEUs) will be able to mate with every hyperbaric reception facility (HRF). Currently, the International Marine Contractors Association (IMCA) has a guidance document, IMCA D051, that addresses interface compatibility between HEUs and HRFs. Subsection 7-12 has been added to address the unique aspects associated with hadal-zone submersibles.

ASME PVHO-1–2023 was approved and adopted by the American National Standards Institute as meeting the criteria as an American National Standard on September 27, 2023. Previous editions were published in 1977, 1981, 1984, 1987, 1993, 1997, 2002, 2007, 2012, 2016, and 2019.

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(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Standard

(4) to permit the use of a new material or process

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(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Standard and the paragraph, figure, or table number

(4) the editions of the Standard to which the proposed case applies

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ASME PVHO-1–2023
SUMMARY OF CHANGES

Following approval by the ASME PVHO Committee and ASME, and after public review, ASME PVHO-1–2023 was approved by the American National Standards Institute on September 27, 2023.

In ASME PVHO-1–2023, paras. 1-7.13 and 2-2.6 have been revised and redesignated as Nonmandatory Appendix G and subsection 2-11, respectively. Subsequent paragraphs in subsections 1-7 and 2-2 have been redesignated, and cross-references have been updated. In addition, ASME PVHO-1–2023 includes the following changes identified by a margin note, **(23)**.

Page	*Location*	*Change*
1	1-5	Last paragraph added
2	1-7.1	Subparagraph (d) added
4	1-7.9	(1) Redesignated as 1-7.9.1, and last paragraph added (2) Paragraph 1-7.9.2 added
5	1-9	(1) Revised and redesignated as 1-9.1 (2) Paragraph 1-9.2 added
9	1-14	Revised
12	Figure 1-7.1-1	Added
13	PVHO-1 Form GR-2	Added
14	PVHO-1 Form GR-2S	Added
15	Figure 1-9.1-1	Former Figure 1-9-1 redesignated
15	Figure 1-9.1-2	Former Figure 1-9-2 redesignated
16	Figure 1-9.2-1	Added
16	Figure 1-9.2-2	Added
18	2-1.3.2	Subparagraph (c) revised
18	2-1.4	Added
24	2-2.10.10	Former para. 2-2.11.10 revised
25	2-2.11.4.1	Former para. 2-2.14.1(c) revised
29	2-3.7	Subparagraph (g) added
45	Figure 2-2.2.1-2	In illustration (a), definition of D_i added
46	Figure 2-2.2.1-3	Illustration (b) revised
47	Table 2-2.3.1-1	Editorially revised
48	Table 2-2.3.1-2	Editorially revised
48	Table 2-2.3.1-3	Editorially revised
49	Table 2-2.3.1-4	Editorially revised
49	Table 2-2.3.1-5	Editorially revised
69	Figure 2-2.9.1-5	In former Figure 2-2.10.1-5, illustration (b), M revised to M_c
70	Figure 2-2.9.1-6	Former Figure 2-2.10.1-6 revised
73	Figure 2-2.10.10-1	Former Figure 2-2.11.10-1 revised
76	Figure 2-2.13.11-1	Former Figure 2-2.14.11-1 revised
78	Figure 2-2.13.15-1	Former Figure 2-2.14.15-1 revised

