7TH GLOBAL SUMMIT ON PROCESS SAFETY

Hosted by CCPS and JSSE

VISION 20/20

NOVEMBER 27-29, 2023

HIMEJI, JAPAN

ORGANIZED BY

AIChE
The Global Home of Chemical Engineers

An AIChE Technology Alliance
CCPS
Center for Chemical Process Safety

JSSE

「今日のあたり前」を支え、
「明日のあたり前」をリードする。

何気ない暮らしを、不断の努力とリーダーシップで支えつづける
変化を楽しみ、多様な人・技術・アイデアの掛け算の発想で、挑みつづける

日々の暮らしの中の、あたり前のような景色。
それらは、「あたり前」にそこにある訳ではない。

「今日のあたり前」の生活があたり前ではなかった時代から、
私たち ENEOS グループは常に先駆者として、
その時々の日常に不可欠なエネルギー・素材を
開発し支えることに全力を注いできた。

そして今、脱炭素・循環型社会という、
「明日のあたり前」の実現へ。
そのためには、
次世代のエネルギー・素材・サービスが求められている。

私たちはこれかも先頭に立って挑戦し、
次なるあたり前を創りつづける事で、
常に社会から信頼され、求められる存在でありたい。

ENEOSグループ

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Welcome Address

We are delighted to extend our invitation to you for the 7th Global Summit on Process Safety Conference, scheduled for November 28-29, 2023, at the Arcrea HIMEJI (Himeji Culture and Convention Center) in Himeji-city, Hyogo, Japan.

This conference represents an exciting fusion of traditional process safety principles with the cutting-edge advancements of Industry 4.0 and digital technologies, and it is the result of a collaborative effort between the Center for Chemical Process Safety (CCPS) and the Japanese Society of Safety Engineers (JSSE). Together, we aim to help companies excel in process safety while leveraging the transformative power of technology.

CCPS, a corporate-sponsored organization, affiliated with the American Institute of Chemical Engineers (AIChE), is dedicated to advancing expertise in preventing catastrophic incidents such as fires, explosions, and toxic releases in facilities handling hazardous chemicals. With over 260 corporate members worldwide, CCPS operates on a global scale. The Japan Society of Safety Engineers (JSSE), our co-host for the summit, focuses on developing safety engineering as a structured body of knowledge related to engineering and technology. This knowledge is essential for preventing disasters or accidents. Additionally, JSSE's goal is to enhance awareness of safety engineering among top-level management, researchers, and engineers, and to provide specialized training for safety engineering professionals.

Building on the substantial interest and participation observed in the Six previous Global Summit conferences held in India, Malaysia, Saudi Arabia, Japan, and Singapore since 2014, we have chosen Japan as the host country for the second time. The 7th Global Summit on Process Safety anticipates the attendance of more than 400 delegates, including prominent global and regional industry leaders.

This event represents a key step in CCPS's efforts to transform the "Process Safety Vision 20/20" into tangible steps towards achieving excellence in process safety. Given the fast-paced evolution of process safety management in light of technological advancements, we recognize the imperative for industries in the Asia Pacific, China, and the Middle East to adapt to these transformations. Our conference provides an excellent opportunity for in-depth conversations about the convergence of process safety and advancing technologies.

This exchange will occur through formal paper presentations, panel discussions, poster presentations and informal discussions, providing an opportunity for process safety leaders and policy-makers to envision the evolution of process safety in the coming decade. Industry leaders, process safety experts, regulatory authorities, individual process safety practioners and academia are invited to engage in deliberations, be aware of critical issues, and address the significant challenges that organizations must overcome to succeed. We eagerly anticipate meeting you in Himeji, Japan on 28-29 November 2023.

Kind regards,

Shakeel H Kadri
Executive Director, CCPS
American Institute of Chemical Engineers

Jun Mutoh
President, JSSE, Japan

Exhibitors

- AcuTech Consulting Group Inc.
- ASAHI KASEI Corporation
- CCPS-AIChE
- Cosmo Oil Co., Ltd.
- ECOLAB
- ERM Japan Corporation
- Idemitsu Kosan Co., Ltd.
- JGC CORPORATION
- JSSE
- Mitsubishi Chemical Corporation
- Mitsui Chemical Corporation
- PSRG
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CCPS, Executive Director & CEO

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Ng Chee Wai, General Manager (Plant) Petrochemical Corporation Of Singapore

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Tetsuya Konno, ENEOS Corporation

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Yukinobu Takaishi, Taiyo Oil Co., Ltd.

Kazuhiko Kato, Mitsui Chemicals, Inc.

Yasuji Inoue, Mitsubishi Chemical Corporation

Mr. Junzo Yamamoto, Senior Executive Officer, Manufacturing & Technology., Idemitsu Kosan Co. Ltd

Mr. Masanobu Yumoto, Administrative Chair of JSSE

Hiroshi Nakatsui, Managing Executive Corporate, ESH ASAHI KASEI Corporation

TECHNICAL COMMITTEE

Dr. Anil Gokhale, Conference Chair, *Senior Director of Projects, CCPS*

Dr. Ritsu Dobashi, Conference Co-Chair, *Professor, Graduate School of Engineering, The University of Tokyo, Vice President, (JSSE)*

Umesh Dhake, Associate Director - Asia, *Oceania and Africa, CCPS*

Ainor Syahril, Head of PSM, *GHSE Petronas, Malaysia*

Philip Mak, Process Safety Learning Leader NSRP, *Vietnam*

Balajee Raman, Director Engineering - Process Safety and Sustainability; International Markets; Global Supply Chain, *Ecolab*

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Dr. Yuichiro Izato, Yokohama National University

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Eizaburo Miyata, Sumitomo Chemical Co. Ltd.

Shinichirou Gotou, Mitsui Chemicals, *Inc*

Hisashi Shibuya, ENEOS Corporation

Abdulwahab A. Al-Shahrani, Manager- Process Safety EHSS & Responsible Care

ADMINISTRATIVE COMMITTEE

Dr. Kazuhiko Suzuki, Planning WG Chair, Okayama University, Honorary Professor

Dr. Atsuko Nakai, Planning WG Sub-Chair, *Mitsubishi Chemical Corporation*

Masanori Takahashi, ASAHI KASEI Corporation

Kunthira Kheanprasit, Process Safety Manager, *HMC Polymers Co. Ltd.*

Kazuya Kawakami, Idemitsu Kosan Co., *Ltd.*

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Kouzo Mitani, Sponsorship Member (Member of JSSE), *ZEON CORPORATION*

Toshimichi Nishi, Sponsorship Member (Non-Member of JSSE), *ERM JAPAN CORPORATION*

27 November: Pre-conference Workshop for Early Career Professionals **Welcome Reception** **Venue: 1st floor (South side), Exhibition Hall C**	
Day 1- 28 November (Tue) Venue : Room 1	
8.00 - 8.15	**Conference Opening** by Jun Mutoh – President, Chief Executive Director, Kashima Oil Co. Ltd. & President- JSSE, Japan
8.15 - 8.30	**Opening Address** by Shakeel Kadri – Executive Director & CEO- Center for Chemical Process Safety (CCPS), USA
8.30 - 9.00	**Invited Lecture** by Hideki Matsuo – Chairman, Japan Industrial Safety Competency Center
9.00 - 9.30	**Keynote** by Scott Meikle – Vice President, Global Technical Organization, Ecolab, USA
9.30 - 10.00	**Keynote** by Professor Hiroshi Ishimaru – Professor, Osaka University, Japan
10.00 - 10.30	**Coffee Break & Networking; Poster Session**
10.30 - 12.00	**Leadership Panel Discussion**: **Topic:** The role of leadership to address challenges in creating effective Process Safety **Moderators**: Shakeel Kadri – Executive Director & CEO, CCPS and Jun Mutoh – President, Chief Executive Director, Kashima Oil Co. Ltd. & President- JSSE, Japan **Panel:** • Yusop Sahari, Group HSE, Head, PETRONAS, Malaysia • Marco Stam, Global Business Process Owner, Teijin Aramid BV, Netherlands • Ahmed Shaheen Al-Khaldi, General Manager, Sipchem, Saudi Arabia • Hiroshi Nakatsui, Managing Executive Corporate ESH, ASAHI KASEI Corporation, Japan • Yukinobu Takaishi, General Manager, Environment, Safety & Quality Control dept., Taiyo Oil Co., Ltd., Japan • Kazuhiko Kato, General Manager, Safety & Environment Technology Division, Production & Technology Center, Mitsui Chemicals, Inc. Japan
12.00 - 13.00	**Lunch**

Day 1- 28 November (Tue) Venue: Special Conference Room	
13.30 - 16.30	**Leaders Forum on Process Safety** **Theme: Process Safety at Senior Leadership Level – "How I drive Process Safety in my organization"** **Moderator:** Shakeel Kadri – Executive Director & CEO, CCPS **Participating Leaders:** 1. Ng Chee Wai – General Manager (Plant), PCS Pte. Ltd; Singapore 2. Scott Meikle – Vice President- Global Technical Organization, Ecolab Inc; USA 3. Syawaludin Azwar – Director of Operations, PT Polytama Propindo; Indonesia 4. David Moore – President & CEO, AcuTech Consulting; USA 5. Ramabhadran Srinivasan – Vice President, Global Technical Organization, dss+; Singapore 6. Yusop Sahari, Group HSE Head, PETRONAS, Malaysia 7. Jun Mutoh – President, Chief Executive Director, Kashima Oil Co. Ltd; Japan 8. Junzo Yamamoto – Senior Executive Officer, Manufacturing & Technology, Idemitsu Kosan Co. Ltd; Japan 9. Keiji Kinoshita – General Manager, Risk Management Dept, Cosmo Oil Co. Ltd; Japan 10. Yasuji Inoue – Senior Manager, Environment and Safety Department, Mitsubishi Chemical Corporation; Japan 11. Kozo Mitani – Environmental & Safety Affairs Department, Production Center, Zeon Corporation; Japan 12. Tetsuya Konno – General Manager Safety, Health & Environment Dept, ENEOS Corporation; Japan 13. Prof. Jong-bae Baek – President, Korean Society of Safety (KOSOS); South Korea 14. Prof. Seungho Jung – Ajou University; South Korea 15. Eisaburo Miyata – Chief Specialist, Sumitomo Chemical Co. Ltd; Japan 16. Masahiro Masuzawa – Consulting Director, ERM Japan, Yusop Sahari, Group HSE Head, PETRONAS, Malaysia

Parallel Technical Sessions Day 1:

(20 minutes presentation by each speaker followed by 10 minutes of Q&A session for each presentation)

	Technical Session 1 Venue: Middle Hall	**Technical Session 2 Venue: Room No. 408 & 409**	**Technical Session 3 Venue: Room No. 407**
13.00 - 15.00	**Big Data and Data Analytics in Process Safety-1** **Session Chair:** Yuto Mizuta, Mitsubishi Chemical Corporation **Session Co-Chair:** Bernard Leong, PCS Pte Ltd.	**Committed Culture & Process Safety Leadership-1** **Session Chair:** Malcolm Pu, Wanhua Chemical **Session Co-Chair:** Mojgan Vafaei; Ecolab	**Disasters and Emergency Responses** **Session Chair:** Palaniappan Chidambaram, dss+ **Session Co-Chair:** Hiroiku Kawai, ENEOS Corporation
13.00 - 13.20 ***Q&A: 13.20 - 13.30***	**Our DIGITAL TWIN Journey has begun: (J-15)** Kiyohide Yoshii, Cosmo oil, Japan	**Application of Safety Culture Survey in Japanese Industries: (J-36)** Akira TOSE, Niigata University, Japan	**Comparison of stairs and ladders use in evacuation from oil and gas plants: (J-7)** Tomohiro Ogami, Yoshinori Hiroya; JGC Corporation, Japan Prof. Katsuhiro Nishinari, The Tokyo University
13.30 - 13.50 ***Q&A: 13.50 - 14.00***	**Digital Breakthrough in Process Safety Near Misses Management : (25)** Mariam Abdul Rahim; PrefChem; Malaysia	**Risk Containment As a Vehicle of Change in Process Safety Culture Transformation: A Case Study in Polypropylene Producer : (81)** Wifandy Raymond Tobias Purba Sidadolog , Bunyamin Komar, Lintang Adi Pradana Polytama Propindo & dds+, Indonesia	**The NATECH Safety Management Framework and the efforts of Japan Society for Safety Engineering (JSSE) to establish it.: (J-8)** Yusuke Wada- SUMITOMO CHEMICAL Co., Ltd. & Yoshiki Kinehara- Mitsubishi Research Institute, Inc., Japan Hiroshi ISHIMARU- Osaka University
14.00 - 14.20 ***Q&A: 14.20 - 14.30***	**How e-Permit to Work System Improve the Safety Culture and Operation Discipline Which Enhance the Plant Safety System Effectiveness: (17)** Talay Petcharat; SCG Chemicals, Thailand	**"World Class Process Safety By Mixed Reality": (15)** Kunthira Kheanprasit, HMC Polymers, Thailand	**Study of emergency countermeasures for abnormal polymerization of monomer tank : (J-18)** Makoto Nitta- Mitsubishi Chemical Corporation Kei Matsuzaki- JGC Corporation

Parallel Technical Sessions (continues): Day 1

(20 minutes presentation by each speaker followed by 10 minutes of Q&A session for each presentation)

14.30 - 14.50 ***Q&A: 14.50 - 15.00***	**Using Machine Learning and Survival Analysis for Maintenance of Aboveground Gas Risers in Domestic High-Rise Buildings: (26)** Pasindu Samaranayake, ERM Hong Kong Limited	**Visualization of Risk Points about Contact Accident with Cranes and Calculation of Optimal Number of Workpieces at Manufacturing Sites using Behavioral Analysis Approach (J-24)** Prof Hojo Rieko; The Nagaoka University of Technology, Japan	**Advanced Method for Disaster Severity Assessment through Semi-Quantitative Risk Analysis for Emergency Response Plan : (128)** Kei Matsuzaki & Masayuki JGC Corporation Tanabe- JGC Corporation, Japan
15.00-15.30	**Coffee Break & Networking**		
	Technical Session 4: Venue - Middle Hall	**Technical Session 5: Venue - 408 & 409**	**Technical Session 6: Venue - 407**
15.30 - 17.30	**Applying Artificial Intelligence (AI) to Process Safety** **Session Chair: Shinichirou Gotou, Mitsui Chemicals, Inc** **Session Co-Chair:** Fatima Fertilizer Company	**Committed Culture & Process Safety Leadership-2** **Session Chair:** Ohtani Tomoya, ENEOS Corporation Palaniappan Chidambaram, dss+ **Session Co-Chair:** Kazuya Kawakami, Idemitsu Kosan Co., Ltd	**Intentional Competency Development-1** **Session Chair:** Dr. Tekin Kunt, PSRG Inc. **Session Co-Chair:** Benjamin Tan, PCS Pte. Ltd.
15.30 - 15.50 ***Q&A: 15.50 - 16.00***	**Smart Industrial Safety Initiatives at Sumitomo Chemical (J-13)** Yoshikazu Sako; Sumitomo Chemical Co., Ltd., Japan	**Gas Transmission & Regasification's Journey to Generative Culture through Process Safety Care Conversation and Other Process Safety Culture Programs: (99)** Gary Lee Shaw Yong, PETRONAS Gas Berhad	**Human resource development for risk management: (J-10)** HIROKI NAKABAYASHI; Cosmo Oil Co., Ltd, Japan

