ASME PVHO-1–2012
(Revision of ASME PVHO-1–2007)

Safety Standard for Pressure Vessels for Human Occupancy

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

INTENTIONALLY LEFT BLANK

ASME PVHO-1–2012

(Revision of ASME PVHO-1–2007)

Safety Standard for Pressure Vessels for Human Occupancy

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

Three Park Avenue • New York, NY • 10016 USA

Date of Issuance: May 31, 2012

The next edition of this Standard is scheduled for publication in 2015.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Periodically certain actions of the ASME PVHO Committee may be published as Cases. Cases and interpretations are published on the ASME Web site under the Committee Pages at http://cstools.asme.org/ as they are issued.

Errata to codes and standards may be posted on the ASME Web site under the Committee Pages to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in codes and standards. Such errata shall be used on the date posted.

The Committee Pages can be found at http://cstools.asme.org/. There is an option available to automatically receive an e-mail notification when errata are posted to a particular code or standard. This option can be found on the appropriate Committee Page after selecting "Errata" in the "Publication Information" section.

The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

CONTENTS

Figures

Tables

Forms

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 has been to design such chambers in accordance with Section VIII, Division 1, of the ASME BPVC; 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 Section VIII, Division 2, of the BPVC. The user is expected to be familiar with the principles and application of the Code sections.

BPVC criteria furnish the baseline for design. In PVHO-1, design temperature is limited to 0°F (−18°C) to 150°F (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 were the addition of sections pertaining to application-specific PVHOs. Sections were included for medical hyperbaric systems, diving systems, submersibles, and quality assurance. The piping section was expanded. Where possible, Mandatory Appendices were incorporated into the body of the document. All forms were revised to reflect the document (PVHO-1), an abbreviation denoting the corresponding section (e.g., General Requirements is GR), and the form number within that Section. An example is PVHO-1 Form GR-1.

The 2012 edition includes additional expansions made to the General Requirements, Viewports, and Diving Systems sections. There is still important work being accomplished by the Subcommittees in areas of PVHOs utilizing nonstandard materials, including nonmetallic PVHOs. A companion document (PVHO-2) that covers in-service guidelines for PVHOs has been published.

The 2012 edition was approved and adopted by the American National Standards Institute as meeting the criteria as an American National Standard on January 13, 2012. Previous editions were published in 1977, 1981, 1984, 1987, 1993, 1997, 2002, and 2007.

ASME PRESSURE VESSELS FOR HUMAN OCCUPANCY COMMITTEE

(The following is the roster of the Committee as of June 13, 2011.)

STANDARDS COMMITTEE OFFICERS

G. K. Wolfe, *Chair*
S. D. Reimers, *Vice Chair*
G. E. Moino, *Secretary*

STANDARDS COMMITTEE PERSONNEL

M. W. Allen, Life Support Tech Group, Inc.
W. F. Crowley, Jr., Cal Dive International
W. Davison, Oxyheal Health Group
E. G. Fink, Fink Engineering Ltd.
M. A. Frey, Naval Sea Systems Command
T. R. Galloway, Naval Sea Systems Command
L. J. Goland, Southwest Research Institute
G. P. Jacob, Navy Experimental Diving Unit
C. B. Kemper III, Kemper Engineering
J. D. Lawrence, U.S. Coast Guard
P. A. Lewis, Hyperbaric Technologies, Inc.
J. R. Maison, Adaptive Computer Technology
T. T. Marohl, Veolia ES Special Services
G. E. Moino, The American Society of Mechanical Engineers
H. Pauli, Germanischer Lloyd AG
S. D. Reimers, Reimers Systems, Inc.
G. Richards, Blanson Ltd.
T. C. Schmidt, Lockheed Martin Naval Systems Services
J. S. Selby, SOS Hyperlite Ltd.
J. C. Sheffield, International ATMO, Inc.
K. A. Smith, U.S. Coast Guard
R. C. Smith, Naval Facilities Engineering Command
D. Talati, Sechrist Industries, Inc.
R. Thomas, American Bureau of Shipping
M. R. Walters, Oceaneering International, Inc.
J. Witney, Atlantis Submarines International
G. K. Wolfe, Southwest Research Institute
W. T. Workman, Undersea and Hyperbaric Medical Society Satellite Office
P. L. Ziegler III, Submersible Consulting

