

Center for Hydrogen Safety Americas Conference 2024

**Las Vegas, Nevada, USA
21 - 23 May 2024**

ISBN: 979-8-3313-0081-4

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2024) by AIChE
All rights reserved.

Printed with permission by Curran Associates, Inc. (2024)

For permission requests, please contact AIChE
at the address below.

AIChE
120 Wall Street, FL 23
New York, NY 10005-4020

Phone: (800) 242-4363
Fax: (203) 775-5177

www.aiche.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

SESSION 1 - HYDROGEN SAFETY FUNDAMENTALS & BEST PRACTICES

Hydrogen – Success by Design	1
<i>Karen Vilas, Peter Diakow</i>	
Process Safety Management for the Hydrogen Industry	3
<i>David Moore</i>	
Hydrogen Recombiners: An Alternative Strategy for Hydrogen Mitigation	5
<i>Lee Gardner, Zhe Liang, Marco Zanoni, Long Sang</i>	
Safety Approach and Accomplishments During Fuel Cell Technology Demonstration at Microsoft Data Center.....	7
<i>Steven Parente</i>	

SESSION 2 - REGULATIONS, CODES, AND STANDARDS

Hydrogen Regulations, Codes, and Standards Landscape.....	9
<i>Jennifer Hamilton</i>	
IEA TCP Hydrogen Task 43 - Safety and Rcs of Large Scale Hydrogen Energy Applications: Progress	11
<i>Andrei V. Tchouvelev, Elena Vyazmina, Tadahiro Shibutani, Nick Barilo, Nicolas Mey, Richard Chang, David Torrado, Katrina Groth, Guy De Reals, Lee Phillips</i>	
Beta-Release of Hydrogen Safety Codes and Standards Applicability Navigator (HySCAN) Informational Tool.....	13
<i>Brian Ehrhart, Kevin Hartmann, Nick Barilo, Angela Dalton, William Buttner</i>	

SESSION 3 - HYDROGEN MATERIALS & RISK MANAGEMENT

Hydrogen Sealability: Alt. Designs, Materials, Facing	15
<i>Justinn General</i>	
The Next Evolution in Hydrogen Risk Analysis: “Knowledge Based” Process Hazards Analysis Utilising Developments in Digital Technology and Platforms	17
<i>Khama Matiti, Michael Scott</i>	
PEM Electrolysis Failure Scenarios Identified by Failure Modes and Effects Analysis (FMEA).....	19
<i>Samantha Wismer, Katrina Groth, Ahmad Al-Douri, Alejandro Jimenez</i>	

SESSION 4 - PUBLIC EDUCATION

Public Facing Safety and Education for Hydrogen Fueling Infrastructure.....	21
<i>Jake Grant</i>	
Public Awareness and First Responder Training in India on View of National Green Hydrogen Mission 2023	23
<i>Gayatri Kelkar</i>	

SESSION 5 - SAFETY CULTURE DISCUSSION

Safety Culture.....	25
<i>N/A</i>	
Safety Culture – The Missing Link	26
<i>Susan Bayley</i>	
Safety Culture Panel.....	27
<i>David Moore</i>	

KEYNOTE SPEAKER - DAY 2

Overview of the U.S. Department of Energy's Hydrogen and Fuel Cell Technologies Office Safety, Codes & Standards Activities	28
<i>Laura Hill</i>	

SESSION 6 - INCIDENTS & LESSONS LEARNED

Lessons Learned from a Medium Pressure Tank Leak at Nrel's Hydrogen Refueling Station	30
<i>Kevin Hartmann, Phillip Clark, Owen Smith, Daniel Leighton</i>	
Hydrogen Plant Relief Line Failure Due to Acoustically Induced Vibrations.....	32
<i>Ken Wohlgeschaffen, George Galloway</i>	

