

**Proceedings of  
ASME 2021 Pressure Vessels  
and Piping Conference**

**(PVP2021)**

**Volume 1**

**July 13-15, 2021  
Virtual, Online**

**Conference Sponsor**  
Pressure Vessels and Piping Division

**THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS**

Two Park Avenue \* New York, N.Y. 10016

© 2021, The American Society of Mechanical Engineers, 2 Park Avenue, New York, NY 10016, USA  
(www.asme.org)

All rights reserved. Printed in the United States of America. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the publisher.

INFORMATION CONTAINED IN THIS WORK HAS BEEN OBTAINED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS FROM SOURCES BELIEVED TO BE RELIABLE. HOWEVER, NEITHER ASME NOR ITS AUTHORS OR EDITORS GUARANTEE THE ACCURACY OR COMPLETENESS OF ANY INFORMATION PUBLISHED IN THIS WORK. NEITHER ASME NOR ITS AUTHORS AND EDITORS SHALL BE RESPONSIBLE FOR ANY ERRORS, OMISSIONS, OR DAMAGES ARISING OUT OF THE USE OF THIS INFORMATION. THE WORK IS PUBLISHED WITH THE UNDERSTANDING THAT ASME AND ITS AUTHORS AND EDITORS ARE SUPPLYING INFORMATION BUT ARE NOT ATTEMPTING TO RENDER ENGINEERING OR OTHER PROFESSIONAL SERVICES. IF SUCH ENGINEERING OR PROFESSIONAL SERVICES ARE REQUIRED, THE ASSISTANCE OF AN APPROPRIATE PROFESSIONAL SHOULD BE SOUGHT.

ASME shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B7.1.3). Statement from the Bylaws.

For authorization to photocopy material for internal or personal use under those circumstances not falling within the fair use provisions of the Copyright Act, contact the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923, tel: 978-750-8400, www.copyright.com.

Requests for special permission or bulk reproduction should be addressed to the ASME Publishing Department, or submitted online at: <https://www.asme.org/publications-submissions/journals/information-for-authors/journalguidelines/rights-and-permissions>

ISBN: 978-0-7918-8531-4

# CONTENTS

## Proceedings of ASME 2021 Pressure Vessels and Piping Conference Volume 1

### CODES AND STANDARDS

#### ASME Code Section XI Activities

<b>PVP2021-61728</b> .....	<b>V001T01A001</b>
Technical Basis for Revision of Code Case N-809 on Reference Fatigue Crack Growth Curves for Austenitic Stainless Steels in Pressurized Water Reactor Environments <i>Russell C. Cipolla, Warren H. Bamford, Kiminobu Hojo, and Yuichiro Nomura</i>	
<b>PVP2021-62968</b> .....	<b>V001T01A002</b>
Simplified HTHA Evaluation Using Larson Miller Parameter Concepts <i>Sujay Krishnamurthy and Benjamin F. Hantz, IV</i>	
<b>PVP2021-64992</b> .....	<b>V001T01A003</b>
Modeling Crack Growth in ASME Section XI Flaw Evaluations <i>W. H. Bamford and Anees Udyawar</i>	

#### Developments in HDPE and Non-Metallic Pipe Codes and Standards

<b>PVP2021-61748</b> .....	<b>V001T01A004</b>
Lifetime Estimation Method of Polyethylene Pipe Based on the Full Notch Creep Test <i>Zhigang Wang, Bo Yang, Maodong Li, Xianshun Xu, and Yue Li</i>	

#### Environmental Fatigue Issues (Joint M and F)

<b>PVP2021-60433</b> .....	<b>V001T01A005</b>
Review of Determining Transformed Temperature Over 325°C Based on Monte Carlo Simulation for Environmental Fatigue Evaluation <i>Bonghee Lee and Ilkwun Nam</i>	
<b>PVP2021-61507</b> .....	<b>V001T01A006</b>
Material and Temperature Effects in Low and High Cycle EAF of Austenitic Stainless Steels <i>Tommi Seppänen, Jouni Alhainen, Esko Arilahti, and Jussi Solin</i>	
<b>PVP2021-61522</b> .....	<b>V001T01A007</b>
AFCEN Fatigue Calculations Benchmark: Implementation of the RCC-M Rules in Probationary Phase for Environmentally Assisted Fatigue (EAF) Assessment on a Simple Test Case <i>Sam Cuvilliez, Jia Li, Zichen Kong, Jürgen Rudolph, François Billon, and Hai Xie</i>	
<b>PVP2021-61651</b> .....	<b>V001T01A008</b>
Comparison of International Codes for a Fatigue Crack Growth Flaw Tolerance Sample Problem <i>Gary L. Stevens</i>	
<b>PVP2021-61793</b> .....	<b>V001T01A009</b>
INCEFA-SCALE (Increasing Safety in NPPs by Covering Gaps in Environmental Fatigue Assessment - Focusing on Gaps Between Laboratory Data and Component-Scale) <i>Kevin Mottershead, Roman Cicero, Alec McLennan, Stephan Courtin, Caitlin Huotilainen, and Sergio Cicero</i>	
<b>PVP2021-61961</b> .....	<b>V001T01A010</b>
Investigations on the Environmentally Assisted Fatigue Behavior of Steel Specimens for a Better Understanding of Component Fatigue in Nuclear Applications <i>Christian Swacek, Ludwig Stumpfrock, and Stefan Weihe</i>	