Parallel Technical Sessions (continues): Day 1

(20 minutes presentation by each speaker followed by 10 minutes of Q&A session for each presentation)

16.00 - 16.20 ***Q&A: 16.20 - 16.30***	**Efforts to Stabilize Process Variables and Anomaly detection through using AI (J-11)** Shohei Imaoka; Taiyo Oil Co., Ltd. Shikoku Office, Japan	**Establishment of a quantitative evaluation method for worker well-being at work: (J-26)** Rieko Hojo, Keiju Anada,Yuka Koremura,Shoken Shimizu; Nagaoka University of Technology; Japan	**Ecolab Process Safety Qualification Process: (32)** Nathan Thompson, Ecolab, USA
16.30 - 16.50 ***Q&A: 16.50 - 17.00***	**The Strategy for Implementing Artificial Intelligence in the Process Safety Studies (12)** B.Ambalavanan; Kuwait Oil Company, Kuwait. KS.Haarish Dharan; LT Partners USA.	**Enhancing Risk Management and Accountability through Barrier Ownership Program: A Framework of Operational Strategies and Culture Shift: (02)** Ir. Mohammad Sofi Nurdin, M Ridzhuan Jinal Petronas, Malaysia	**Audience targeted competency program for Process Safety Knowledge & Application at Cargill: (94)** Naim Muhammad; Cargill, Malaysia
17.00 - 17.20 ***Q&A: 17.20 - 17.30***	**Estimation of Flammable Range of Gasses and Vapors Using Neural Network (J-25)** Hiroshi Yamanaka, Katsufumi Yasui; Mitsui Chemicals, Inc. Yu-ichiro Izato, Atsumi Miyake; Yokohama National University	**Learning from Nantong Hydrogen Loading Jet Fire incident** Bin Liu, Cargill, China	**Enhanced Sustainability Requirements in Financial Reporting and Their Impact on Process Safety Professionals: (82)** Srinivasan Ramabhadran; Palaniappan Chidambaram; dss+, Singapore
17.30	**Venue • Location: Himeji Castle, Garden of Museum**		

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PSRG Overview

PSRG is a premier, full service and integrated Health & Safety, Security, and Environmental (HSSE) consulting and training firm specializing in Process Safety, Risk Management, Fire Protection, Emergency and Crisis Management, and Security Risk Management. We provide some of the finest quality, most responsive and reliable, and cost- effective services and solutions to companies worldwide from Fortune 500 companies to smaller and medium-sized companies to help manage risks to as low as reasonably practical (ALARP).

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Project Execution Philosophy

- Clear Alignment with Customer Goals & Objectives
- Team with Customer Personnel
- Leverage Industry Lessons Learned and Best Practices
- Develop Simple, yet effective, User-friendly Programs,
- Procedures and Reports
- Finish On-Time, Within Budget
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- "No Surprises"
- Build for Long-Term, Mutually Beneficial Relations

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- Industrial Fire Protection
- Fire & Explosion Modeling / Impact Assessment
- Loss Prevention
- Hazardous Area Classification / ATEX
- Combustible Dust Hazard Analysis
- Human Reliability Analysis
- Facility Siting / QRA / OBRA
- Emergency Relief System / Flare Analysis
- HSE Management
- Project Risk Management
- Failure Mode Effect Analysis (FMEA)
- Training (onsite/public)
- And more per request

Day 2- 29 November (Wed) Venue: Room 1

8.00 - 08.20	**Recap of Day-1 by Co-Chairs of Technical Committee of 7th GSPS** Dr. Anil Gokhale, Chief Operating Officer (COO), Center for Chemical Process Safety (CCPS) Dr. Ritsu Dobashi, Professor, The University of Tokyo
8.20 - 9.00	**Presenting Summary of Leadership Forum held on Day-1 (Call for Action)**
9.00 - 9.30	Keynote by Dr. Kenichi Uno, Japan Industrial Safety Competency Center (Former Managing Director of Mitsubishi Chemical Corporation) (Former Advisory Board Member of CCPS)
9.30 - 10.00	**Keynote by Ahmed Shaheen Al-Khaldi, General Manager, EHSS & Responsible Care; Sipchem, Saudi Arabia**
10.00 - 10.30	**Coffee Break & Networking**
10.30 - 12.00	**Topic: Building a Safe Future: Harnessing Digital Solutions and Analytics for Process Plant Safety** **Moderators:** Dr. Pratap Nair, President & CEO, Ingenero Inc. **Panel Members:** • Dr. Toru Nakata, National Institute of Advanced Industrial Science and Technology, Artificial Intelligence Research Center, Japan • Ainor Syahril Kamarudin, Head of Process Safety Management, PETRONAS, Malaysia. • Keiichiro Kobuchi, Executive Officer / General Manager, Yokogawa Digital Corporation, DX Services Division, Japan • Mojgan Vafaei, Global Engineering Manager - Sustainability and Process Safety, Ecolab • Dr. Kazuya Furuichi, General Manager- AI Engineering Department, Frontier Business Division, Chiyoda Corporation
12.00 - 13.00	**Lunch**

Parallel Technical Sessions: Day 2

(20 minutes presentation by each speaker followed by 10 minutes of Q&A session for each presentation)

	Session 7: Venue: Middle Hall :	**Session 8: Venue: Room 408 & 409**	**Session 9: Venue: Room 407**	**Session 10: Venue: Room 404**
13.00 - 15.00	**Asset Integrity Management & Aging Facilities** **Session Chair:** Bernard Leong, PCS Pte. Ltd **Session Co-Chair:** Anup Kumar, Tata Steel Ltd	**Vibrant Management Systems** **Session Chair:** Yasuhiro Sugano , Mitsui Chemicals, Inc. Shinichirou Gotou **Session Co-Chair:** Palaniappan Chidambaram, dss+	**Committed Culture & Process Safety Leadership-3** **Session Chair:** Hisashi Shibuya, ENEOS Corporation **Session Co-Chair:** Nathan Thompson, Ecolab Inc.	**Advanced Safe Technologies in Process Safety** **Session Chair:** William Giang, PSRG Inc **Session Co-Chair:** Hiroki Nakabayashi, Cosmo-oil Co. Ltd.
13.00 - 13.20 ***Q&A: 13.20 - 13.30***	**Improving Reliability by Introducing Asset Policies for Risk-Based Inspection: (J-5)** Hiroki Ishikawa; Idemitsu Kosan Co.,Ltd, Japan	**Vulnerability Index (VI) -- a New Innovative Tool for Job Risk Management: (08)** Nitin Warkhedkar, HPCL, India	**How to Measure Process Safety Culture. Key Indicators of Successful Evolution Case: (59)** Martin Fernandez, Whycomm, Argentina	**Rigorous Dynamic Simulations for Effectiveness Assessment of Independent Protection Layers in Chemical Processes: (52)** Meng Qi; China University of Petroleum (East China)

Parallel Technical Sessions (Continues): Day 2

(20 minutes presentation by each speaker followed by 10 minutes of Q&A session for each presentation)

13.30 - 13.50 ***Q&A: 13.50 - 14.00***	**Asset Integrity and Reliability Implementation Challenges and Failure Factors in Developing Countries: (42)** Hany Tawfek; Ethydco, Egypt	**Strategic Implementation of Risk-Based Process Safety Management System: (J-1)** Dr. Masayuki Tanabe, Professor Atsumi Miyake Strategic PSM Initiative Group, Yokohama National University, Japan	**Operational Discipline for High-Performance Process Safety: (100)** David Moore, President & CEO, AcuTech Consulting Group, USA	**Effects of small space structure with fillers or small tubes on gas explosion characteristics (J-22)** Keito Ichinose, Yuto Mizuta, Tatsuzo Kawano, Motohiko SuminoKeito Ichinose, Tatsuzo Kawano, Motohiko Sumino, Mitsubishi Chemical Corporation;
14.00 - 14.20 ***Q&A: 14.20 - 14.30***	**APP Application on Digital Devices to Improve Asset Integrity : (87)** William Zhou; Ecolab, China	**A practical approach to run Process Safety Management System vibrantly: (J-4)** Masaki Iguchi, ENEOS Corporation, Japan	**Experience with CCPS Risk-Based Process Safety Implementation in European and Japanese Cultures (102)** Marco Stam, Global Business Process Owner, Teijin Aramid & David Moore, President & CEO, AcuTech Consulting Group	**Hydrogen Injection in Blast Furnace to Reduce Co_2 Footprint (64)** Naveen Kumar, Tata Steel Ltd, India
14.30 - 14.50 ***Q&A: 14.50 - 15.00***	**Proposal for Aging Infrastructure Countermeasures Using High-Sensitivity Semiconductor Sensors and New Safety Management Approaches: (J-23)** Natsumi Abe; New Cosmos Electric Co., Ltd., Sensor Development 1, Research and Development Division, Japan	**The Human Factor in Safety-Critical Control Systems: (24)** Saleh Alshammari, Saudi Aramco, Saudi Arabia		**Electrostatic discharges in pilot-scale metal silo during loading of powders (J-32)** Mizuki Shoyama, Kwangseok choi, National Institute of Occupational Safety and Health, Japan Yuki Osada, Kasuga Denki, Inc., Japan Osada, Teruo Suzuki
15.00 - 15.30	**Coffee Break & Networking**			

Parallel Technical Sessions (Continues): Day 2

(20 minutes presentation by each speaker followed by 10 minutes of Q&A session for each presentation)

15.30 - 17.30	**Session 11: Big Data and Data Analytics in Process Safety-2** **Session Chair:** Eisaburo Miyata, Sumitomo Chemical Co. Ltd. **Session Co-Chair:** David Moore, AcuTech Consulting Group	**Session 12: Enhanced application of Lessons Learned** **Session Chair:** Palaniappan Chidambaram, dss+ **Session Co-Chair:** Keito Ichinose; Mitsubishi Chemical	**Session 13: Intentional Competency Development-2** **Session Chair:** Nathan Thompson, Ecolab **Session Co-Chair:** Malcolm Pu, Wanhua Group	**Session 14: Multifaceted Session– Disasters and Emergency Response + Asset Integrity Management & Aging Facilities** **Session Chair:** Professor Kazunori KuwanaHisashi Shibuya, Tokyo University of Science **Session Co-Chair:** Takuji Soga, Taiyo Oil Co., Ltd
15.30 - 15.50 ***Q&A: 15.50 - 16.00***	**Effectiveness of Using Digital PSSR Checklist in Petrochemical Industry: (30)** Joompote Ketkeaw; SCG Chemicals, Thailand	**Incident impact estimation of a liquefied petroleum gas tank using CCPS assessment tools CHEF/RAST: (J-17)** Yasuo Nomura, ENEOS NUC Corporation, Japan	**Knowledge Retention for Continuous Workforce Competency- A Case Study: (93)** Benjamin Tan, PCS Pte. Ltd, Singapore	**Performance Monitoring of Rotating Machinery, Electrical, and Instrumentation Equipment for Achieving Condition-Based Maintenance (CBM): (J-28)** Kotaro Morikawa; Idemitsu Kosan Co.,Ltd., Japan
16.00 - 16.20 ***Q&A: 16.20 - 16.30***	**Enhancing Safety in the Process Industry- Leveraging Data Analytics, Machine Learning, and Knowledge Management: (85)** Mayuresh Mokal, Ingenero Inc, India	**Learning from Failures to Mitigate Risk of Disaster in Iron & Steel Manufacturing R&D through Process Safety Management: (40)** Anup Kumar, Tata Steel Ltd, India	**Competency Development through Process Safety Knowledge Management (6)** Dr. Tekin Kunt, PSRG Inc., USA, Avanna Tan, PSRG Asia Pacific Pte Ltd.	**Benefits of Planning for Black Swan Events: (101)** Chan Keng Yong, Manager & Principal, AcuTech Consulting Pte. Ltd. (Singapore), USA

Parallel Technical Sessions (Continues): Day 2

(20 minutes presentation by each speaker followed by 10 minutes of Q&A session for each presentation)

16.30 - 16.50 *Q&A: 16.50 - 17.00*	**Barrier Management and Safe Work Control (BMSWC) - an Insightful Tool to Improve Risk-Based Plant Operational Decisions: (35)** Najah Mohd Jamal, Malaysian Refining Company Sdn Bhd, Malaysia	**Prevention of Breakouts in Slab Caster at Tata Steel Kalinganagar: (58)** Manjunathan M, Tata Steel Ltd, India	**Utilizing Videos for Technical Heritage and Work Procedures: (J-09)** Kazuhiro Koyama & Yasuhiro Kawakata; Maruzen Petrochemical Co. Ltd. Japan	**Elevating Process Safety in Steel Plants: A Comprehensive Case Study on Mitigating Unconfined Vapor Cloud Explosions (UVCEs) in Coke Oven Gas Pipelines: (88)** Abhinav Sharma, Viralkumar Gheewala, JSW Steel
17.00 - 17.20 *Q&A: 17.20 - 17.30*		**Essential Practices for Sustaining Integrity of Safety Instrumented Systems throughout Facility Lifecycle (22)** Efiok Ekanem, Saudi Aramco, Saudi Arabia	**Loss Prevention Eyes on the Field (56)** Naif Aldakhayel, Saudi Aramco, Saudi Arabia	**A Comparative Study: Various Modeling (Empirical, Integral, 3D CFD) Approach for Accurate Consequence Analysis and Risk Management of Accidental Release of Ammonia (90)** Govind Patil, Sastry Mangipudi; Gexcon India & Middle East
17.30 - 17.40	**Closing ceremony [CCPS+JSSE]**			