SESSION 7 - SAFETY IN PRODUCTION & ELECTROLYZERS

CGA H-17, Guideline for Small Scale Hydrogen Production	34
<i>Rob Early</i>	
Electrical Area Classification Safety-In-Design Considerations for a Large Alkaline Electrolyzer Hydrogen Plant.....	36
<i>Tim Gardner</i>	
Large-Scale Electrolysis Plant Design and Emerging Safety Considerations, an EPC's Perspective	38
<i>Justin Distler</i>	
Facility Siting and Risk Analysis of a PEM Electrolyzer	40
<i>Andrés Ruiz-Tagle, Colin Armstrong, Rich Macnguyen</i>	
IEA TCP Task 43 - Subtask Safety Distances: Electrolyser	41
<i>Elena Vyazmina, Richard Chang, Quesnel Sébastien, Truchot Truchot, Jerome Hocquet, David Torrado, Nick Hart, Marcus Runefors, Brian Ehrhart, Thomas Jordan, Karen Ramsey-Idem, Matias Halinen, Lucie Bouchet, Ricardo A. Pérez, Guy De Reals, Lee Phillips, Deborah Houssin, Simon Jallais</i>	

SESSION 8 - SAFE STORAGE OF HYDROGEN

The Importance of Integrated Safety Applied to Large Scale Gaseous Hydrogen Storage	43
<i>Cory Kreutzer</i>	

Value Proposition of Commercially Available Metal Hydrides; In Terms of Safety, Footprint and Integration to Various Hydrogen Use-Cases..... 45
Jim Petrecky

Gap Assessment of Natural Gas Pipeline for Hydrogen-Natural Gas Blend Transport..... 47
Ben Pierce

Beyond the Hype - Mastering Safety in Hydrogen Transport and Storage..... 49
Chris Granger

SESSION 9 - BLENDING APPLICATIONS

Safe Hydrogen-Natural Gas Blending: Research, Projects, and Addressing Gaps..... 51
Tyler Ruggles

Hydrogen Blending – Design and Safety Considerations for Pilot Projects at Power Generation Facilities 53
Megan Reusser

Safety and Design of an East Coast Utility Hydrogen Demonstration for Commercial and Industrial Customers..... 55
Timothy Harris

Safety and Environmental Lessons from Hydrogen-Natural Gas Cofiring Demonstrations 57
Alex Gupta

All Aboard: Hydrogen on Rail..... 59
Achim Wechsung, Ryan Hart, Delmar Morrison

KEYNOTE SPEAKER - DAY 3

The Cool Fuel School: Development of a Hands-On Liquid Hydrogen Safety Training Program for Early-Stage Research..... 61
Jacob Leachman

SESSION 10 - SAFETY OF HYDROGEN FUELING STATIONS

Reliability and Safety in Technology Development: H2 Mobility Applications 63
Juan H. Bello

Empowering Safety and Awareness: Htec's Journey in Hydrogen Fueling Station Development and Public Education Initiatives..... 65
Danielle Press

Statistics, Lessons Learned, and Recommendations from Analysis of the First 40 Fueling Station Component Failure Events in Hycred..... 67
Ahmad Al-Douri, Katrina Groth, Olivia Robinson, Kevin Hartmann, Genevieve Saur, William Buttner

SESSION 11 - NEW APPLICATIONS AND APPLIED R&D

Overview of Doe Activities Addressing Hydrogen Release Concerns 69
Christine Watson, Genevieve Saur, Kevin Hartmann, Katrina Groth, William Buttner

R&D Safety Investigations for Underground Liquid Hydrogen Storage.....	71
<i>Deborah Houssin</i>	
Thermal Radiation Investigations of Real-Scale Hydrogen Jet Flames at High Pressure	73
<i>Christopher Bernardy, Karim Habib, Alessandro Orchini</i>	
Preliminary Findings from Liquid Hydrogen Pooling and Vaporization Experiments.....	75
<i>Ethan Hecht</i>	

SESSION 12 - SAFETY STRATEGIES

Pressure Relief Device Failure Taxonomy for a Proper Data Collection Strategy	77
<i>Alejandro Jimenez, Katrina Groth</i>	
A Global Mapping of Best Practice Design Standards for Hydrogen Project Developers	79
<i>Will Sharpe, Colin Crowley, Claus Christoffersen</i>	
Ensuring Electrolyzer Safety: Key Strategies for Decarbonizing Industrial-Scale Hydrogen Production	81
<i>Jesse Schulthess, Jitesh Panicker, Michael Buchman, Alex Panchula</i>	

Author Index