SUBCOMMITTEE ON DESIGN AND PIPING

T. C. Schmidt, *Chair,* Lockheed Martin Naval Systems Services
S. D. Reimers, *Vice Chair,* Reimers Systems, Inc.
M. W. Allen, Life Support Tech Group, Inc.
W. F. Crowley, Jr., Cal Dive International
W. Davison, Oxyheal Health Group
P. Forte, Woods Hole Oceanographic
M. A. Frey, Naval Sea Systems Command
T. R. Galloway, Naval Sea Systems Command
R. M. Webb, *Alternate,* Naval Sea Systems Command
C. Gaumond, Hemato Max
L. J. Goland, Southwest Research Institute
B. K. Miller, *Alternate,* Southwest Research Institute
G. P. Jacob, Navy Experimental Diving Unit
C. B. Kemper III, Kemper Engineering
K. A. Wohlfeil, *Alternate,* Kemper Engineering
R. Kumar, Reimers Systems, Inc.
P. A. Lewis, Hyperbaric Technologies, Inc.
G. Richards, Blanson Ltd.
C. D. Johnstone, *Alternate,* Blanson Ltd.
J. S. Selby, SOS Hyperlite Ltd.
D. Talati, Sechrist Industries, Inc.
R. Thomas, American Bureau of Shipping
M. R. Walters, Oceaneering International, Inc.
J. Witney, Atlantis Submarines International
W. T. Workman, Undersea and Hyperbaric Medical Society Satellite Office
P. L. Ziegler III, Submersible Consulting

SUBCOMMITTEE ON DIVING SYSTEMS

T. R. Galloway, *Chair,* Naval Sea Systems Command
M. R. Walters, *Vice Chair,* Oceaneering International, Inc.
M. W. Allen, Life Support Tech Group, Inc.
W. F. Crowley, Jr., Cal Dive International
W. Davison, Oxyheal Health Group
E. G. Fink, Fink Engineering Ltd.
C. B. Kemper III, Kemper Engineering
K. A. Wohlfeil, *Alternate,* Kemper Engineering
J. D. Lawrence, U.S. Coast Guard
T. Gilman, *Alternate,* U.S. Coast Guard
P. A. Lewis, Hyperbaric Technologies, Inc.
T. T. Marohl, Veolia ES Special Services
B.K. Miller, *Alternate,* Southwest Research Institute
H. Pauli, Germanischer Lloyd AG
J. S. Selby, SOS Hyperlite Ltd.
K. A. Smith, U.S. Coast Guard
R. Thomas, American Bureau of Shipping
P. L. Ziegler III, Submersible Consulting

SUBCOMMITTEE ON GENERAL REQUIREMENTS

G. P. Jacob, *Chair,* Navy Experimental Diving Unit
M. W. Allen, *Vice Chair,* Life Support Tech Group, Inc.
M. A. Frey, Naval Sea Systems Command
T. R. Galloway, Naval Sea Systems Command
R. M. Webb, *Alternate,* Naval Sea Systems Command
C. B. Kemper III, Kemper Engineering
K. A. Wohlfeil, *Alternate,* Kemper Engineering
S. D. Reimers, Reimers Systems, Inc.
J. S. Selby, SOS Hyperlite Ltd.
J. Witney, Atlantis Submarines International
W. T. Workman, Undersea and Hyperbaric Medical Society Satellite Office
P. L. Ziegler III, Submersible Consulting

SUBCOMMITTEE ON MEDICAL HYPERBARIC SYSTEMS

M. W. Allen, *Chair,* Life Support Tech Group, Inc.
W. T. Workman, *Vice Chair,* Undersea and Hyperbaric Medical Society Satellite Office
W. Davison, Oxyheal Health Group
K. Evans, Perry Baromedical
E. G. Fink, Fink Engineering Ltd.
C. Foreman, U.S. Food and Drug Administration
W. T. Gurnee, Oxyheal Health Group
C. B. Kemper III, Kemper Engineering
K. A. Wohlfeil, *Alternate,* Kemper Engineering
P. A. Lewis, Hyperbaric Technologies, Inc.
H. Pauli, Germanischer Lloyd AG
S. D. Reimers, Reimers Systems, Inc.
G. Richards, Blanson Ltd.
J. C. Sheffield, International ATMO, Inc.
D. Talati, Sechrist Industries, Inc.
P. L. Ziegler III, Submersible Consulting

SUBCOMMITTEE ON POST CONSTRUCTION

R. C. Smith, *Chair,* Naval Facilities Engineering Command
W. Davison, *Vice Chair,* Oxyheal Health Group
M. W. Allen, Life Support Tech Group, Inc.
W. F. Crowley, Jr., Cal Dive International
M. A. Frey, Naval Sea Systems Command
T. R. Galloway, Naval Sea Systems Command
R. M. Webb, *Alternate,* Naval Sea Systems Command
G. P. Jacob, Navy Experimental Diving Unit
C. B. Kemper III, Kemper Engineering
K. A. Wohlfeil, *Alternate,* Kemper Engineering
J. D. Lawrence, U.S. Coast Guard
T. Gilman, *Alternate,* U.S. Coast Guard
G. Richards, Blanson Ltd.
T. C. Schmidt, Lockheed Martin Naval Systems Services
J. C. Sheffield, International ATMO, Inc.
D. Talati, Sechrist Industries, Inc.
J. Witney, Atlantis Submarines International
J. S. Wood, Hyperbaric America, LLC
P. L. Ziegler III, Submersible Consulting

