

STP-PT-043

# ASME FLAWED CYLINDER TESTING



Currently in preview, click buy full version

STP-PT-043

# ASME FLAWED CYLINDER TESTING

ASME STANDARDS  
TECHNOLOGY, LLC

Date of Issuance: December 17, 2010

This report was prepared as an account of work sponsored by ASME Pressure Technologies Codes and Standards and the ASME Standards Technology, LLC (ASME ST-LLC).

Neither ASME, ASME ST-LLC, the authors, nor others involved in the preparation or review of this report, nor any of their respective employees, members or persons acting on their behalf, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe upon privately owned rights.

Reference herein to any specific commercial product, process or service by trade name, trademark, manufacturer or otherwise does not necessarily constitute or imply its endorsement, recommendation or favoring by ASME ST-LLC or others involved in the preparation or review of this report, or any agency thereof. The views and opinions of the authors, contributors and reviewers of the report expressed herein do not necessarily reflect those of ASME ST-LLC or others involved in the preparation or review of this report or any agency thereof.

ASME ST-LLC does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a publication against liability for infringement of any applicable Letters Patent, nor assumes any such liability. Users of a publication are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this publication.

ASME is the registered trademark of the American Society of Mechanical Engineers.

No part of this document may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

ASME Standards Technology, LLC  
Three Park Avenue, New York, NY 10016-5990  
ISBN No. 978-0-7918-3353-7

Copyright © 2010 by  
ASME Standards Technology, LLC  
All Rights Reserved

## TABLE OF CONTENTS

Foreword .....	iv
Abstract .....	v
1 INTRODUCTION .....	7
2 PRESSURE VESSEL CONFIGURATION .....	8
3 TEST PLAN .....	9
4 FLAWS .....	10
5 FATIGUE TEST .....	13
6 BURST TESTING .....	15
7 RESULTS AND DISCUSSION .....	16
8 SUMMARY AND CONCLUSIONS .....	19
Appendix A .....	20
Appendix B.....	33
Appendix C.....	46
Acknowledgments .....	72

### LIST OF TABLES

Table 1 - Randomly Assigned Tank Numbers, Flaw Depths and Number of Cycles .....	9
Table 2 - Test Tank Flaw Depths Using the Nominal Structural Composite Thickness of 11.4mm (0.449 inches) .....	10
Table 3 - Pressure Cycling Tests Results .....	13
Table 4 - Summary of Burst Data .....	15
Table 5 - Comparison of Burst Data .....	17

### LIST OF FIGURES

Figure 1 - Composite Pressure Vessel, P/N 240075-023 .....	8
Figure 2 - Location of Flaws on the Tanks .....	11
Figure 3 - Locations of Longitudinal and Transverse Flaws .....	11
Figure 4 - Cross-Sectional View of Flaw .....	12
Figure 5 - Record of Flaw Depths, in Inches, after Machining .....	12
Figure 6 - Longitudinal Flaw in Tank 3B Before Cycling .....	14
Figure 7 - Longitudinal Flaw in Tank 3B after 20,000 Cycles .....	14
Figure 8 - Burst Pressure Versus Depth of Flaw and Cycling .....	18
Figure 9 - Burst Pressure Versus Cycling and Depth of Flaw .....	18

## FOREWORD

The ASME BPV Project Team on Hydrogen Tanks, in conjunction with other ASME Codes and Standards groups, is developing Code Cases and revisions to the Boiler & Pressure Vessel Code, including such to address the design of composite pressure vessels. The project team had an interest in further understanding the effect of cuts to the surface of composite tanks, and how the burst pressure would be affected during the lifetime of the pressure vessel.

A test program was initiated to provide data on initial burst pressure, and burst pressure after pressure cycling, of composite cylinders with cuts of different depths. These results were considered during the development and approval of the ASME Code Cases and Code revisions.

Established in 1880, the American Society of Mechanical Engineers (ASME) is a professional, not-for-profit organization with more than 127,000 members promoting the art, science and practice of mechanical and multidisciplinary engineering and allied sciences. ASME develops codes and standards that enhance public safety, and provides lifelong learning and technical exchange opportunities benefiting the engineering and technology community. Visit [www.asme.org](http://www.asme.org) for more information.

The ASME Standards Technology, LLC (ASME ST-LLC) is a not-for-profit Limited Liability Company, with ASME as the sole member, formed in 2004 to carry out work related to newly commercialized technology. The ASME ST-LLC mission includes meeting the needs of industry and government by providing new standards-related products and services which advance the application of emerging and newly commercialized science and technology, and providing the research and technology development needed to establish and maintain the technical relevance of codes and standards. Visit [www.stllc.asme.org](http://www.stllc.asme.org) for more information.

### ABSTRACT

The effect of flaws with and without cyclic loading was investigated on a composite overwrapped pressure vessel with a non-load sharing polymer liner. Flaws were machined in the structure to four depths and then were cycled for 0, 10,000 and 20,000 cycles. Finally, the cylinders were hydrostatically burst. These data were compared to a reference burst value of a cylinder without flaws or cycles. The cylinder was 406 mm (16 in.) in diameter by 1020 mm (40 in.) long with a service pressure rating of 24.8 MPa (3600 psi).

The lowest burst-to-operating pressure ratio was 2.13, which occurred with the flaws cut 40% into the structure and no cycles. Even with the deepest flaw and cycling, the resulting burst pressure margin would allow safe operation of the pressure vessel over a period of time. The lack of significant additional strength loss with cycling gives a degree of confidence that even if flaws are not found immediately, the risk of a failure due to the flaw is low.