Page	*Location*	*Change*
79	Figure 2-2.13.16-1	Former Figure 2-2.14.16-1 revised
82	Table 2-3.4-1	Revised
89	Table 2-11.5.2-1	Added
90	Figure 2-11.5.2-1	Added
100	4-9.4	(1) Title and paras. 4-9.4.2 through 4-9.4.4 revised (2) First paragraph and paras. 4-9.4.4.1 through 4-9.4.7 added
107	5-2	(1) Revised and redesignated as 5-2.1 (2) Paragraph 5-2.2 added
107	5-3	Revised in its entirety
108	5-6	Added
114	6-4.1.6.1	Subparagraphs (b), (d), (e), and (f) revised
114	6-4.1.6.2	Subparagraphs (a), (b), and (d) revised
117	6-4.5.2	Revised
117	6-5.2	Second paragraph revised
118	6-6.1	First paragraph revised
120	6-6.5	Added
124	7-1.6	Subparagraphs (j)(1), (j)(2), (j)(2)(-a), and (j)(2)(-b) added
125	7-2.4.4	First paragraph revised
126	7-4.3	Paragraph 7-4.3.3 deleted and subsequent paragraphs redesignated
128	7-10.1	Revised
129	7-10.4	Subparagraph (c) revised in its entirety
130	7-12	Added
131	Mandatory Appendix I	Updated
133	Mandatory Appendix II	(1) Definition of *pressure vessel for human occupancy (PVHO)* revised (2) Definitions of *PVHO system* and *PVHO system boundary* added
181	Nonmandatory Appendix F	Updated
189	Figure G-1-3	In former Figure 1-7.13.1-3, nomenclature deleted from illustrations and set as Legend

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Section 1
General Requirements

1-1 INTRODUCTION

This Standard defines the requirements that are applicable to all pressure vessels for human occupancy (PVHOs) fabricated to this Standard (Sections 1 through 4) and shall be used in conjunction with specific requirements in Sections 5 through 7, as applicable, and Mandatory Appendices of this Standard. In the event of conflict between Sections 1 through 4 and Sections 5 through 7, the application-specific requirements from Sections 5 through 7 shall govern.

PVHOs shall be designed, fabricated, inspected, tested, marked, and stamped in accordance with the requirements of this Standard and of the ASME Boiler and Pressure Vessel Code (ASME BPVC), Section VIII, Division 1 or Division 2, unless otherwise permitted within this Standard.

In-service requirements for PVHOs are found in ASME PVHO-2.

1-2 SCOPE

1-2.1 Application

This Standard applies to all pressure vessels that enclose a human within their pressure boundary while under internal or external pressure exceeding a differential pressure of 2 psi (15 kPa). PVHOs include, but are not limited to, submersibles, diving bells, and personnel transfer capsules, as well as decompression, recompression, hypobaric, and hyperbaric PVHOs.

1-2.2 Geometry

The scope of this Standard in relation to the geometry is the pressure boundary as defined in the User's Design Specification and shall include, but not be limited to, the following:

(a) shells of revolution
(b) openings and their reinforcements
(c) nozzles and other connections
(d) flat heads
(e) quick-actuating closures
(f) vessel penetrations
(g) attachments and supports
(h) access openings
(i) viewports
(j) pressure relief devices
(k) pressure-retaining covers for vessel openings

1-2.3 Limitations

The pressure boundary of the PVHO shall be as follows:

(a) welding end connection for the first circumferential joint for welded connections
(b) the first threaded joint for screwed connections
(c) the face of the first flange for bolted, flanged connections
(d) the first sealing surface for proprietary connections or fittings

1-3 EXCLUSIONS

The following types of vessels are excluded from this Standard:

(a) nuclear reactor containments
(b) pressurized airplane cabins
(c) aerospace vehicle cabins
(d) caissons

1-4 USER REQUIREMENTS

It is the responsibility of the user, or an agent acting for the user who intends that a PVHO be designed, fabricated, inspected, tested, marked, stamped, and certified to be in compliance with this Standard, to provide or cause to be provided for such PVHO, a User's Design Specification. The User's Design Specification shall set forth the intended operating conditions of the PVHO to provide the basis for design. It shall identify the external environment to which the PVHO will be exposed, the intended function of the PVHO, mechanical loads imposed on the PVHO, specific installation requirements, and applicable codes and standards.

1-5 MANUFACTURER'S DATA REPORT (23)

The manufacturer or a designated agent shall make design calculations and prepare a Manufacturer's Data Report stating that the design, as shown on the design drawings, complies with this Standard and the User's Design Specification.

A registered Professional Engineer, or the equivalent in other countries, shall certify that the Manufacturer's Data Report is in compliance with this Standard and the User's Design Specification.