Abstract Number	Abstract ID	Abstract Title	Author Name	Company	Country
103	Japan-12	Issues encountered during the handling of fine powdered coal and study on its thermal risk	Yeongsoo Choi,Kouya Murai	Mitsubishi Chemical Corporation	Japan
110	Japan-19	Efforts to prevent process accidents caused by oxidative exotherm of resins	Kouya Murai, Manabu Okuyama,Takashi Odagiri,Motohiko Sumino	Mitsubishi Chemical Corporation	Japan
18	673842	Predictive Dynamic Risk Register	Bao Lin Tan	PETRONAS	Malaysia
37	675192	Enhancing Warehouse Safety: Implementing the Chemical Reactivity Matrix in PETRONAS Kertih Refinery, Inspired by Major Process Safety Incidents.	Muhammad Huzaimi Tahir	PETRONAS Penapisan (Terengganu) Sdn. Bhd.	Malaysia
1	660861	Upstream Process Safety Golden Rules (PSGR) and Process Safety Essentials (PSE) Operationalization Program: Developing Competency and Promoting Process Safety Culture	Ir. Mohammad Sofi Nurdin	PETRONAS	Malaysia
112	Japan-21	Computational Fluid Dynamics Study of the Factors of Inner Surface Thinning of a Nozzle Connected to a Volute Pump	Shin-ya Suzuki, Kenta Natsuhara,Masataka Morinaga	Cosmo Oil Co., Ltd.	Japan
34	675138	Importance of Emergency and Crisis Management in Achieving the Strategic Objectives	Nurken Sabyrgaliyev	Saudi Aramco	Saudi Arabia
46	675312	Standarize Design of Internal Floating Roof Tank to Improve Process Safety in Refining & Petrochemical Subholding	Ragaguci Ragaguci	PERTAMINA Refinery Balikpapan	Indonesia
118	Japan-27	Enhancing Asset Integrity Management by adopting HIRA information using Hazard Register, Fault Schedule.	Kauzyuki Namba, Masayuki Tanabe	JGC Corporation	Japan
122	Japan-31	Study on establishment of a quantitative measurement method for workplace-specific well-being in Japanese Vietnamese companies	Mami Katsumi, Nguyen Huong Que, Le Ngoc Thuy Lin	Nagaoka University of Technology- Center for International Industry -Academia Collaboration, Sorimachi Viet Nam	Japan
66	675696	Competency Development in the Area of Process Safety Management to Make World Class Steel Industry Experts	Naveen Kumar	Tata Steel Limited India	

Abstract Number	Abstract ID	Abstract Title	Author Name	Company	Country
126	Japan-35	Proposal of Quantitative Evaluation Method for Dangerous and Safe Errors ?Demonstration Experiment Using Tablets by Graduate Students in Japan	Kazan Omata, Rieko Hojo, Yuka Koremura, Shoken Shimizu	Nihon University, Computer Science, Nagaoka University of Technology, Koremura Giken, Ballast dept., Japan GOP Co. Ltd., -Safety and ANSHIN Technical Research Center (SATEC)	Japan
129	Japan-38	Study on the Quantitative Evaluation of Well-being among University Students in Japan and Overseas	Mami KATSUMI, Xuan Long Nguyen, Toru SASAKI, Rieko HOJO	The Nagaoka University of Technology; Ho Chi Minh City University of Technology,	Japan
120	Japan-29	A study of the workers safety behaviour on portable work platforms.	Shoken Shimizu, Rieko Hojo, Yuka Koremura	GOP co. Ltd.- Safety and ANSHIN Technical Research Center (SATEC), Nagaoka University of Technology, System Safety dept KOREMURA GIKEN. Co., Ltd, Ballast Department,	Japan
121	Japan-30	Measuring repetitive worker's answering behaviors of well-being at work	Yuka Koremura, Rieko Hojo, Christoph Boerdlein, Kohei Nomura	KOREMURA GIKEN. Co.,Ltd- Ballast Dept. / Safety and ANSHIN Technical Research Center SATEC)	Japan
124	Japan-33	Activities to develop "Safety Engineers" at Mitsubishi Chemical Corporation Hiroshima Plant	Atsuko Nakai, Akio Muneto	Mitsubishi Chemical Corporation	Japan
130	Japan-39	Quantitative risk assessment of diversified hydrogen refueling stations with a case study of hydrogen refueling stations with filling facilities	Tomoya Suzuki, Jo Nakayama , Yu-ichiro IzatoAtsumi Miyake	Yokohama National University	Japan
73	Japan-6	The activity of incident investigation in Idemitsu Kosan Co., Ltd. Hokkaido Refinery	Keita Iida	Idemitsu Kosan Co., Ltd., Japan	Japan
125	Japan-34	Effort of Mitsui chemicals Advanced Risk Assessment	Shinichiro Goto, Yasuhiro Sugano	Mitsui Chemicals Inc.	Japan

Session 1: Big Data and Data Analytics in Process Safety-1

Our DIGITAL TWIN Journey has begun

Kiyohide Yoshii, Cosmo Oil, Japan

"In Japan, due to the declining working-age population caused by the aging society with a low birth rate, it is anticipated that securing engineers will become even more challenging in the future. Therefore, we aim to utilize digital technology to achieve a highly productive and efficient work environment while also striving to enhance equipment reliability at the refinery and improve safety through early detection of anomalies, leading to increased operational availability of the asset. We are currently in the process of integrating the Digital Twin of our constructed refinery with generative AI, working on establishing a system that enables AI to perform decision-making and troubleshooting. We will present examples and concepts as part of our ongoing efforts."

Digital Breakthrough in Process Safety Near Misses Management

Mariam Abdul Rahim, PrefChem, Malaysia

Process Safety Near Misses could be viewed as indicator for a high potential incident with significant adverse consequence. These warning signs represents challenges in the process safety management program which are required to maintain the integrity of process equipment and safety barriers.

Pressure Relief Device (PRD) Activation and Critical Operating Parameters (COP) Never Exceed Limits (NEL) Excursion are among Process Safety Near Misses related to a safety system and process deviation or excursions which need to be monitored and reported in running plant operation. Repeated PRD activation and NEL excursions could indicate process or operational issue and also instrumentation malfunction.

Process Safety Near Misses monitoring journey in PRefChem has started since 2022 starting with PRD Activation followed by COP NEL Excursion with a focused execution of multi-disciplinary team to achieve full stage of Process Safety Near Misses implementation. The implementation of Process Safety Near Misses is categorized into two stages; identification and management which includes the understanding of PRD and COP NEL database and reporting and investigation. Digitalization of Process Safety Near Misses enable real time data availability for prudent and efficient monitoring of operating parameters compared to manual self-reporting.

The early stage of this journey involves PRD validation and COP NEL identification by Process Engineering Technical Authority supported by Operations team to develop a comprehensive PRD and COP NEL database. The approved COP NEL database is continuously monitored by Operations team to ensure operating parameters stays within safe operating limits and equipment performance are maintained. As part of digitalization solution, an automated monitoring tool using real time plant data captured in Plant Information Management System (PIMS) has been developed by Process Safety Management team in collaboration with Advanced Process Control team to strengthen Process Safety Near Misses implementation. A special DCS page for Process Safety Near Misses monitoring has been created to enable Panel Man to oversee the present condition of the running plant.

PRD activation occurrence triggered by the monitoring tool and deviations to NEL are required to be verified by Operations team prior to reporting to ensure accuracy of data and continuous improvement on Process Safety Near Miss reporting. These deviations or excursions from safe operating limit are required to be analysed via Process Safety after Incident Review (AIR) form; a quality review exercise intended to identify the cause of excursions or deviations and recommendation to prevent recurrence in the future. To ensure robustness in Process Safety Near Misses implementation, the AIR recommendations are closely monitored and tracked till closure. Improvement in Process Safety Near Miss reporting can be observed after implementation of digitalization monitoring tool especially through reduction in the number of PRD activation recorded.

How e-Permit to Work System Improve the Safety Culture and Operation Discipline Which Enhance the Plant Safety System Effectiveness

Talay Petcharat; SCG Chemicals, Thailand

The implementation of the ePTW (Electronic Permit to Work) system by SCGC began in Q4 of 2020. Initially, the system was developed using a low-code platform to facilitate remote working during the COVID-19 pandemic. This first phase yielded several benefits, including time savings, improved documentation, and data visualization.

Building upon this foundation, the second phase focused on enhancing the ePTW system to cover on-site activities. Key areas of focus included Job Safety Analysis (JSA), Safe Work Certificates, Safety Talks, site condition checks, and worker qualifications. The digital platform provided access to information that was previously difficult to track using paper-based systems.

After one year of implementation, a significant amount of interesting data was collected. During the initial phase, there were a high number of PTW deviations. The percentage of PTW deviations per total number of PTW permits peaked at 65% when ePTW was first implemented. However, after six months, the average percentage dropped to 14.7%. The most notable changes in PTW deviations were observed in two areas: PTW delay/expiration and gas/site condition checks. The percentage of PTW permits experiencing delays or expiration decreased from 65% to an average of 5.3% per month. Similarly, the percentage of PTW with issues related to gas/site conditions decreased from 41% to an average of 15.3% per month.

The main challenges encountered during implementation included insufficient IoT infrastructure, the transformation of working processes, user familiarity, and capabilities. The reduction in PTW deviations serves as a key indicator of the effectiveness of the ePTW system, as it reflects changes in working culture and the mindset of all personnel involved in the PTW process. Furthermore, an analysis of PTW deviations in relation to data from the Safe Work Practice (SWP) auditing program revealed a direct correlation between the two parameters. Since the implementation of ePTW, there has been a noticeable change in the trend of reported unsafe conditions in the SWP auditing program. Prior to ePTW implementation, unsafe conditions peaked at 84 cases per month, but this number decreased to an average of 10.6 cases in the last six months (an 88% reduction). Similarly, unsafe actions decreased from a peak of 59 cases per month to an average of 17.6 cases in the last six months (a 71% reduction).

It can be concluded that ePTW has had a significant impact on personnel discipline and safety awareness among on-site workers, as evidenced by the reduction in reported unsafe conditions and actions. Although these factors may not directly relate to the occurrence of incidents, they reflect the discipline and safety consciousness of personnel, which are crucial elements in preventing accidents. Another benefit of the ePTW system is its ability to enhance visibility into various factors such as contractor safety, equipment activity tracking, personnel headcount, the number of permits issued, and various safety Key Performance Indicators (KPIs).

For instance, the ePTW database allows for the identification of contractor expertise and familiarity with specific equipment. By analyzing the data, it was determined that for equipment A, the top three contractors with the most experience were as follows: Company A (27.4% of total work permits), Company B (8.51% of total work permits), and Company C (8.30% of total work permits). This information aids the maintenance team in selecting contractors for relevant tasks and activities. Additionally, contractors familiar with plant safety rules contribute to on-site safety control and potentially reduce the likelihood of accidents. The aforementioned example and implementation results highlight the benefits of SCGC's ePTW software, which is based on our practices and procedures. More content will be shared in an upcoming seminar. Thank you for your attention to our story.

Using Machine Learning and Survival Analysis for Maintenance of Aboveground Gas Risers in Domestic High-Rise Buildings

Stephen Pang, ERM Hong Kong Limited

High-rise metropolitan areas depend on aboveground risers to supply domestic gas for occupants. Given the density and elevation, ensuring maintenance for all risers is a challenge, with failures leading to supply disruptions and possible accidents. The current O&G industry is moving away from Run-2-Failure (R2F) and Periodic Preventive Maintenance (PvM), while increasingly adopting Condition-based Maintenance (CBM) and Predictive or Statistical-based Maintenance (PdM). Nevertheless, the former is the only viable option for aboveground risers, as constant online conditional monitoring of individual risers is impractical. Exposure to different external environments causes risers to have high variance in Time Between Failure. Additionally, the failures tend to be sparse. Such characteristics are analogous to Survival Analysis being conducted in medical industry, where patients' survival rate is estimated on, in addition to patient's physical conditions, their environment, habits and behaviour. Hence, a data driven Machine Learning model utilizing survival analysis could be a viable solution. Properties of the gas risers (e.g. pipe diameter, environmental conditions etc.) were correlated with time to failure using each riser incident records in the Feature Engineering step. Upon identification of meaningful properties with high correlations, a machine learning algorithm, implementing non-parametric survival analysis, namely Random Survival Forests (RSF), is used to model failure probability of pipelines. A Graphical User Interface is also built to visualize and help users to assess regions of concern. Additionally, climatological, geographical and pipe operational data are used to identify various factors and intercorrelations which accelerate pipe failure. Our work aims to present potential solutions for gas suppliers to adapt PdM in current and future developments using statistical inference and Machine Learning. But perhaps even more so, assist engineers to understand influential factors that could not be accounted for previously, in typical operational settings.

Session 2: Committed Culture & Process Safety Leadership-1

Application of Safety Culture Survey in Japanese Industries

Akira TOSE, Niigata University, Japan

The Safety Culture Survey developed by the author's team has been responded by more than 100,000 employees in over 300 sites in total since 2009. Notably, more than 60,000 people have responded to the survey since 2021, and the number of participating companies and sites is currently increasing rapidly. Several major Japanese companies have adopted this Safety Culture Survey as a company-wide Safety Culture assessment method. This survey covers Japanese high-risk industries such as Chemicals, Oil refineries, Oil Exploration, Materials production, and Telecommunication. The Safety Culture Survey is currently offered in 12 languages and has been implemented in 13 countries/regions. The Safety Culture Survey consists of 110 questions based on the 8-axis model of Safety Culture, and includes questions related to the company's safety management and safety engineering practices. It also includes questions related to organizational integrity and employee motivation and commitment. The presentation describes the main challenges identified through the implementation of the Safety Culture Survey and discusses the future of safety culture improvement through the application of this survey. Also, based on case studies of sites that have conducted the Safety Culture Survey multiple times, discuss the differences between sites that have made progress in improving their safety culture in comparison to those that failed to improve their safety culture.

Risk Containment as a Vehicle of Change in Process Safety Culture Transformation: A Case Study in Polypropylene Producer

Wifandy Raymond Tobias Purba Sidadolog, Bunyamin Komar, Lintang Adi Pradana Polytama Propindo & dds+, Indonesia

Safe operation remains to be a challenge for high-risk industries in Indonesia. As a poly-propylene manufacturer operating in developing country such as Indonesia, Polytama has to manage multiple challenges in ensuring safe operation. One of the expectations from the local government is for Polytama to support the economic development of the community and location where it is operating. This requires the company to employ local workforce with varying levels of knowledge, skills and competence. Over time, the company has also faced a series of changes in ownership and personnel attrition, leading to performance that is dependent on individuals instead of systems and process resulting in inconsistent implementation of management systems. .

Recent trends indicated that process safety incidents still occurred in companies in Indonesia and globally despite them having well established process safety management systems. One of the reasons we believe is the tendency to focus on management system elements individually by different functions without having an integrated and holistic view on the purpose underlying all the elements and interrelation between elements by the individuals involved which is to manage the risks systematically and effectively. This can help meet compliance requirements and result in a compliance mentality and false sense of security.

Despite good lagging safety performance (zero major accidents) over the years, Polytama leadership felt the need for change and desired to ensure safe and sustainable operations without any incidents and build an organizational culture that is line led, risk aware, competent and system driven. This desire culminated in decision to embark on an organizational culture transformation journey to drive implementation of process safety management effectively, realize zero incidents and sustain changes. Polytama believes that such cultural change will enable organizations to maintain the relevance of PSM to ever-expanding and dynamic operational risks.

Developing standards, training personnel, implementing systems in entirety takes time to get embedded within an organization. For any transformation to be successful, it is important to demonstrate successful outcomes as soon as possible and create buy-in and ownership at the frontline. In view of this, Polytama adopted a bifocal risk-based approach with intent to ensure catastrophic risks are well understood and managed effectively by engaging the frontline and middle management while senior leadership team were engaged in becoming more visible and active. The presentation will cover the transformation roadmap, journey so far, share the approach, outcomes achieved, challenges in implementation which needs to be managed actively.