<b>PVP2021-62187</b> .....	<b>V001T01A011</b>
Design by Analysis, Codes, Standards and Rules on EAF - Applicability to Stainless Steels in PWR Primary Piping <i>Jussi Solin, Tommi Seppänen, Rami Vanninen, Erkki Pulkkinen, and Petri Lemettinen</i>	
<b>PVP2021-62429</b> .....	<b>V001T01A012</b>
A Method for Investigating Multi-Axial Fatigue in a PWR Environment <i>Peter Gill, Paul Onwuarolu, Russell Smith, Ben Coult, Mark Kirkham, Matt Sutcliffe, Karen Cooper, Tom Schofield, Colin Madew, Alec McLennan, and Chris Currie</i>	
<b>PVP2021-62909</b> .....	<b>V001T01A013</b>
Negative R Fatigue Short Crack Growth Rate Testing on Austenitic Stainless Steels <i>Adam Griffiths, Peter Gill, Ben Coult, Jack Beswick, Norman Platts, Jonathan Mann, Chris Currie, and Joe Airey</i>	
<b>PVP2021-65972</b> .....	<b>V001T01A014</b>
A Fatigue Crack Growth Model for Type 304 Austenitic Stainless Steels in an Elevated Temperature Air Environment <i>Kathleen C. Barron</i>	
<b>PVP2021-65973</b> .....	<b>V001T01A015</b>
A Fatigue Crack Growth Model for Type 304 Austenitic Stainless Steels In a Pressurized Water Reactor Environment <i>Kathleen C. Barron and Denise J. Paraventi</i>	
<b>High Temperature Codes and Standards</b>	
<b>PVP2021-60672</b> .....	<b>V001T01A016</b>
Development of the Buckling Evaluation Method for Large Scale Vessel by the Testing of Gr. 91 Vessel Subjected to Horizontal and Cyclic Vertical Loading <i>Takashi Okafuji, Kazuhiro Miura, Hiromi Sago, Hisatomo Murakami, Masanori Ando, and Masashi Miyazaki</i>	
<b>PVP2021-60773</b> .....	<b>V001T01A017</b>
Evaluation of the Japanese Fatigue Test Data in Gr.91 for Elevated Temperature Design <i>Masanori Ando, Kodai Toyota, Ryuta Hashidate, and Takashi Onizawa</i>	
<b>Hydrogen Effects on Material Behavior for Structural Integrity Assessment (Joint MF-2)</b>	
<b>PVP2021-62072</b> .....	<b>V001T01A018</b>
A Newly Developed Measuring Principle for Precise Measurement of Forces in Test Autoclaves <i>Alexandra Oßwald, Martin Werz, and Stefan Weihe</i>	
<b>PVP2021-62927</b> .....	<b>V001T01A019</b>
High Temperature Hydrogen Attack (HTHA) Models for the Petrochemical Industry <i>Michael Swindeman, Erik J. Pavlina, and Jorge Perdomo</i>	
<b>Improvement of Flaw Characterization Rules for FFS</b>	
<b>PVP2021-60379</b> .....	<b>V001T01A020</b>
Dedicated CT Tests and Numerical Simulations to Assess Crack Arrest by Quasi-Laminar Flaws <i>Pierre Dulieu, Valéry Lacroix, Robert Gérard, Tomasz Brynk, Inge Uytendhouwen, and Rachid Chaouadi</i>	
<b>PVP2021-60413</b> .....	<b>V001T01A021</b>
Assessment of the Resolution of Nonplanar Flaws in Pressure Retaining Components in Terms of Stress Intensity Factors <i>Valéry Lacroix, Pierre Dulieu, and Kunio Hasegawa</i>	
<b>PVP2021-61934</b> .....	<b>V001T01A022</b>
A Review of Conservatism in Fracture Mechanics Assessments <i>John Sharples and Peter James</i>	