SUBCOMMITTEE ON VIEWPORTS

J. Witney, *Chair,* Atlantis Submarines International
P. L. Ziegler III, *Vice Chair,* Submersible Consulting
M. W. Allen, Life Support Tech Group, Inc.
J. Crane, Blanson Ltd.
C. B. Kemper III, Kemper Engineering
K. A. Wohlfeil, *Alternate,* Kemper Engineering
W. Kohnen, Hydrospace Group LLC
J. D. Lawrence, U.S. Coast Guard
T. Gilman, *Alternate,* U.S. Coast Guard
G. Richards, Blanson Ltd.
T. C. Schmidt, Lockheed Martin Naval Systems Services
R. C. Smith, Naval Facilities Engineering Command
D. Talati, Sechrist Industries, Inc.
R. Thomas, American Bureau of Shipping

SUBCOMMITTEE ON SUBMERSIBLES

J. Witney, *Chair,* Atlantis Submarines International
P. L. Ziegler III, *Vice Chair,* Submersible Consulting
W. F. Crowley, Jr., Cal Dive International
T. R. Galloway, Naval Sea Systems Command
R. M. Webb, *Alternate,* Naval Sea Systems Command
W. Kohnen, Hydrospace Group LLC
J. D. Lawrence, U.S. Coast Guard
J. R. Maison, Adaptive Computer Technology
B. K. Miller, Southwest Research Institute
H. Pauli, Germanischer Lloyd AG
T. C. Schmidt, Lockheed Martin Naval Systems Services
K. A. Smith, U.S. Coast Guard
R. Thomas, American Bureau of Shipping
M. R. Walters, Oceaneering International, Inc.
K. A. Wohlfeil, Kemper Engineering
C. B. Kemper III, *Alternate,* Kemper Engineering

HONORARY MEMBERS

F. T. Gorman
L. G. Malone
R. P. Swanson

CORRESPONDENCE WITH THE PVHO COMMITTEE

General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions, proposing PVHO cases and attending Committee meetings. Correspondence should be addressed to:

Secretary, PVHO Standards Committee
The American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Interpretations. Upon request, the PVHO Standards Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the PVHO Standards Committee.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request. ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

PVHO Cases. The ASME PVHO Committee issues Cases. Although PVHO Cases do not constitute formal revisions of the Standard, they may be used as representing considered opinions of the PVHO Committee. Once approved, Cases are posted on the ASME PVHO Committee Web page at http://cstools.asme.org and are subsequently published with the next edition of this Standard. PVHO Cases are not part of the Standard and are included for information only following the nonmandatory appendices.

Requests for PVHO Cases shall provide the following:

(a) Statement of Need. Provide a brief explanation of the need for the revision(s) or addition(s).

(b) Background Information. Provide background information to support the revision(s) or addition(s) including any data or changes in technology that form the basis for the request that will allow the Committee to adequately evaluate the proposed revision(s) or addition(s). Sketches, tables, figures, and graphs, should be submitted as appropriate. When applicable, identify any pertinent paragraphs in the standard that would be affected by the revision(s) or addition(s) and paragraphs in the standard that reference the paragraphs that are to be revised or added. Furthermore, the proposed Case should be written as a question and a reply in the same format as existing Cases. Requests for PVHO Cases should also indicate the applicable edition to which the proposed Case applies.

Errata. ASME issues errata (corrections to errors introduced in the Standard during the publishing process; e.g., typographical errors, misspellings, grammatical errors, incorrect publication of revisions). Once approved, errata are posted on the ASME PVHO Committee Web page at http://cstools.asme.org and are subsequently published with the next edition of the Standard.

Attending Committee Meetings. The PVHO Standards Committee regularly holds meetings, which are open to the public. Persons wishing to attend any meeting should contact the Secretary of the PVHO Standards Committee.

ASME PVHO-1–2012
SUMMARY OF CHANGES

Following approval by the PVHO Committee and ASME, and after public review, ASME PVHO-1–2012 was approved by the American National Standards Institute on January 13, 2012.

ASME PVHO-1–2012 has been revised in its entirety.

SPECIAL NOTE:

The interpretations and Cases to PVHO-1 follow the last page of this Edition. However, they are not part of the Standard itself.

SAFETY STANDARD FOR PRESSURE VESSELS FOR HUMAN OCCUPANCY

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 and shall be used in conjunction with specific requirements in other Sections and mandatory appendices of this Standard.

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 (Code), Section VIII 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 its 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, personnel transfer capsules; and 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 closure
(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

The Manufacturer or a designated agent shall make design calculations and prepare a Manufacturer's Data