Building a Line-Led, Risk Aware Culture

Polytama embarked on a program called Risk Containment in its first year of the transformation program with the following principles:

1. Top risks to be identified, agreed upon, and allocated to their respective risk owners
2. Critical controls to â€œcontainâ€ top risks to be determined and along with their effectiveness criteria
3. Communicate top risks and controls with the use of bow tie to the frontline.
4. Critical controls effectiveness status to be monitored through committee review and field observations.
5. Any actions to address ineffectiveness of critical controls to be tracked by action owners.

Leadership was engaged to show case the current state of risk management and for alignment on the prioritization of risks and # of risks to focus on the 1st year. Leadership injected a sense of urgency through active and visible involvement through regular field visits and engagement, involvement in the risk containment committee, the establishment of KPIs and monitoring through HSE Committee to highlight the importance of this program and its implementation. This enabled prioritization and focus on top risks of concern and provided visibility to leadership on how well risks are managed and support required from them to address any gaps.

Cultural & Mindset Changes Observed

Several behavioral changes from the risk containment program were noted:

Increased Awareness of top risks and associated controls: 21 of top risks identified and detailed assessment to identify critical controls and implementation carried out for 6 (six) risks in 1st year

Improve Reporting Culture: Formal reporting of Tier 3 Process Safety Events has started since the beginning of the program in 2022. Such events were previously considered as part of dynamics in operation and thus not reported resulting in not identifying and taking proactive actions.

Increase in focus and management of critical controls: Deviations of critical controls are captured, reported, and actioned by the line management. 237 number of actions identified and 83% closed related to deviations in critical controls effectiveness (the remaining 17% are planned to be closed in the next turnaround).

Increased level of line ownership for process safety risk management *:* Risk containment program was driven by production and maintenance team with the support of HSE and process safety where required. Plan to complete 6 (six) of risks established by the risk containment committee.

We can clearly see how risk containment program served as the vehicle in Polytama to create a sense of purpose (why we do what we do), create buy-in and ownership among frontline and line management, raise risk awareness and increase visibility and importance of risk management among leadership. Our journey continues with focus on continuing and expanding coverage of risk containment program as well as review, upgrade and establish Process Safety Management Elements, build competency in the coming years and stay focused on sustaining line led, risk aware culture.

World Class Process Safety by Mixed Reality

Kunthira Kheanprasit, HMC Polymers, Thailand

HMC has strongly commit to continue press the technology and data as the enable factor to drive for world class process safety. One operation risk management concern is how to operate the facility contained hazardous material with no loss of containment. PS incidents such as fire, explosion and toxic gas release resulting in high consequence impact to operating plant, license to operate and business interruption. Our Process Safety Management (PSM) is the heart of excellence of production and operations to keep people as well as the environment safe. Implemented and embedded digitalization in day-to-day operation with seamless integration is our optimum goal and can accelerate the journey to be best in class.

Our Journey to Process Safety Excellence

The digitalization and smart device as Mixed Reality glasses can accelerate to improve process safety, occupational safety, and productivity. It is combining centralized data to the physical world of manufacturing facility with the virtual work of data and information. Special glasses can connect resources and allow the expert colleagues to essentially see through their eyes and offer the shoulder coach anytime anywhere.

Project Benefit:

- Enhance competency development with more training efficiency
- Cost and efficiency improvement (resource utilization, cost optimization)
- Engage the expert to involve the onsite troubleshooting activity, incident investigation, real-time approach, etc.

Leverage Application:

- Emergency preparedness and response(on-scene situation, fire team training)
- Real-time troubleshooting
- Incident investigation and Pre-Startup Safety Review
- Qualify operation team (simulate the high risk situation and how to response)

Visualization of Risk Points about Contact Accident with Cranes and Calculation of Optimal Number of Work pieces at Manufacturing Sites using Behavioural Analysis Approach

Prof Hojo Rieko; The Nagaoka University of Technology, Japan

Due to recent trends such as SDGs, “Well-being (WB)” is now one of the keywords that is attracting worldwide attention. Because it is closely related to people’s work motivation and organizational management, it can be said that it is important for people involved in corporate management to know well-being. WB in a company is a state in which “employees are physically, mentally, and socially satisfied,” and the idea that creating such an environment should strengthen organizational strength and improve performance and motivation has been emphasized in recent years. In this project, based on the subjective well-being and psychological well-being scales of Diener (1984) and Ryff (1989), the creators of the WB scale, we constructed a worker-specific well-being scale during working. Intended to in this presentation, we will outline the construction of a method that focuses on changes in the well-being of workers during work and examples of experiments. In the future, we will aim to construct a more sensitive scale that takes into consideration work styles and backgrounds of workers, and will also conduct similar verifications for multiple occupations to investigate whether there are differences between occupations. From the field of occupational safety, we believe that it is necessary to establish measures not only to reduce negative risks such as occupational accidents, but also to create workplaces that are happier or achieve self-fulfilment.

Session 3: Disasters and Emergency Responses

Comparison of stairs and ladders use in evacuation from oil and gas plants

Tomohiro Ogami, Yoshinori Hiroya; JGC Corporation, Japan

Many studies have been conducted on evacuation from inside buildings, however, there have not been many studies on evacuation from process plants. A simulator incorporating previous studies on building evacuation while taking into account the features of both was developed.

In recent years, module construction methods and the construction of flouting plants are getting common. In both cases, the facility is designed module by module, and the design is such that the facility is crammed into a limited space, so ensuring adequate evacuation routes has become an important consideration.

In a module of approximately 40m x 30m, 4 stories high, the number and location of stairs and ladders were varied, as well as the method of operating ladders, to shorten time to evacuate all people from the facility. As a result, it was found that for the module of this size, placing the two stairs on the outside of the module was the best design for fast evacuation without excesses or deficiencies. It was also found that, since the flow rate and travel speed of ladders are inferior to that of stairs, evacuation can be accomplished more quickly by using stairs, but only when there are ladders within sight of the module.

Furthermore, the time required for evacuation was quantified for both the one-stairs-and-one-ladders design and the two-stairs-and-two-ladders design, making it easier to determine whether the second evacuation route should be a high-cost stairs or a low-cost ladders. This study contributed to the optimization of evacuation strategies in process plants using the developed simulator.

The NATECH Safety Management Framework and the efforts of Japan Society for Safety Engineering (JSSE) to establish it.

Yusuke Wada- SUMITOMO CHEMICAL Co., Ltd. & Yoshiki Kinehara- Mitsubishi Research Institute, Inc., Japan

With the aim of creating a state in which process industry companies can implement a NATECH (industrial accidents resulting from natural disasters) safety management system that aims to enable them to effectively manage response actions and secure resources related to the prevention of the occurrence of harm and the spread of damage in response to NATECH, the Industrial Disaster Prevention Study Group of Japan Society for Safety Engineering (JSSE) has continued its activities with the aim of proposing a 'NATECH Safety Management Frame' based on the existing Process Safety Management System (PSM), with additional elements and initiatives required for NATECH measures. In this presentation, an overview of the 'NATECH Safety Management Frame' will be given, as well as an introduction to the studies that have been carried out to date towards the construction of the NATECH Safety Management Frame. In addition, efforts to improve understanding of NATECH disaster prevention through "the NATECH Roundtable Meeting" of JSSE, a questionnaire survey conducted from October to November 2021 for corporate members of JSSE on 'Safety Management in the Process Industry under COVID-19' and the results of its analysis will also be presented.

Study of emergency countermeasures for abnormal polymerization of monomer tank

Makoto Nitta- Mitsubishi Chemical Corporation

The monomers that initiate polymerization by heat, light, or acid have the risk of generating a large amount of heat of polymerization. In tanks where these monomers are stored, the addition of a polymerization inhibitor or temperature control is implemented to prevents the occurrence of abnormal polymerization. However, if the polymerization inhibitor concentration or temperature inside the tank is not appropriately controlled, polymerization may occur and lead to a major accident. In Japan, there was an accident of an acrylic acid crude tank in 2012. One firefighter was killed in the explosion, and it also caused serious consequences around the tank. To control polymerization before it becomes an accident, an emergency injection of a polymerization inhibitor is one of the effective safety measures. In this study, the necessary verification was conducted to install a facility to inject emergency polymerization inhibitors into commercial tanks. Based on the results of thermal analysis, the risk of runaway polymerization of these monomers was classified in terms of the risk of polymerization occurring under storage conditions and the risk of runaway polymerization after polymerization occurs, and the equipment configuration was considered according to the magnitude of the risk. Next, the effects of addition of polymerization inhibitors in an emergency was confirmed by thermal analysis, and the temperature detection position to quickly detect the temperature rising at the abnormal polymerization was discussed. Gas bubbling was assumed to be a method of homogeneous mixing the polymerization inhibitor in a tank that is not equipped with a stirring device, and the effect of mixing by this method was confirmed by computational fluid dynamics (CFD). As a result of the CFD, the required time to mix polymerization inhibitor homogenously varies depending on the shape and size of the tank, but it was confirmed that required time are shorter than the time until runaway reaction occur. As described above, the risk of abnormal polymerization during storage of monomers and the emergency injecting system of polymerization inhibitors as an emergency measure after the unfortunate occurrence of polymerization was comprehensively evaluated, and the system was introduced to the plant.

Advanced Method for Disaster Severity Assessment through Semi-Quantitative Risk Analysis for Emergency Response Plan

Kei Matsuzaki & Masayuki Tanabe- JGC Corporation, Japan

Emergency response plan should be established based on the proper understanding of potential accident event in the plant facility. There are several methods in the assessment of accident scenario and event severity (e.g., fire and explosion). Consequence Analysis (CA) is a method to assess the severity of accident event without probability consideration. Quantitative Risk Analysis (QRA) is a different method to assess the risk by applying both Consequence and Frequency Analysis. The CA is sometimes preferred since QRA takes more time. However, as the event frequency is not taken into account in the CA, the release size, which is a key of assessment, cannot be simply determined.

The representative hole diameter of 2 inch is typically applied in the CA, in addition, the event severity of Worst-Case scenario is assessed, in general. However, it is difficult to select which case is more suitable for emergency response plans. The Worst-Case is desirable to be applied in a conservative manner, however, it would be unrealistic scenario since its likelihood of occurrence is relatively low, in general range of 10-5 to 10-7 per year. As per the Guidelines for Disaster Prevention Assessment of Petroleum Industrial Complexes issued by the Fire and Disaster Management Agency in Japan, the risk-based concept seems permeated in Japan industry in recent years. From these trends, it is considered necessary to formulate more realistic emergency response plans based on the probabilistic approach.

JGC developed the semi-quantitative risk analysis method that is in between QRA and CA. This “JGC method” was established based on JGC engineering experiences. The release frequency analysis has been simplified by using the database that identifies leak sources of typical process equipment including piping and valve components. By applying those equipment-based release frequency for each process segment (segregated by emergency shutdown valves), the release size at a frequency of specific criterion can be determined. Further, some conditions generally considered in QRA, such as ignition probability, wind speed probability of occurrence, etc., were simplified and applied in this method. As a result, JGC method can assess the event severity and show the result nearly equal to the QRA with shorter period.

We applied CA, QRA, and JGC method in the LNG plant as a case study to evaluate the effectiveness of JGC method. Consequently, the results were similar to the QRA (slightly conservative) although the Worst-Case CA showed extensive consequence.

By JGC method based on semi-quantitative risk analysis, the extent from accident event can be identified in conjunction with event frequency. The emergency response plan in existing plant can be developed with specific and realistic accident scenarios identified by JGC method.

Session 4: Applying Artificial Intelligence (AI) to Process Safety

Smart Industrial Safety Initiatives at Sumitomo Chemical

Yoshikazu Sako; Sumitomo Chemical Co., Ltd., Japan

While technological innovation and digitalization are progressing rapidly, Japan’s declining birthrate, aging population, and declining population have become important issues for the manufacturing industry.

In Japan, amidst these environmental changes, so-called “Smart Industrial Safety” activities are being promoted to achieve safety and efficiency in industrial safety through the introduction of new technologies such as IoT and AI.

In 2020, in order to promote smart security more strongly, the “ Smart Industrial Safety Public-Private Council” was established by the government, and the tops of government agencies and private companies participate.

The council aims to clarify the fundamental principles of Smart Industrial Safety, share its significance and strategic direction among governmental bodies and private companies.

Based on this shared understanding, companies will proactively promote initiatives such as the development, demonstration, and introduction of new technologies, and the government will flexibly review safety regulations and systems.

Through these activities, we aim to further improve safety through “Smart Industrial Safety” and strengthen the self-initiated safety capabilities of companies, as well as improve the productivity and competitiveness of related industries.

Sumitomo Chemical has become a member of the High-Pressure Gas Security Subcommittee of the Council starting from 2023. We would like to introduce the status of our Smart Industrial Safety initiatives.

Efforts to Stabilize Process Variables and Anomaly detection through using AI

Shohei Imaoka; Taiyo Oil Co., Ltd. Shikoku Office, Japan

Several AI-based operation supports and anomaly predictive detection systems were installed at Taiyo Oil Shikoku Operations to complement

The Strategy for Implementing Artificial Intelligence in the Process Safety Studies

Ambalavanan B; Kuwait Oil Company, LT Partners USA, Kuwait

Artificial intelligence can be used in Process Safety studies. In this paper, the author explains the future Roadmap for PHA (Process Hazard Analysis) studies through Machine Learning and Deep Learning Algorithms. The following will be explained during the presentation:

- How both human expertise and Machine Learning algorithms can be combined and get benefits out of it.
- PHA revalidation is being performed once in 5 years, and this PHA demands massive person-hours. Operations and Maintenance people are required during revalidation. Once in 5 years, End-users cannot spare their effective workforce to spend time in the sessions. Yet, people's experience is vital for completing PHA. How the various information such as outcome from Root Cause Analysis, the abnormalities observed during the running of the plants, lessons learnt from the process near-miss events, recent Management of Changes (MOCs), Triggers of Safety overrides and many other Process Safety information, can be utilised during revalidation with minimal person-hours by using Machine Learning& Deep Learning algorithms.
- During the PHA, Concurrent causes cannot be discussed in detail due to various limitations, including time constraints. But concurrent incidents are possible in the industry. How this can be handled using Machine learning algorithms.
- No PHA facilitator can keep complete details of thousands of process safety incidents that happened worldwide and the lessons learnt from them in their minds, but Machines can keep them. So how can we use this capability of Machines while performing PHAs?
- And a few more

The author will explain the strategy for implementing Machine Learning and Depp Learning algorithms in future Process Safety Studies.