**PVP2021-61989** ..... **V001T01A023**  
Improvement and Assessment of the Plastic Collapse Bending Moment Equations in  
Circumferentially Cracked Pipe  
*Cécilia Desclaux, Valéry Lacroix, and Kunio Hasegawa*

**Master Curve Method and Applications**

**PVP2021-61969** ..... **V001T01A024**  
Effect of Neutron Irradiation on the Mechanical Properties of an A508 CL2 and 15Kh2NMFA  
Irradiated in the NOMAD\_3 Rig in the BR2 Cooling Water  
*Inge Uytdenhouwen and Rachid Chaouadi*

**PVP2021-62040** ..... **V001T01A025**  
Determination of Eurofer97 Fracture Toughness by Testing Small C(T) Specimens  
*David Andres, Marta Serrano, Rebeca Hernandez, Yiqiang Wang, and Mark Richardson*

**Probabilistic and Risk-Informed Methods for Structural Integrity Assessment**

**PVP2021-61097** ..... **V001T01A026**  
Quantitative Risk Assessment of Densely Populated High Consequence Area of Gas Transmission  
Pipeline  
*Li-Guo Zhou, Xiao-Lin Wang, Ming Li, Lei Shi, Yong Wang, and Jing Yang*

**PVP2021-61202** ..... **V001T01A027**  
Benchmarking Study on Probabilistic Fracture Mechanics Analysis Codes xLPR and PASCAL-SP  
Considering Primary Water Stress Corrosion Cracking  
*Akihiro Mano, Jinya Katsuyama, and Yinsheng Li*

**PVP2021-61509** ..... **V001T01A028**  
Development of Guideline on Seismic Fragility Evaluation for Aged Piping  
*Yoshihito Yamaguchi, Jinya Katsuyama, Koichi Masaki, and Yinsheng Li*

**PVP2021-62169** ..... **V001T01A029**  
A Multi-Scale Failure-Probability-and-NDE-Based Fatigue Life Model for Estimating Component  
Co-Reliability of Uncracked and Cracked Pipes  
*Jeffrey T. Fong, Pedro V. Marcal, Robert Rainsberger, N. Alan Heckert, James J. Filliben,  
Steven R. Doctor, and Ned A. Finney, Jr.*

**PVP2021-62560** ..... **V001T01A030**  
Technical Basis for Increased Inspection Interval of Cold Leg Pressurized Water Reactor Dissimilar  
Metal Welds Using xLPR  
*Chris Lohse, Do Jun Shim, Dilip Dedhia, Rohan Dutta, and Nathan Glunt*

**PVP2021-62933** ..... **V001T01A031**  
Probabilistic Fracture Mechanics Evaluation of a BWR Feedwater Nozzle  
*Kevin K. L. Wong, Garivalde Dominguez, Do Jun Shim, and Steven K. Richter*

**Recent Developments in ASME Codes and Standards**

**PVP2021-61295** ..... **V001T01A032**  
ASME Section III Standards Committee Fatigue Action Plan  
*Suzanne McKillop, Paul Donavin, and Robert Keating*

**PVP2021-61570** ..... **V001T01A033**  
A Probabilistic Margin Assessment of the ASME Section III, Division 5 Primary Load Design Rules  
for Class A Components  
*Andrea Nicolas, Mark C. Messner, and T.-L. Sham*

**PVP2021-61607** ..... **V001T01A034**  
A Viscoplastic Model for Alloy 617 for Use With the ASME Section III, Division 5 Design by  
Inelastic Analysis Rules  
*M. C. Messner and T.-L. Sham*

