

Standard

Space Systems – Composite Overwrapped Pressure Vessels (COPVs)

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Sponsored by

American Institute of Aeronautics and Astronautics

Abstract

This standard establishes baseline requirements for the design, fabrication, test, inspection, operation and maintenance of composite overwrapped pressure vessels (COPVs) containing a separate metallic liner. These vessels are used for pressurized, hazardous or non-hazardous liquid or gas storage in space systems including spacecraft and launch vehicles. These requirements when implemented on a particular system will assure a high level of confidence in achieving safe and reliable operation.

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Foreword

This version of S-081 was developed in conjunction with launch-site operators and range safety authorities including the U.S. Air Force (USAF) 45th Space Wing, NASA Centers, and the Federal Aviation Administration (FAA) to ensure consistency and/or compatibility with local regulatory requirements that will be imposed on the space system customer. For space systems that operate on commercial and federal ranges, it is necessary that the latest safety requirements document, e.g., AFSPCMAN 91-710 (which supercedes EWR 127-1), be identified as a compliance document, even though there is commonality with this AIAA standard. The requirements in this standard, as well as launch-site and range safety requirements are intended to be tailored for specific missions by adding, deleting and modifying them as necessary to satisfy the manufacturer, customer and launch-site/range safety requirements. Launch-site/range safety approval of all requirements and the method of implementation or compliance are mandatory. Moreover, manufacturers that are engaged in the development of composite technologies for space systems are highly encouraged to involve the appropriate range safety authority and/or launch-site operator in the initial development process to ensure that the prototype design and demonstration testing incorporate their input.

The AIAA Aerospace Pressure Vessels Standards Working Group operates within the AIAA Structures Committee on Standards. It was formed in March 1996 with an emphasis on inclusion of aerospace prime companies, pressure vessel suppliers, and all applicable government agencies. Deliberations focused on adapting the standard to address commercial procurement of aerospace composite pressure vessels.

One of the goals of the project is to provide a performance standard which can easily be used by commercial launch and re-entry vehicle operators in seeking licenses from the FAA/AST. Another goal is to assist the U.S. Department of Defense in its transition to procuring aerospace items on a commercial basis to the maximum extent possible.

At the time of approval, the members of the AIAA Aerospace Pressure Vessels Standards Working Group were (* denotes voting member):

Henry Babel*	The Boeing Company
Keith Beckman*	NASA Johnson Space Center
Harold Beeson	White Sands Test Facility
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The above consensus body approved this document in October 2005.

The AIAA Standards Executive Council (Mr. Amr ElSawy, Chairman) accepted the document for publication in March 2006.

The AIAA Standards Procedures dictate that all approved Standards, Recommended Practices, and Guides are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement between industry or trade, in general or specific, and AIAA to adhere to any AIAA standards publication and no commitment to conform to or be guided by standards reports. However, should a procuring authority choose to use this standard and contractually impose it upon a contractor and/or subcontractor, the use of this standard will be as defined by that particular contract.

In formulating, revising, and approving standards publications, the committees on standards will not consider patents that may apply to the subject matter. Prospective users of the publications are responsible for protecting themselves against liability for infringement of patents or copyright or both.

1 Scope

This standard establishes baseline requirements for the design, fabrication, test, inspection, operation and maintenance of composite overwrapped pressure vessels (COPVs) containing a metallic liner. These vessels are used for pressurized, hazardous or non-hazardous liquid or gas storage in space systems including spacecraft and launch vehicles. These requirements when implemented on a particular system will assure a high level of confidence in achieving safe and reliable operation. This standard is applicable to COPVs with metallic liners and is written to address COPVs at the component (i.e., pressure vessel) level. This document may also be applicable for Reusable Launch Vehicles (RLV) if appropriate changes are agreed upon between the responsible safety authorities and RLV operators.

2 Tailoring

When viewed from the perspective of a specific program or project context, the requirements defined in this Standard may be tailored to match the actual requirements of the particular program or project. Tailoring of requirements shall be undertaken in agreement with the procuring authority and the authority having safety jurisdiction (i.e., range safety) where applicable.

NOTE Tailoring is a process by which individual requirements or specifications, standards, and related documents are evaluated and made applicable to a specific program or project by selection, and in some exceptional cases, modification and addition of requirements in the standards.

3 Applicable Documents

The following documents contain provisions which, through reference in this text, constitute provisions of this standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

AIA NAS 410	<i>Certification & Qualification of Nondestructive Test Personnel</i>
ASNT	<i>Recommended Practice No. SNT-TC-1A</i>
DOT/FAA/AR-MMPDS-01	<i>Metallic Materials Properties Development Standardization (MMPDS)</i>
MIL-HDBK-17	<i>Military Handbook, Polymer Matrix Composites, Five Volumes</i>
CINDAS/USAF	<i>Aerospace Structural Metals Handbook</i>
MIL-STD-1540	<i>Military Standard, Test Requirements for Launch, Upper-Stage, and Space Vehicles</i>

4 Vocabulary

4.1 Acronyms and Abbreviated Terms

a	Crack depth
AIAA	American Institute of Aeronautics and Astronautics
ANSI	American National Standards Institute
ASNT	American Society of Nondestructive Testing
ASME	American Society for Mechanical Engineers

ASTM	American Society for Testing and Materials
2c	Surface-crack length
COPV	Composite Overwrapped Pressure Vessel
EWR	Eastern and Western Range Safety
da/dN	Fatigue crack growth rate
DBF	Design burst factor
DoT	Department of Transportation
FAA/AST	Federal Aviation Administration/Office of Commercial Space Transportation
Ft-lb	Foot-pounds
HDBK	Handbook
K	Stress intensity factor
K_{Ic}	Plane strain fracture toughness
K_{IE}	Surface crack specimen fracture toughness
K_{IEAC}	Environment aided fracture toughness
Ksi	Kips per square inch
LEFM	Linear Elastic Fracture Mechanics
MDCP	Mechanical Damage Control Plan
MEOP	Maximum Expected Operating Pressure
MGOP	Maximum Ground Operating Pressure
MIL	Military
MRB	Material Review Board
MS	Margin of Safety
NASA	National Aeronautics and Space Administration
NDE	Nondestructive evaluation/examination
NDI	Nondestructive inspection
Psi	Pounds per square inch
S-N/ ϵ -N	Fatigue stress-life/strain-life data
STD	Standard
VDT	Visual Damage Threshold