Estimation of Flammable Range of Gasses and Vapors Using Neural Network

Hiroshi Yamanaka, Katsufumi Yasui; Mitsui Chemicals, Inc. & Yu-ichiro Izato, Atsumi Miyake; Yokohama National University

In the safety evaluation of chemical processes that handle flammable gases or vapors, it is always necessary to evaluate the flammable range/limit in the gas/vapor phase for every process. But, since the measurement of flammable range usually requires significant time and cost, chemical companies often use conventional/traditional estimation methods in many cases to avoid such time-consuming and costly measurements.

Various estimation methods of flammable range are well known, and especially for hydrocarbons, those estimation methods give sufficiently accurate results that can be directly applied to practical use. However, for the compounds containing heteroatoms such as oxygen or nitrogen, estimation errors become significant, making them unsuitable for practical safety evaluation. Therefore, obtaining reliable flammable range data sometimes requires practical measurements, which are time-consuming and costly.

In this study, we tried to estimate the flammable range such as lower flammable limit (LFL) and limiting oxygen concentration (LOC) of various chemical substances using neural network based on publicly available flammable range data from academic literature, safety data sheet (SDS) and other sources.

The result of this study showed the great possibility that neural network can accurately estimate the flammable range of CHON compounds and it can be effectively utilized for practical safety evaluations, mentioning how many data are needed for practical safety evaluations, what kind of input data are important/unimportant for estimation, etc.

Session 5: Committed Culture & Process Safety Leadership-2

Effective Approach to Roll out and Monitor the Performance Process Safety Management System (PSMS)

Faysel Al-Romaihi; Qatar Energy, Qatar

The Presentation covers background of PSMS approach adopted by QatarEnergy and present how the use Process Safety Fundamentals and building capabilities in Process Safety improve the Process Safety Culture in the organization, which is as per CCPS RBPS, considered the primary pillar to facilitate the roll out of all PSMS elements. Also, the presentation covers the best approach to monitor the Performance of PSMS.

Establishment of a quantitative evaluation method for worker well-being at work

Rieko Hojo, Keiju Anada, Yuka Koremura, Shoken Shimizu; Nagaoka University of Technology; Japan

Due to recent trends such as SDGs, "Well-being (WB)" is now one of the keywords that is attracting worldwide attention. Because it is closely related to people's work motivation and organizational management, it can be said that it is important for people involved in corporate management to know well-being. WB in a company is a state in which "employees are physically, mentally, and socially satisfied," and the idea that creating such an environment should strengthen organizational strength and improve performance and motivation. has been emphasized in recent years. In this project, based on the subjective well-being and psychological well-being scales of Diener (1984) and Ryff (1989), the creators of the WB scale, we constructed a worker-specific well-being scale during working. intended to In this presentation, we will outline the construction of a method that focuses on changes in the well-being of workers during work and examples of experiments. In the future, we will aim to construct a more sensitive scale that takes into consideration work styles and backgrounds of workers, and will also conduct similar verifications for multiple occupations to investigate whether there are differences between occupations. From the field of occupational safety, we believe that it is necessary to establish measures not only to reduce negative risks such as occupational accidents, but also to create workplaces that are happier or achieve self-fulfilment.

Enhancing Risk Management and Accountability through Barrier Ownership Program: A Framework of Operational Strategies and Culture Shift

Ir. Mohammad Sofi Nurdin, Petronas, Malaysia

This paper summarizes the importance of effective asset integrity management in ensuring the condition of all Process Safety barriers to prevent incidents. PETRONAS has established the SCE Barrier Owner (BO) to ensure the barrier management process is implemented and to provide a clear line of sight of the SCE's performance. To strengthen this implementation, the **IPOCS** for Barrier Owner Operationalization Framework has been rolled out, which consists of 5 key steps, including **I**dentify, **P**ersonnel Upskilling, **O**perationalization, **C**ontinuous Monitoring, and **S**ustainability. It has managed to provide a clear expectation and scene setting to each barrier owner for them to execute their roles and responsibilities. It provides a roadmap for operation team to enhance their risk management efforts and instill a culture of Process Safety Excellence throughout their operations.

The paper outlines the methods used by the operation team to enhance risk management and instill accountability for each barrier owner. Leveraging the highest management review meeting at location, strengthening reporting, enhancing risk visibility and acknowledgment by the leadership team, and a transformational shift in Process Safety culture were among the factors that contributed to the successful implementation of the Barrier Ownership Program in PETRONAS Sabah Asset operations.

The Process Safety Management Steering Committee (PSMSC) Meetings were utilized as a venue to discuss barrier compliance and performance, determine performance improvement, and develop an intervention plan to safeguard asset integrity in operation. This approach ensured that process safety risk was monitored and addressed timely where the respective BO had analyzed, mitigated, and identified improvement areas within the respective functionâ€™s boundary. Leaders were also able to instill the right mindset and behaviors through a clear and pervasive tone on Process Safety priorities and accountability.

As a result of these efforts, PETRONAS Sabah Asset achieved ZERO Major and Minor Process Safety occurrences in both offshore and terminal operations for the year 2022, thanks to the visibility of asset integrity status and the adoption of conscious risk-based decisions for inspection, maintenance, and operation. This achievement demonstrates the effectiveness of the Barrier Ownership Program in promoting Process Safety culture and enhancing risk management.

Session 6: Intentional Competency Development-1

Human resource development for risk management

HIROKI NAKABAYASHI; Cosmo Oil Co., Ltd, Japan

Cosmo Oil introduced the "Operations Management System" in 2016 as a company-wide unified management system for safe operation and stable supply. OMS is a business system that serves as the operational foundation of a refinery. It promotes the implementation of autonomous safety management activities and continuous improvement based on the three keywords of "Completely Done," "Risk-Based," and "Continuous Improvement." In addition, OMS has defined 23 requirements as essential items for realizing safe operation and stable supply, one of which is risk management. Comprehensively identify sources of hazards, correctly assess their risks, prioritize the allocation of management resources to risks that have the potential to cause more serious accidents, reduce the risks, and effectively deal with serious accidents. In order to prevent serious accidents, we believe that it is important not only to improve mechanisms and rules and take engineering measures, but also to develop human resources. Since 2016, in order to develop human resources with diverse knowledge and experience especially related to process safety, we have implemented an in-house qualification system and training of in-house experts. There are many issues in the enhancement and review of the system, and continuous improvement is being pursued without end. This paper introduces our company's efforts, current issues, and responses to human resource development related to risk management.

Enhanced Sustainability Requirements in Financial Reporting and Their Impact on Process Safety Professionals

Srinivasan Ramabhadran; Palaniappan Chidambaram; dss+, Singapore

A global shift towards greater transparency in ESG/ Sustainability is driving increasingly intensive reporting requirements and a greater demand for that reporting to be material, relevant, consistent, and comparable â€“ thereby enabling effective and timely decision making.

One such development is the release of International Financial Reporting Standards (IFRS) S1 and S2 in June 2023 by the International Sustainability Standards Board (ISSB).

IFRS S1 is a set of disclosure requirements designed to enable companies to communicate the current and anticipated material sustainability risks and opportunities they are likely to face over the short-, medium-, and long-term. IFRS S2 is designed to be used in conjunction with IFRS S1 and sets out specific climate-related disclosures.

These standards will be effective for annual reporting periods beginning 1 January 2024 in several jurisdictions which endorse them (eg. Thailand is likely to implement with a one year delay) as well as for companies who voluntarily decide to adopt them. Other jurisdictions, such as the European Union through the Corporate Sustainability Reporting Directive (CSRD), are taking a similar approach.

As of August 2022, ISSB of the IFRS foundation has assumed responsibility for SASB standards. The Sustainability Accounting Standards Board (SASB) has issued standards which map industry-specific, sustainability-related disclosure topics â€“ and related metrics â€“ which are material and relevant to company performance across 77 industries. â€˜Critical Incident Risk Managementâ€™ is identified as material and relevant for oil & gas (upstream and refining) whist â€˜Operational Safety (process safety), Emergency Preparedness & Responseâ€™ is identified for the chemical and midstream industry.

Up to now, highly hazardous industries such as the oil & gas, refining, petrochemical and chemical sectors have leaned on API 754 and CCPS Process Safety Leading and Lagging Metrics as guidance for monitoring and reporting on process safety performance.

To date, external reporting has been limited to those industry specific affiliations a company may belong to, such as American Chemistry Council (Tier 1 and DOT 4800 incidents) and the American Petroleum Institute (Tier 1 and 2 incidents). Details of the metrics gathered by these institutions and what is released publicly varies.

The new requirements highlighted above will necessitate greater transparency, accuracy and emphasis on reporting qualitative (management/governance system to manage critical incident risks along the asset lifecycle and value chain) and quantitative metrics (pipeline incidents, % pipelines inspected, transportation incidents, Tier 1, 2, 3, 4 metrics). Qualitative and quantitative metrics prescribed in the SASB standard currently vary; this will likely streamline as users become more aware of the similarity in materiality for any given disclosure topic across industries.

Altogether, disclosing this information will provide the company and its investors with enhanced decision-making capability, balancing sustainability risks against their potential impact on performance including cash flow, access to finance, or cost of capital over the short, medium or long term. Process Sustainability professionals will have a key role to play in gathering and assessing this information.

What are the pain points?

Materiality: Companies find it challenging to develop a process to identify, assess, manage and report on sustainability-related risks and opportunities, including climate. Currently, many companies engage third party organisations to identify and assess risks for process safety, but this is often completed without considering each organisationâ€™s risk tolerance. The materiality definitions are also inconsistent at best across multiple functions, thereby not providing a holistic, consistent view across the company. While each company can self-define â€œmaterialityâ€ , the impact on business continuity, emergency response and financial implications across the value chain is a key data point investors want reported in an integrated manner.

Reporting requirements and target audience: In general, the target audience for process safety reporting is limited to the company and its regulators, and occasionally to industry bodies, with requirements varying across jurisdictions. External reporting reflects lagging indicators and primarily viewed from a compliance standpoint, rather than an objective decision-making tool for stakeholders outside the organisation regarding current and potential future performance on the basis of risks and materiality. Investors and financial institutions are increasingly looking at the disclosure topics and reporting to make decisions on lending and interest rates. This will require a change of mindset across many organisations.

Responsibility and accountability: Not all organisations, even in high hazard industries, have visible leadership involvement in process safety management. Given the enhanced requirements in sustainability reporting as part of financial disclosures, each company must re-evaluate and clearly define the roles, responsibility and accountability of process safety leadership. This will facilitate how the range of risk management issues faced by the company should be prioritised, managed, and reported on. Companies must assess whether they have the capability and capacity to support the emerging reporting requirements and ensure that process safety risks are integrated in their Enterprise Risk Assessment, and appropriately managed.

Lack of a holistic approach â€“ It is important to recognize the interrelation between sustainability disclosure topics for a given industry, operational risks and other risks managed via corporate-wide risk management. Only a holistic and integrated view on risks and opportunities within the organization will render accurate, relevant, comparable information. This will enable the primary users to make appropriate assessment of company current and future performance.

What needs to change?

Determining key stakeholders: To identify the information of common needs by its primary users, an organisation will first and separately identify the information needs of one of the three types of primary usersâ€”for example, investors (existing and potential). The organisation will then repeat the same assessment for the two remaining typesâ€”lenders (existing and potential) and other creditors (existing and potential).

The combined information needs identified by these assessments form the set of common information and the holistic needs that the organisation aims to meet.

Defining and establishing common understanding of materiality: An entity shall disclose *material information* about the sustainability-related risks and opportunities that could reasonably be expected to affect the entityâ€™s prospects. This should relate to the overall Enterprise Risk Management. The processes/methods that an organisation uses to define risks and their materiality must be consistent across business parameters such as safety, process safety, social and/or other business metrics. In the context of sustainability-related financial disclosures, information is material if omitting, misstating or obscuring that information could reasonably be expected to influence decisions that primary users of general-purpose financial reports make on the basis of those reports, which include financial statements and sustainability-related financial disclosures and which provide information about a specific *reporting entity*.

Organisational competency and capacity: Companies must ensure they have the capacity, competency and right risk assessment mindset to a) identify and assess the critical incident risks incorporating process safety and emergency response aspects/risks, b) integrate these risks into the enterprise risk management framework and understand the financial dimensions impacted (direct/indirect), and c) match these risks to the IFRS S1&2 reporting requirements in order to come up with meaningful performance indicators to monitor, manage and report to external and internal stakeholders.

Governance process including clear definition of responsibility and accountabilities: Establishing a robust governance process leveraging existing forums to ensure visible involvement of the senior leadership team is critical. This requires clear definition of responsibilities and accountabilities for all functions involved, including the risk function, and for them all to be involved and engaged in an integrated manner. In addition to enabling appropriate management and reporting of sustainability-related risks, this will also demonstrate a risk aware organisational culture, visible leadership commitment, robust system, and governance process.

What is expected going forward?

Organisations need to assess material risks associated with technical failure, human error, or external factors. For example, the combustible nature of chemical substances, combined with the high operating temperatures and pressures involved in chemical manufacturing facilities elevates the risk of explosions, hazardous spills, or other emergency situations. The materiality of this example can be linked to potential harm on workers and nearby communities through the release of harmful air emissions and chemical substances, and adverse impact on the environment. In turn, such occurrences would have a potentially financially significant impact on the organisation involved.

In terms of reporting, the expectation is to include a section on Sustainability risks and opportunities management as part of the IFRS S1 Sustainability â€“ or other similar â€“ requirement. The reporting may be subject to independent verification by an external agency and will be in the public domain like any financial reports; the basis for deciding on â€œmaterialityâ€ must be sound. Process safety professionals will have particular input into critical incident risk management.

The increased expectation on reporting externally will result in increased visibility of risks among the leadership and will require higher level of leadership engagement and involvement than in the past. This will directionally result in better management of critical incident risk management associated with process safety. This will help enhance current and future business performance as well as influence the ability to get future financing and/or cost of capital.

Sources:

IFRS - IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information

SASB Standards

Audience targeted competency program for Process Safety Knowledge & Application at Cargill: (94)

Naim Muhammad; Cargill, Malaysia

High attrition rate and people movement into a safety critical position has led into a drastic demand for more robust upskilling program. Traditional competency program does not effective to address the scenario. Hence, we developed a direct and targeted competency program. There are 2 programs with different targeted audience. 1. Process Safety Basic Training (PSBT) "This is an awareness level and targeted to all technical employees. Also, a part of new employee onboarding program. 2. New Leader Process Safety Program (NLPSP) "This is targeted to a plant manager, production manager who will be an approver for PTW, MOC etc.

PSBT
An online program with pathway targeted for adult learning with each topic followed by actual application. The speed is managed by the participants.

- Focus on PSM management system.
- 6 weeks duration.
- There will be 3 check points for coaching and will provide a tracking mechanism.
- Completion is tracked through percentage of completion in the pathway.
- At the end of the program, participant will develop a framework which will describe the process safety management system and actual status of their respective plant/facility. The framework is a live document which will be updated by the next participant from the same facility. Note: The framework template is used, and the participant only update their respective facility.

NLPSP

An online program with pathway targeted for adult learning with each topic followed by actual application. The speed is managed by the participants.