<b>PVP2021-61641</b> .....	<b>V001T01A035</b>
Proposed Alternative Rules for Establishing Pressure-Temperature Rating of Aluminum Alloy Flanges <i>Ayman Cheta</i>	
<b>PVP2021-61658</b> .....	<b>V001T01A036</b>
Evaluation of Primary-Load Effects on Creep-Fatigue Life of Alloy 617 Using Simplified Model Test Method <i>Yanli Wang, Peijun Hou, Robert I. Jetter, and T.-L. Sham</i>	
<b>PVP2021-61858</b> .....	<b>V001T01A037</b>
Simplified Criteria With Reduced Testing Effort for Selecting Clad Materials for High Temperature Reactor Structural Components <i>B. Barua, R. I. Jetter, M. C. Messner, and T.-L. Sham</i>	
<b>PVP2021-62067</b> .....	<b>V001T01A038</b>
A Comprehensive Comparison Between Different Multiaxial Cycle Counting Procedure <i>Andrea Rovinelli, Mark C. Messner, and T.-L. Sham</i>	
<b>PVP2021-62293</b> .....	<b>V001T01A039</b>
A Case for New Low Pressure Vessel (LPV) Codes for Design Pressures Below 15 psi (100 kPa) <i>Barry Millet, Kaveh Ebrahimi, James Lu, and Donald Spencer</i>	
<b>PVP2021-62836</b> .....	<b>V001T01A040</b>
ASME Post Construction Standards: 25 Years of Progress <i>Clay D. Rodery</i>	

**Recent Developments in Chinese Codes and Standards**

<b>PVP2021-60905</b> .....	<b>V001T01A041</b>
Comparison of Vehicle-Mounted High-Pressure Hydrogen Storage Cylinders in United Nations Standards and Chinese Standards <i>Ju Ding, Yiwen Yuan, and Yixi Yu</i>	
<b>PVP2021-61083</b> .....	<b>V001T01A042</b>
Cause Analysis and Database Establishment of Typical Pressure Equipment Explosion Accidents <i>Zhou Fang, Junjie Fu, Zhe Wang, Zhiwei Chen, and Guanghai Li</i>	
<b>PVP2021-61330</b> .....	<b>V001T01A043</b>
Research on Action Layers and Application and Database Design of Safety Barrier in Petrochemical Plant <i>Zhou Fang, Zhibo Huan, Zhe Wang, Guanghai Li, and Ruxin Chen</i>	
<b>PVP2021-61356</b> .....	<b>V001T01A044</b>
Prediction Method and Application Case Analysis of Dangerous Parts of Pipelines in Petrochemical Plants <i>Zhou Fang, Ruxin Chen, Zhe Wang, Zhibo Huan, Qia Liu, and He Yan</i>	
<b>PVP2021-61376</b> .....	<b>V001T01A045</b>
Research on Characterization Method of Pressure Equipment Accident <i>Zhou Fang, Zhibo Huan, Zhe Wang, Junjie Fu, Puan Shi, Qia Liu, and Gang Wu</i>	
<b>PVP2021-61470</b> .....	<b>V001T01A046</b>
Safety Assessment of Long Term Serviced Pressure Vessels: A Case Study of Typical Refining and Chemical Plants in China <i>Zhiyuan Han, Guoshan Xie, Haiyi Jiang, and Xiaowei Li</i>	
<b>PVP2021-61727</b> .....	<b>V001T01A047</b>
Application and Limitation of Safety Valves Inspection Codes in China <i>Jian Xing, Zhiyuan Han, and Shuping Ai</i>	
<b>PVP2021-61814</b> .....	<b>V001T01A048</b>
Failure Analysis and Intelligent Prevention and Control Technology of High Pressure Air Cooler in Hydrogen Environment <i>Guofu Ou, Haozhe Jin, Yong Gu, Xiaofei Liu, and Chenyang Yu</i>	