- Focus on PSM management system and respective participants technology.
- 3 months duration.
- There will be a several coaching sessions with the generalist and SME.
- Completion is tracked through percentage of completion in the pathway.
- At the end of the program, there will be a panel board session. Participant will be judged, and any substandard will be extended depending on panel member advise.
- Note: Prior to the completion, the participant will not allow to authorize any related PS authorization e.g., MOC, PTW etc

Challenges & Learnings

- We have 1500 locations globally. It will take times to hit all facility.
- Some of the facility manpower is very lean and remote.
- Language is also a barrier for some country.
- Limited SME with the right technology competency.
- Conflicting priority with another domain.

Ecolab Process Safety Qualification Process

Nathan Thompson, Ecolab, USA

Ecolab Process Safety Qualification Process: Executive Summary

Ecolab, a global petro/chemical manufacturer, was in danger of not meeting their goals for Process Safety Event Reduction. Human Resources had also developed an Engineering Career Ladder which created a clear path for career development and role/responsibilities in the Process Safety Team and Global Engineering spaces

The *Process Safety Qualification Process (PSQ)* was developed to drive performance improvement:

1. Ensure engineering employees at all global plant sites have the knowledge and expertise to complete Process Safety tasks.
2. Provide tools, support, and training for employees growing leadership skills in the Engineering Career Ladder

Outline of PSQ1:

1. Employee completes self-assessment
2. Employee completes training and testing
   1. Passes tests in all 12 core elements
3. Employee shows skill application with examples of their work and coaching
   1. Submits summary of work to Review Panel to show skill application
4. Review Panel confirms qualification through consensus

Core Elements of Qualification:

Compliance with Global Standards	RBPS/PSM Program Knowledge	Managing/ Using Process Safety Information	Regulatory Compliance/ RAGAGEP
Chemical Compatibility/ Red List	Management of Change	HIRA/ PHA Tools	Plant Design
Measurement and Metrics	Root Cause Analysis	Critical Equipment	Process Safety Culture

The PSQ was launched globally in early 2020 in a phased approach. Launch goal was at least half the global plant sites completing the PSQ by the end of 2020 which was met.

After test piloting, the PSQ was adjusted to include all plant employees with an interest in developing Process Safety competency, not just engineers. This adjustment significantly boosted participation and influenced other training programs to follow a similar model.

A second, higher level of PSQ was developed for Principal/Chartered engineers, and Engineering managers. This evolution puts stronger focus on complex technical concepts, such as chemistry platforms, and risk assessment (HAZOP Leadership). Leadership competencies were also added to address gaps in compliance and cultural issues at the sites.

After the first year of deployment, PSQ was added into Ecolab™ *Leadership Development Program.* This program is a selected group of employees early in career, with the intention of building leadership and knowledge for future roles at Ecolab. Incorporating PSQ into the program requirements ensures long-term Process Safety results and competency enhancement.

Session 7: Asset Integrity Management & Aging Facilities

Improving Reliability by Introducing Asset Policies for Risk-Based Inspection

Hiroki Ishikawa; Idemitsu Kosan Co., Ltd, Japan

1. Introduction

We believe that achieving safe operation is our social responsibility without unplanned shutdown in aging equipment which handles large quantities of combustible substances as well as it secures a competitiveness and stable energy supply. In light of this essential role, we are challenging to raise the reliability of equipment to the global top-level by 2030.

To secure the reliability of equipment, it is extremely important for integrating the technical knowledge system for each technology fundamental element.

Examples of the elements include 1) comprehensive understanding of potentially weak components, 2) failure mode and effect analysis, 3) appropriate inspection, 4) risk assessment and fitness-for-service assessment, 5) technically correct repair methods. And continuous improvement is also an essential element.

The integrated system can perform as a result of consistency and continuity, and it cannot perform properly if only one of the elements is superior or missing. Engineering capacity to systematically utilize each technical element in a well-balanced manner becomes a key.

2. Our Challenge

We have established Technology and Engineering Center that oversees specialized technologies. It links each field such as engineering and cutting-edge technology, and aggressively supports our refineries for pursuing their operational excellence.

Based on comprehensively linked global standards such as ASME, API, CCPS, we are developing a mechanical integrity program that mutually complements the basic elements mentioned in the previous section to ensure reliability. Swiss cheese model (multi-layer protection) explains our idea for the challenge. Rather than completing maintenance with a single protective layer, adding multiple layers can provide overall reliability. For consolidating consistent protective layers, we put the most importance on understanding all relevant damage mechanisms and reflecting lesson learned. Some layers compose a guideline how to respond to possible hazards and risks. We call them asset policies; they are the basis of our risk assessment.

In addition, we are focusing on the development of asset management system, including equipment information data, inspection histories, which suggests efficient risk-based inspection and maintenance plan.

In oral presentation, examples of improvement of equipment reliability by these methods will be introduced.

Asset Integrity and Reliability Implementation Challenges and Failure Factors in Developing Countries

Hany Tawfek; Ethydco, Egypt

For decades, Asset Integrity Management (AIM) activities have been a part of industry's efforts to prevent incidents and maintain productivity. The research utilized variant references to define the most common challenges and failures of AIM, in advance the research illustrated the activities, workflows, and lifecycle of an AIM, the purpose is to systematically address the correspondent challenges and failures and to avoid overlooking a major challenge or failure factor, then ultimately highlight the possible solutions and recommendations.

The technical data were gathered from the most well-known and globally used guidelines and standards. field data were gathered from interviews with knowledgeable personnel, publishment and research papers, global platforms, and forums and Questionnaire.

The research results and conclusion are concluded mainly from expert reviews, technical papers, technical books, forums, and webinars. The research supported the results with, 1) case study that addressed the AIM implementation failures in 10 production facilities belongs to one of the biggest industrial sectors in Egypt, 2) Questionnaire for an experts and knowledgeable people in the field of Asset integrity in Egypt. Finally, the research addressed a recommendation in correspondent to each failure category.

Failure to apply asset integrity management system practices will definetly increase the probability a major accident to exist, considering the PDCA cycle that represents a typical management system components, failures related to system planning could be avoided by building the AIM needs on a business case, regulatory enforcement that should be supported by spreading the culture of sustainability.

On the other hand, failures related to system implementation could be avoided by defining the Asset integrity program at the top levels in the company, assigning clear responsibilities, and empower implementation.

Failures related to performance assurance could be avoided by Implementation of an encompassing corporate Asset integrityprogram at each local establishment, metrics must be established to evaluate the intended compliance of the corporate MI program.

And lastly for human factors failures, AI responsibilities to be obligated in a dedicated law same as HSE in the Egyptian labor law, availing AI required resources including manning and to be linked to the facilities objectives & obligations (if considered), and train and familiarize the assigned team for AIM implementation with change management function as a key of success.

APP Application on Digital Devices to Improve Asset Integrity

William Zhou; Ecolab, China

Ecolab is a globally chemicals manufacturer and there is a manufacturing plant in Nanjing China. There are a lot of different equipment in this plant and several maintenance orders are generated everyday due to equipment failure. The maintenance department need to arrange the resources according to the maintenance orders. Maintenance orders generated by hand-writing or computerized maintenance system can't be seen by maintenance people timely. Not available at any time. As a result, maintenance people didn't response to maintenance requests. This impacted normal operation. On the other hand, computerized spare parts management system is not convenient to use and it's expensive. All these impact people's passion to improve mechanical integrity.

The people in Nanjing plant utilized zero code platform to build up a maintenance management APP which runs on digital devices. People can use this APP to initiate maintenance orders, accept maintenance orders, schedule resources, confirm maintenance results by maintenance supervisor and production team, etc.

The users can define the content and drop downs according to plant needs in each page. The work flow (shown in Figure 1) from requesting maintenance orders to maintenance results confirmation is simple and easy to use.

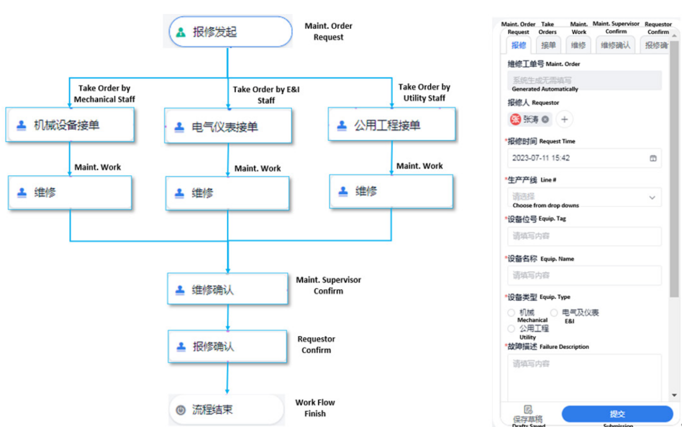

Figure 1 Maintenance work flow in this APP

Meanwhile, they can check the spare parts stock conditions quickly, using the filter, such as storage location, name, specification, number, etc. in warehouse on digital devices with this APP (shown in Figure 2).

Equip. Number 物品编号 | Contains 等于任意一个 | Equip. Type 专业类别 | Contains 等于任意一个 | 机械 | Storage Location 库位 | Contains 等于任意一个 | Equip. Name 物品名

Inventory list 库存清单

Storage Location 库位	Equip. Number 设备编号	Equip. Name 物品名	Specifications 规格型号	Equip. Type 专业类别	Stock Qty 库存量	Stock Amt 库存金额
1FA2	008807	盲板	DN32	机械	3	0
1FB3	008907	螺帽	M6	机械	1	8
1FB3	008910	螺帽	M8	机械	1	8
1FA14	119146	小伞齿轮	5-4 45	机械	1	0
1FA11	115014	轴承	HJ218-E	机械	1	0
1FA14	119145	大伞齿轮	5-3 45	机械	1	160
1FD14	110042	双偏心软密封蝶阀	3 寸/150LB/RTFE/CF3M	机械	2	8400
1FB14	008889	砂轮片	/	机械	1	0
1FA13	115015	滑阀	HR400	机械	1	0
1FA14	112194	轴套+垫片	MVR进料泵：OJK	机械	1	0
1FB8	008922	不锈钢螺帽	M16	机械	1	8
1FA5	008835	柜门锁链	/	机械	4	0
1FA10	008862	新打包机密封件	/	机械	6	0

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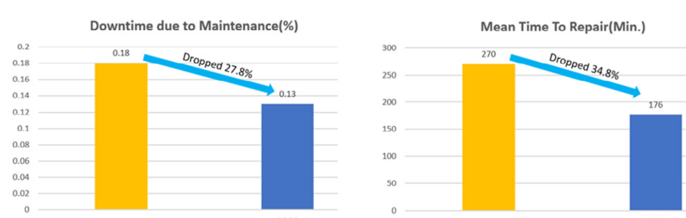
Figure 2 Spare Parts Inventory Condition Shown in the APP

They can scan with digital devices to identify the information when new spare parts come into warehouse and spare parts leave the warehouse for maintenance.

This APP can run some analysis reports with maintenance data. Figure 3 shows one of these analysis reports. We



can see the total maintenance orders, the completed maintenance orders and the on-going maintenance orders. With the analysis, we know whether we need to have more employees or improve work efficiency for E&I, utility or mechanical. Also, the data in this APP can be extracted to Excel for further analysis. All these can support maintenance KPI setting.

Figure 3 One of these analysis reports generated by this APP

This APP was put into use in Nanjing plant since 2023. People can be notified earlier with this APP and response faster. The downtime due to maintenance is reduced from 0.18% to 0.13%. That's 27.8% decrease. And the mean time to repair dropped 34.8%, from 270 minutes to 176 minutes. The data is for same time period in 2022 and 2023, from Jan to July.

Figure 4 The downtime due to maintenance and mean time to repair in 2022 and 2023 (Jan to July)

Proposal for Aging Infrastructure Countermeasures Using High-Sensitivity Semiconductor Sensors and New Safety Management Approaches

Natsumi Abe; New Cosmos Electric Co., Ltd., Sensor Development 1, Research and Development Division, Japan

Semiconductor gas sensors excel at detecting low concentrations of various combustible gases. They are compact, have fewer components, and can be mass-produced with stable quality at a relatively lower cost compared to other sensors like infrared (IR) sensors. Due to these advantages, semiconductor gas sensors have been widely adopted across Japan for gas safety, ranging from use in residential gas alarms to industrial gas detection systems. In the case of residential gas detection in particular, where there are many interfering gases present, these sensors are able to operate at 1/100 of the Lower Explosive Limit (LEL) of natural gas and comply with standards that include a 5-year warranty period.

In recent years, semiconductor gas sensors' long-term stability and selectivity have further improved, and their susceptibility to temperature and humidity effects has significantly diminished. As a result, their adoption has been expanding across Asia, and their areas of use are also rapidly increasing. Furthermore, the utilization of MEMS technology has led to advancements in miniaturization, energy efficiency, and wireless capabilities. With the elimination of wiring, installation costs have also been reduced, making it easier to install multiple sensors, thus further broadening potential applications.

In this presentation, we will propose semiconductor gas sensors as a solution to the issue of aging infrastructure, along with specific examples such as the adoption of methane detectors in the United States. Additionally, we will propose new methods for safety management, while showcasing the latest gas alarms which combine cutting-edge technologies like IoT with semiconductor gas sensors.

Session 8: Vibrant Management Systems

Vulnerability Index (VI) -- a New Innovative Tool for Job Risk Management

Nitin Warkhedkar, HPCL, India

Refinery being a technologically advanced, complex and highly hazardous industry, needs special impetus on Safety. Any incident in the Refinery has the potential to disrupt the entire supply chain and adversely affects Corporation ESG score. Thus, the motto of the Refinery is to have NIL incidents.

In an effort to further consolidate on the job safety in the Refinery, Mumbai Refinery Safety department has developed a novel concept called â€œJob Vulnerability Index (VI)â€ . This online automatic calculated index indicates the vulnerability of the job being planned / carried out. This Vulnerability Index will enable to identify the criticality of the job from safety point of view and enable better monitoring and planning of mitigation measures.

This VI concept has been developed based on the Tie-Chart of three vectors taken into consideration They are Area Vector (based on the location /plant of the job like LPG plant, Fabrication Yard, Offsite area etc) Job vector(based on the nature of the job like cutting/grinding, working at height, confined space entry etc) and Human Vector (based on the skillset and experience of the people involved in carrying out the job). VI index for each vector ranges from 1-10 with increasing hazard approaching towards 10. The combined Job Vulnerability Index is the mean of all these three vectors.

Predefined VI values are assigned to Area Vector and Job vector while the user /executing agency has to select amongst various parameter options for Human Vector. This online data acquisition eliminates the bias for knowing the overall hazard of the job being carried out.

Thus, based on the VI, HODs . Division Heads, Section Heads visit the job site for safety audit and compliance.

This online system also sends SMS to Senior Management in case High VI jobs (Score> 8) and thus is very useful to have a glance to the Senior Management regarding various critical and vulnerable activities being carried out in the field and plan their site visits accordingly. This also improves the presence of Senior People in the field for critical jobs.

The system is completely online and has been developed in house by Safety Team and the IS Team. This VI is a working solution to dynamically map the hazards of day-to-day activities and leverages digital technology for work permit system.

Strategic Implementation of Risk-Based Process Safety Management System

Dr. Masayuki Tanabe, Professor Atsumi Miyake Strategic PSM Initiative Group, Yokohama National University, Japan

Aims

The US OHSA PSM and the CCPS RBPS clarifies the requirements for operation and asset management elements related to process safety. Since the departments in charge of these elements are different in organizations and sometimes tend to organizational silo of operation-maintenance-safety, the ability to organize process safety information across departments becomes important. The Strategic PSM (SPSM) Initiative Group has been established by industry-government-academia collaboration to propose a solution to Japanese industry to effectively implement the risk-based approach for process safety management, since Japanese Safety Regulation systems had been moving from prescriptive approach to emphasizing operator's accountability and risk-based approach.

Methods

The SPSM Initiative Group firstly clarified the management concept for risk-based approach, that is based on the process-based management system (e.g., Goal-Strategy-Process).

Then the SPSM Initiative Group conducted a questionnaire survey with Japanese operators to identify process safety management structure and process safety information flow in their organizations. The questionnaires are designated to clarify the organizational and technical challenges to conduct risk-based process safety (RBPS) management in actual organization.

For organizational aspect, the results showed that the main horizontal communication channel was between middle management, but information traffic jam was occurring due to the dependence on capability of middle management persons, who are also busy for normal operation activities. For technical aspect, the results showed that hazard registers are not well used to transfer the risk Information from Hazard Identification and Risk Assessment (HIRA) to operation and maintenance (O&M) management.

In order to overcome the identified organizational challenge, the process safety roles and activities that middle management has played should be clarified for required competencies to delegate the role to a dedicated inline process safety leader leading the multi-discipline process safety communication for organizational aspect.

In order to overcome the identified technical challenge, the SPSM Initiative Group discussed importance of risk information transfer from HIRA to O&M management through hazard register. Due to the purpose of HIRA (such as HAZOP, LOPA) targeting on "identification" and "assessment", their data format is not convenient to directly use in O&M management. Therefore, the use of hazard register become important. The types and requirements of hazard register are introduced to clearly define what is difference between HIRA and hazard register.

Consideration

However, since the required risk data format to be effectively used by O&M management is much different from HIRA data format, which is tailored for systematically identifying hazards using guidewords, restructuring the risk data format becomes time consuming work and requires rigorous understanding of risk theory.

The SPSM Initiative Group suggests using a digitalized tool managing facilities' design basis accidents scenarios with functional requirements for each tagged safety critical item. For example, the facilities' risk management digital tool of "CoreSafety?" should be used to support the concept. A method called Fault Schedule, which is used in the UK nuclear industry, is applied in the CoreSafety? as a register of hazardous scenarios. Although the number of the scenarios is enormous (accident sequences from initiating events to various accident events (i.e., all HAZOP scenarios plus QRA scenarios)), the CoreSafety? simply provides critical operation and maintenance functional requirements from the fault schedule database, based on the dynamic risk information by the Bayesian update of the failure frequency of all causes and safety devices with site specific maintenance information.

Then, a Case Study had been conducted as the Proof of Concept (PoC) for SPSM Concept applying the inline process safety leader and the digital tool of CoreSafety? in an actual operator's site. The PoC results show that the multi-discipline risk communication within the organization was enhanced by reducing information traffic jam by inline process safety leader and effective risk-based management for operation and maintenance (e.g., prioritize training for alarm/operator intervention, regular inspection and functional test for high risk contributors).

Conclusion

The SPSM concept can enhance effective RBPS application especially for the use of design accident scenarios information from HIRA, that was not usually well utilized for operation and asset management due to organizational silo in the organization.

The SPSM Initiative Group has issued Strategic PSM Guideline in the Yokohama National University's home page. The SPSM Initiative Group is further developing the education program for Process Safety Engineer along with the guideline.

A practical approach to run Process Safety Management System vibrantly

Masaki Iguchi, ENEOS Corporation, Japan

Process safety management system has been developed along with occurrence of severe incidents in history of chemical industry. In 1984, Bhopal catastrophic incident and Mexico City BLEVE had happened. In 1985, CCPS was formed by AIChE. In 1992, OHSA PSM regulation was established. In 2005, BP Texas City VCE incident happened. In 2007, guidelines for Risk Based Process Safety Management System of CCPS was established.

The CCPS Risk Based Process Safety Management System (RBPSMS) is composed of 4 pillars 20 elements. The pillars are "Commit to Process Safety" that contains 5 elements, "Understand Hazards and Risk" that contains 2 elements, "Manage Risk" that contains 9 elements and "Learn from Experience" that contains 4 elements. ENEOS has established own RBPSMS and named it as SOMS (Safe Operation Management System) which is composed of 16 elements that covers all 20 elements of CCPS RBPSMS and has been running it since 2018.

When we schematically express our job-related activities or things against process safety incidents in manner of protective layer, Process Safety Culture, Training, Technical Standards, Documents/Information, Equipment, Procedures and Behaviors exists at upstream of incident/Loss of Primary Containment in order. Emergency Response and Incident Analysis locate at downstream. These job-related activities or things are managed by each element of RBPSMS/SOMS. If a defect, which can cause an incident, occurred in these job-related activities or things, time lag generally becomes longer when the defect exists at more upper layer, though Process Safety Culture and Training need special caution. If defect occurred in behavior or procedure layers, process dynamics to have an incident is significantly quick.

When we try to prevent occurrence of process safety incident, developing and monitoring of leading and lagging indicators and perform corrective actions base on these indicators are very effective way.

Practices of development of sensitive leading indicators are to be strongly conscious about Heinrich's law and to regard lagging indicators as leading indicators for more serious events.

To develop effective leading indicator that has sensitivity for incidents, we are conscious about process safety competency of each organization, as well.

When we perform corrective actions or counter measures based on the indicators, those shall be quick enough to corresponding process dynamics of the incident system, which is described above. Also, if those counter measures are human related actions such as sticking to practices or development/usage of procedures, etc., those must be fitting to real root cause of deterioration, such as organizational culture, or personal leadership, etc.

As sensitivity of leading indicators becomes less sensitive, when competency of organizations improved, we need to continue developing leading indicators that has sensitivity corresponding to competency of the organization or shift focus of indicators from past highlighted ones to another ones. This is especially important in case of indicators that is involved with human related deficiencies.

The Human Factor in Safety-Critical Control Systems

Saleh Al-Shammari, Saudi Aramco, Saudi Arabia

The human factor plays a crucial role in safety systems, as it is often the root cause of incidents. Despite advances in technology and engineering, human error remains a significant challenge in the industry. To eliminate the human factor from being a root cause of incidents, explores the importance of understanding human behavior and its impact on safety-critical control systems. It discusses the various factors that contribute to human factor including cognitive biases, communication breakdowns, and over confident.

The presentation will demonstrate the risks of human factor in interfacing with Safety-Critical Control Systems and how to mitigate them. Ultimately, this presentation argues that a comprehensive approach to safety must account for the human factor in order to effectively prevent accidents and protect workers. Furthermore, Human error is a significant contributor to process safety incidents, accounting for up to 80% of incidents in some industries. Moreover, the design of control rooms and human-machine interfaces could lead to a significant impact on process safety, with poorly designed interfaces leading to operator errors and incidents.

In conclusion, understanding human factors risks and manage them while operators interfacing with safety-critical control system is stirring companies to address this subject and the importance of considering human factors in the process life cycle from design phase until decommission phase.

Session 9: Committed Culture & Process Safety Leadership-3

How to Measure Process Safety Culture. Key Indicators of Successful Evolution Case

Martin Fernandez, Whycomm, Argentina

The transformation of the Process Safety Culture requires a work strategy in two main dimensions. On the one hand, strengthen the Sense of Vulnerability in Senior Management, and on the other, Combat the Normalization of Deviance in the work fronts through supervision training, based on operational discipline. That is, sense of vulnerability in the head, operational discipline in the feet.

However, to feed this transformation strategy, it is necessary to deploy a consistent practice of measurement and analysis of the process safety culture, which addresses the central axes of risk and impact management, its opportunities for improvement and how these evolve over time. Measuring culture allows you to adjust the tactics and strategies deployed for its evolution.

In this paper, we complete a seven-year process (2015-2022) and two quantitative measurement exercises that yield results “in numbers” on a success story of cultural evolution. Detailing the process of analysis and interpretation of the qualitative results of culture, while visualizing them in an evolutionary process allowed leaders to focus on critical aspects, and articulate and deploy appropriate strategies, with the goal that the cultural model defined by the organization is reflected in everyday behaviors.

As a methodological note, we explain that the dimensions of culture used in the surveys implemented by organizations presented in this paper were elaborated from the core principles defined in the first element “Process Safety Culture”, of the pillar “Commit to Process Safety”, within the framework of the Process Safety Management System (Risk Based Process Safety, RBPS 2007).

Operational Discipline for High-Performance Process Safety

David Moore, President & CEO, AcuTech Consulting Group, USA

To achieve process safety management excellence requires Conduct of Operations (COD) and Operational Discipline (OD). Formalizing COD/OD makes the difference between good and great control of process safety risks. Leadership in process safety requires clear direction, clear communications, and disciplined execution. This allows for improved process safety implementation including:

- auditable, documented compliance to standards
- more collaborative execution of key process safety activities
- improved communications
- improved process safety culture
- and many other benefits

Topics will include:

- A model of COD/OD for process safety management
- Examples of applications
- Expected value and improvement potential

This presentation will be particularly useful for companies who want breakthroughs in process safety performance and who recognize the leadership skills and efforts required.

Experience with CCPS Risk-Based Process Safety Implementation in European and Japanese Cultures

Marco Stam, Global Business Process Owner, Teijin Aramid & David Moore, President & CEO, AcuTech Consulting Group

Teijin Aramid recognized the value of process safety management and used the CCPS RBPS as a template to start a journey to implement process safety management in 2013. The implementation of process safety was within the regulatory framework of SEVESO under Dutch Authorities at three process plants. The program led to a wide number of positive changes and improved the process safety performance and overall operating performance of the facilities. The paper will describe the activities and experience of implementing as a first phase.

However, as Teijin is a Japanese company and has the majority of its operations in Asia, the success of the Dutch plant’s implementation has led to interest in the parent firm in Japan to have the same framework benefit those facilities. The Japanese safety management framework up to this point has been a more traditional Japanese approach and so the RBPS concept was a learning experience and adjustment. The implementation of this program has led to mutual learning between the Dutch and Japanese sites, as the Dutch sites gain knowledge from the Japanese company’s operational discipline and day-to-day safety activities while the Japanese sites learn from Dutch hazard and risk identification methods.

The authors gained extensive experience in the differences between the US, EU, and Japanese approaches to process safety management, and experience in the management and technical aspects of the concepts. This paper will describe that experience and give advice and guidance on such areas as how to introduce process safety into a Japanese corporation, C-Suite and management concerns and differences in understanding and accepting the concepts, field implementation feedback, auditing advice, and other aspects.

Session 10: Advanced Safe Technologies in Process Safety

Rigorous Dynamic Simulations for Effectiveness Assessment of Independent Protection Layers in Chemical Processes

Meng Qi; China University of Petroleum (East China)

Process safety performance evaluation in the early design stages is crucial for the effective mitigation of potential hazards. Although process simulation tools have been extensively employed for this purpose, a knowledge gap remains concerning the construction of rigorous dynamic process models and the assessment of process indepdent protection layers in a dynamic manner using such models. This study attempts to address these issues by utilizing commercial dynamic simulation software, Aspen Dynamics, to conduct rigorous dynamic simulations and safety analysis of a two-column pressure-swing distillation process. Various protection layers, including basic process controls, alarms, safety instrumented systems, and pressure relief systems, are implemented and simulated to assess their role and effectiveness in accident prevention. Potential hazardous scenarios considered include overpressure and flooding in the distillation columns, with an exploration of the dynamic responses to several deviations, such as coolant and steam utility failures and undesirable throughput and composition disturbances. Scenario-based safety analysis is performed to evaluate the dynamic safety performance and the effectiveness of the implemented protection layers. The presented scenario-based dynamic safety analysis using rigorous dynamic simulations is critical for accurately determining dynamic behaviors of the process, ultimately aiding in the calculation of process safety time and the design of efficient safety protective systems

Effects of small space structure with fillers or small tubes on gas explosion characteristics

Keito Ichinose, Tatsuzo Kawano, Yuto Mizuta, Motohiko Sumino; Mitsubishi Chemical Corporation

To prevent gas explosion accidents in chemical plants, it is necessary to understand the explosion limits under the process conditions and operate the plant with the compositions outside the flammable range. However, at places where combustible gas and air are mixed, such as gas mixers and exhaust gas dilution processes, gas composition included in the flammable range may be formed temporarily. To avoid gas explosion accidents in such places, small space structure formed with fillers, small tubes, meshes, etc. would be effective in decreasing flammable range by increasing the heat loss rate with the increased surface area. Although there have been many studies on flame extinction using small space structure such as flame arresters, there have not been many detailed studies in term of the effects of decreasing flammable range with small space structure.

The purpose of this study is to develop an experimental apparatus for evaluating explosion limits in small space structure and investigate the effects of small space structure on gas explosion characteristics. Combustible gases were ignited by electric discharge in small space structure, and generated pressures were measured to determine explosion limits. The effects of small space structure with ceramic fillers or a ceramic small tube were obtained with comparing the explosion limits without small structure.

In the filler structure, the flammable range decreased compared to that in the explosion vessel only. In addition, the flammable range decreased as the filler size decreased. In the small tube structure, the flammable range similarly decreased, and the flammable range decreased as the tube diameter decreased.

When a gas explosion occurs, heat is generated by a chemical reaction of gases near the ignition source. Whether or not the flame is maintained and propagates depends on the balance between heat generation and heat loss. Heat generation rate is related to the space volume, and heat loss rate is related to the total surface area.

The explosion limits correspond linearly to the S/V ratio. Here, the S/V ratio is the total surface area divided by the total space volume. Even for different small space structure, flammable range decreased as the S/V ratio increased, and the effects can be estimated by the S/V ratio. If this technology can be applied to chemical plants, it enables to operate chemical processes with the flammable range gases having high conversion rates.

Hydrogen Injection in Blast Furnace to Reduce Co2 Footprint

Naveen Kumar, Tata Steel Ltd, India

CO_2 emissions in BF-BOF based steel industry is mainly attributed to usage of coal as a fuel & reducing agent for smelting of iron ore. This results in emission of approximately 1.80 tons of CO_2 per tonne of hot metal. In line with fuel rate reduction in iron making through blast furnace route, alternate fuel injection, alternate reductants are being practiced in different parts of the world. Most of these also are hydrogen rich. These injectants also lead to reduction of CO_2 footprint, thereby participating in carbon direct avoidance (CDA). Different such possible injectants, that are being in use are oils, tar, natural gas, hydrogen, coke oven gas etc.