<b>PVP2021-61876</b> .....	<b>V001T01A049</b>
Research on Fire Test Method of High Pressure Hydrogen Storage Cylinders for Transportation <i>Jun Li, Xiang Li, Jiepu Li, Baodi Zhao, Chunlin Gu, and Jian Guan</i>	
<b>PVP2021-61912</b> .....	<b>V001T01A050</b>
Analysis and Treatment of Defects on the Buried Civil Gas Pipeline <i>Jielu Wang, Wei Li, and Shaoxing Hou</i>	
<b>PVP2021-61938</b> .....	<b>V001T01A051</b>
Review and Problem Analysis on the Development of Hydrogen Fueling Stations in China <i>Zhixiang Duan and Kun Shi</i>	
<b>PVP2021-62032</b> .....	<b>V001T01A052</b>
Failure Analysis of a Cracked Stainless-Steel Steam-Water Separator <i>Jin Shi, Wen Liu, and Xin Cheng</i>	
<b>PVP2021-62147</b> .....	<b>V001T01A053</b>
Numerical Simulation on Fire Test of 45 MPa Hydrogen Storage Vessels for Hydrogen Stations <i>Kun Yang, Guide Deng, Haifeng Liang, and Lin Liang</i>	
<b>PVP2021-64839</b> .....	<b>V001T01A054</b>
Technical Progress Review and Prospect of Safety Guarantee for Long-Term Service Hydrogenation Reactors <i>Chen Xuedong, Fan Zhichao, Dong Jie, Hu Mingdong, Tu Shantung, and Liu Cengdian</i>	
<b>Recent Developments in Japanese Codes and Standards</b>	
<b>PVP2021-61318</b> .....	<b>V001T01A055</b>
Constraint Effect on Fracture in Ductile-Brittle Transition Temperature Region <i>Kiminobu Hojo, Takatoshi Hirota, Yasuto Nagoshi, Takuya Fukahori, Kimihisa Sakima, Mitsuru Ohata, and Fumiyoshi Minami</i>	
<b>PVP2021-61668</b> .....	<b>V001T01A056</b>
Benchmark Analysis by Beremin Model and GTN Model in CAF Subcommittee <i>Takatoshi Hirota, Yasuto Nagoshi, Kiminobu Hojo, Hiroshi Okada, Akiyuki Takahashi, Jinya Katsuyama, Takashi Ueda, Takuya Ogawa, Kenji Yashirodai, Mitsuru Ohata, and Fumiyoshi Minami</i>	
<b>PVP2021-61725</b> .....	<b>V001T01A057</b>
Effect of Plastic Constraint and Cladding on Semi-Elliptical Shaped Crack in Fracture Toughness Evaluation for a Reactor Pressure Vessel Steel <i>Masaki Shimodaira, Tohru Tobita, Yasuto Nagoshi, Kai Lu, and Jinya Katsuyama</i>	
<b>PVP2021-61892</b> .....	<b>V001T01A058</b>
Fracture Toughness in Postulated Crack Area of PTS Evaluation in Highly-Neutron Irradiated RPV Steel <i>Yoosung Ha, Masaki Shimodaira, Hisashi Takamizawa, Tohru Tobita, Jinya Katsuyama, and Yutaka Nishiyama</i>	
<b>PVP2021-61893</b> .....	<b>V001T01A059</b>
Evaluation of Brittle Crack Arrest Toughness for Highly-Irradiated Reactor Pressure Vessel Steels <i>Keiko Iwata, Kuniki Hata, Tohru Tobita, Takatoshi Hirota, Hisashi Takamizawa, Yasuhiro Chimi, and Yutaka Nishiyama</i>	
<b>PVP2021-61942</b> .....	<b>V001T01A060</b>
Development of Leak Before Break Assessment Guidelines for Sodium Cooled Fast Reactors in Japan <i>Hiroki Yada, Takashi Wakai, Takayuki Miyagawa, and Hideo Machida</i>	

**Repair, Replacement, and Mitigation for Fitness-for-Service Rules**

**PVP2021-64176** ..... **V001T01A061**  
Technical Basis Summary for Code Case N-860: Inspection Requirements and Evaluation  
Standards for Spent Nuclear Fuel Storage and Transportation Containment Systems  
*John E. Broussard, III*

**Structural Integrity of Pressure Components**

**PVP2021-60160** ..... **V001T01A062**  
Steam Generator Grade P91 Steel Components Creep-Assessment By Test After Extended  
Service  
*Ottaviano Grisolia, Lorenzo Scano, Francesco Piccini, Antonietta Lo Conte, Massimiliano De  
Agostinis, and Stefano Fini*

**PVP2021-61212** ..... **V001T01A063**  
Study on Influence of Branch Connection That Affects to Design Length of Pressure Design Under  
External Pressure  
*Kyoung-hun Lee*

**PVP2021-61367** ..... **V001T01A064**  
Twice-Yield Method Abaqus Implementation With Application to a Thermally Shocked Stepped  
Pipe  
*Steven M. Smith and David N. Hutula*

**PVP2021-61801** ..... **V001T01A065**  
Design Considerations for Half-Pipe Jackets Operating Under Vacuum Conditions  
*Ameya Mathkar, Shyam Gopalakrishnan, and Sujay S. Pathre*

**PVP2021-61881** ..... **V001T01A066**  
Analysis and Calculation of Strength and Stiffness for Flexible Shell Element of Corner-Corner  
Type in Fixed Tubesheet Heat Exchangers  
*Guodong Zhu, Feng Xu, Guoshan Xie, and Jie Shen*

**PVP2021-61894** ..... **V001T01A067**  
Investigation of Nozzle on Knuckle Region of Dished Head  
*Sujay S. Pathre, Ameya M. Mathkar, and Shyam Gopalakrishnan*