Our company recently concluded its one of its kind, month-long trial with Coal Bed Methane (CBM) injection in one of its blast furnaces with encouraging results in terms of lowering of coke rates. Considering the same, effort was made to inject pure hydrogen in one of its blast furnaces.

News publication link:

[Tata Steel initiates trial for record-high hydrogen gas injection in Blast Furnace at its Jamshedpur Works]

Scope of the project:

Hydrogen injection trial was done in 4 tuyeres via hydrogen tanker. This helped in gaining important answers related to technology required for safe handling and injection of hydrogen in blast furnace.

Project Description:

Trial was carried out with hydrogen injection via 4 tuyeres in one of the blast furnaces. Main objectives of this revolves around learning usage of hydrogen and are listed as follows:

- Hydrogen handling and safety concerns
- Basic engineering
- Plant technology requirements
- Suitability and compatibility of injection hardware

Hydrogen supply for these trials was sourced using truck mounted cascades from potential suppliers along with necessary skid for regulating pressure for injection. Pressure reduction skid and transportation pipelines was laid from tanker position till designated tuyere for injection with all safety features and interlocks.

Injection Scheme:

In the existing tar injection system at one of the blast furnaces, there is a compressed air system present for cooling of the lance. In the concentric lance, tar travels from the center and compressed air flows through the annulus. In this system, compressed air system was used for hydrogen injection with no-tar.

The proposed system was itself a unique design and was modified considering the hazards of blast furnace and peripheral area

Challenges in Hydrogen Handling:

- Very Low Ignition energy - 0.017 mJ as compared to other gases.
- Wide range of explosive mixture 4 – 72% as compared to other gases.
- Leakage probability due to low molecular weight of H_2 & High pressure handling
- Colourless and odourless and can embrittle some metals

Uniqueness:-

- HMI developed with PSM critical real time parameters with more than 100 safety interlock was built in the logic.
- Automatic stoppage of H_2 in case of trip activation interlock and immediate switchover to N_2 Inertising/ purging sequence in each tripping.
- Real time simulations & testing of all safety interlocks was done before injection start up.
- Total no of H2 Tankers used "25 Nos with Hydrogen Tanker Pressure - 200 bar and Furnace Injection pressure "4.5 Bar
- Two stage Pressure reduction from 200 bar to 8 bar and from 8 bar to 4.5 bar with pipeline distance from tanker to furnace ~ 300 mtr
- Excess flow check valve and three way valve with changeover facility and start of purging and venting
- Elimination of entire electrical system from high pressure PRS where multi fold pressure reduction (15 times) is done
- The 1st stage PRS is an inherently safer and reliable design as it consists of mechanical system only, even the flow control valves etc are free from electronic and electrics.
- Safe logistic management of tankers to support the peak hydrogen injection rate @ above 1500 nm3/hr
- The entire injection process of 38000Nm3 is completed safely without a single leak
- Unique system followed to detect leak during injection trial of duration 60 hrs with the help of portable electrochemical H2 PPM detector and Thermography camera as hydrogen leak phenomenon follows opposite to Joule Thomson effect
- There was no unintended leakage of hydrogen.
- Hazop, Consequence modelling through PHAST software, Bow Tie, PSSR conducted before the trial.

Achievements:

- Our company became 1st to inject such large volume of hydrogen in any Blast Furnace
- During Hazop, 52 number of high risk scenarios were identified and mitigated at the design phase itself
- Hydrogen Injection is one of the key strategy of our company in the decarbonisation journey. The endeavour is aligned with the Company's vision of becoming Net Zero by 2045 kick started with this project
- The trial has the potential to reduce the coke rate by 10%, translating into around 7-10% reduction in CO_2 emissions per ton of crude steel produced saving millions of money.
- Very encouraging process results were observed during the trial and team learnt Safe handling/ managing hydrogen injection in Blast Furnace.
- The process sees hydrogen substituted in for carbon as the reducing agent in the extraction process at 40% of the furnaces injection systems.

Electrostatic discharges in pilot-scale metal silo during loading of powders

Kwangseok choi, Mizuki Shoyama, Yuki Osada, Teruo Suzuki; National Institute of Occupational Safety and Health- Electrical Safety Research Group

In this study, the electrostatic discharges generated from a metal protrusion (40mm in diameter) existing inside a metal silo during loading of polypropylene powders(PP, approximately 3 mm) were experimentally investigated. The silo was continuously loaded with PP powders at a mass flow rate of 0.68 kg/s to a total mass of approximately 800 kg. An image intensifier unit was used to observe the electrostatic discharges in silo, and novel Coulomb meter was used to measure the charge transfer (Q) of electrostatic discharges.

As for the results, a multiplicity of brush dischargesfrom the protrusion was clearly observed.

Especially, strong broad bulk surface discharges clearly appeared after the metal protrusion was fully immersed in the powder. The max.Q of about -6000nC obtained during test and this level can be an ignition source for not only gas and vapor, but also for some powders.

Session 11: Big Data and Data Analytics in Process Safety-2

Effectiveness of Using Digital PSSR Checklist in Petrochemical Industry

Joompote Ketkeaw; SCG Chemicals, Thailand

According the existing practice of PSSR onsite in SCG chemicals companies which have been using paper-based tools to perform PSSR, PSSR users have got pains and identified the gaps from PSSR activity regarding to risk coverage concern and PSSR execution concerns. The gaps are including (a) questionnaires on PSSR checklist don't cover all checkpoint aspects in order to ensure all risks and pending actions are identified since there is one PSSR checklist for all SCG Chemicals companies which doesn't fit to all plants practices which leads the PSSR team having insufficient review aspect for start-up activity, (b) PSSR records are kept in uncontrollable and various locations at site, (c) no information linkage to MOC system which generate duplicate work for MOC team, (d) difficulty to assign team to check item by each discipline when performing PSSR and (e) received non-productive time consuming of PSSR leader or PSSR coordinator on PSSR report preparation. Therefore, the digital PSSR checklist platform is developed in order to transform the current PSSR activity to digitalized process to improve the PSSR assessment effectiveness by fully customization of PSSR checklist to fit to each company in order to ensure that all checkpoint for each PSSR activities in each companies are verified to prevent incident when perform start-up process , generate big data storage for PSSR information risk tracking, compliance audit and further data analytic, and optimization of time consuming and manpower in order to prepare and finalize information of PSSR information for approval and submission PSSR information to government office. Moreover, this digital PSSR checklist platform can save the man-day up to 0.5 man-day per PSSR record which is equivalent to 15 man-days per year for normal PSSR in one petrochemical plant (soft-saving 1,400 USD) and 20 man-days per Shutdown Turnaround Project (soft-saving 1,800 USD) and increase effectively on mobile devices at process areas for process safety application utilization up to 30 percent.

Enhancing Safety in the Process Industry-Leveraging Data Analytics, Machine Learning, and Knowledge Management

Mayuresh Mokal, Ingenero Inc, India

Safety is of paramount importance within the Process industry, where the consequences of accidents can be severe for workers, the environment, and the public at large. Emerging technologies such as data analytics and machine learning have the potential to significantly enhance safety performance by offering insights into the causes of incidents, strategies for prevention, and improved risk detection and mitigation.

In this presentation, we conduct a comprehensive review of the current status and challenges associated with the integration of data analytics and machine learning into safety practices within the Process industry. We also propose a robust framework for the development and evaluation of safety solutions driven by data, and we present practical case studies as well as outline potential future directions.

Moreover, we delve into the realm of Applied Artificial Intelligence (AI) and Machine Learning (ML), which have become state-of-the-art tools capable of bolstering safety efforts through Knowledge Management (KM). By facilitating effective learning, communication, and collaboration among stakeholders, KM not only supports occupational safety, health, and ergonomics but also leverages technology to capture, store, retrieve, share, and utilize knowledge efficiently.

Our transformative solution, powered by the advanced Applied AI platform known as DeciGen™, has already delivered substantial benefits to numerous process industries. By harnessing the capabilities of DeciGen™, we have successfully enabled these industries to proactively detect anomalies that could otherwise escalate into significant risks and hazards in the near future. This innovative platform can be tailored to suit specific needs, ensuring decision-making excellence through a comprehensive range of analytical solutions: from providing descriptive insights into current situations, to diagnosing the root causes of issues, predicting potential outcomes, and even offering prescriptive recommendations to mitigate risks.

The application of DeciGen™ marks a pivotal shift in how process industries approach safety and risk management. By leveraging its advanced AI capabilities, industries can now stay ahead of potential incidents, making informed decisions based on a thorough understanding of their operations and the proactive identification of potential issues. This not only enhances safety protocols but also contributes to overall operational efficiency and excellence.

Barrier Management and Safe Work Control (BMSWC) - an Insightful Tool to Improve Risk-Based Plant Operational Decisions:

Najah Mohd Jamal, Malaysian Refining Company Sdn Bhd, Malaysia

The catastrophic fire and explosion that occurred on July 6, 1988 at Occidental, Piper Alpha Offshore Platform relating to risk created by Simultaneous Operations (SIMOPs), once shocked the Oil and Gas industry. SIMOPs occur within process facilities when two or more activities occur at the same time and place. It was overwhelmingly clear, as an Oil and Gas processing facility, risk which was present in Piper Alpha such as risk from the activity of bypassing Safety Critical Elements (SCEs) or the hardware barriers may not be identified when another activity is planned or conducted. Those risks may be present within our processing facility too; hence this triggered the idea to develop and apply the model on Barrier Management and Safe Work Control (BMSWC). BMSWC is intended to provide visibility on barrier impairments, linking any activities pertaining Process Safety Critical Element or barriers and communicate risk insights to the organization to enable better and proactive activity planning near or within the same place.

First version of Barrier Management model was introduced to Malaysia Refining Company Sdn Bhd (MRCSB) in 2019 and throughout the years, the team in MRCSB comprising Process Safety practitioners and other relevant departments such as Reliability, Production and Asset Integrity has improvised the model by identifying carefully what are the potential inputs and targeted output. Hence, a blueprint of MRCSB BMSWC is designed with the objective to operationalize the Bowtie document, creating a valuable and intelligent tool that will be used as a powerful leading indicator to avoid Major Accident Hazard (MAH) incident. BMSWC tool has been deployed to MRCSB starting December 2022.

In this paper, MRCSB will be sharing their experiences applying the BMSWC tool including how the tool has helped to enhance accessibility and usability of essential information in Bow Tie, ALARP document. Next, how the tool enables users to identify SCE impairments from various process safety sensor data and deviations connected to current available stand-alone systems. The input is linked to BMSWC tool and allows user to monitor healthiness and changes in barrier performance near real-time during or before planned key activities. These valuable insights, will be shown in a case study has assist Operations team in optimizing their activity planning, make sound and risk-based decision to avoid incidents related to SIMOPs.

Session 12: Enhanced application of Lessons Learned

Incident impact estimation of a liquefied petroleum gas tank using CCPS assessment tools CHEF/RAST

Yasuo Nomura, ENEOS NUC Corporation, Japan

Japanese chemical industry faces challenges to maintain aged facilities and to hand down process technology for young generation engineers. In this circumstances, serious accidents due to causes related to process safety management systems have been occurred in Japan. There are urgent action needs for most of Japanese chemical plants to conduct risk based assessment in order to estimate the possibility of serious accidents and the preventive improvement actions. We decided to use the CHEF/RAST assessment support tool provided by CCPS for liquefied petroleum gas tank assessment.

These CCPS tools provides impact area estimation in risk based assessment by CHEF and assessment scenario generation according to process information by RAST. RAST provides several estimation modules for assessment and support conducting risk based process safety management system. By using these tools, we can understand current status of potential risks of existing facilities, and TIPS for Japanese facilities through efficient assessment. At our company, we focus on blast impact area when a C4 tank rupture BLEVE) accident occurs at case of pool fire consequence. In this session, we estimate impacted area by the blast wave and also frequency of the pool fire initiation.

Learning from Failures to Mitigate Risk of Disaster in Iron & Steel Manufacturing R&D through Process Safety Management

Anup Kumar, Tata Steel Ltd, India

The iron and steel industry involves numerous process safety hazards like hot liquified metals, superheated high pressure steam, toxic and inflammable industrial and byproduct gases, liquid fuels like light diesel oil and various chemicals which find applications in water treatment, as additives in agglomerates, etc. In order to mitigate the risk of catastrophic incidents due to the loss of containment of these hazardous substances, and to ensure the sustenance of safe production, it is particularly important to have a robust process safety management (PSM) system in place.

Our organization embarked on its process safety excellence journey in 2007 and further strengthened its commitment to excellence in process safety in 2015 with the deployment of Process Safety Centres of Excellence (CoEs) in various departments in a phased manner. These Centres of Excellence focused on the identification of units within the plant as high hazard operations (HHOs) and low hazard operations (LHOs), based on the presence of substantial inventories of hazardous substances or energy, posing a significant process safety hazard. This was followed by the deployment of process safety management in two phases â€“ CoE deployment which includes collection of process safety information (PSI), determination of standard operating conditions (SOC) and safe operating limits (SOL), identification of process safety critical equipment and process hazard analysis (PHA), and CoE sustenance which consists of regular activities involving all levels of the workforce and management like PSM line walks, audits, table top exercises, barrier audits, etc. As of now, nearly all hazardous plant operations have been covered under the scope of process safety management.

Apart from this, a three-stage project hazard study framework has been implemented in engineering projects to assess the upcoming projects for process safety risks that can be mitigated in the concept and design stage of the project itself, through selection of inherently safe design and implementation of past learnings. Since its rollout in 2022, 174 projects have been assessed under this project hazard study framework prior to their concept approval. Out of these, 46 projects were identified having major process safety risks, in which case, further detailed analyses like Hazard and Operability Study (HAZOP) or consequence analysis are also required to mitigate the risks of catastrophic incidents to an acceptable level.

Over the years, we have learned from our failures and the best practices across industries and implemented many novel systems and practices to improve safety at our workplaces. A few examples of such initiatives include Pre-Demolition Safety Reviews, hot work clearance, and digital and IT-based solutions like process safety performance indicator dashboard and real time barrier health monitoring system. In addition to these, we have well-established systems for various kinds of Management of Change (MoC) and Pre-Start Up Safety Review (PSSR) that have enabled us to make our facilities safer.

However, a recent incident of explosion in a hydrogen peroxide storage tank enlightened us on the gaps in our existing system, and our knowledge and experience in process safety management enabled us to bridge those gaps. The tank was part of a facility which was under the ownership of the research and development (R&D) unit of our organization. One of the key insights from the investigation of this incident was that while a lot of focus and effort has been dedicated to safety in regular operations in high hazard facilities and construction projects, laboratories and trial projects under R&D had long been kept out of the scope of such rigorous process safety management systems despite some of the most hazardous and reactive substances being used there, even though in small quantities in most of the cases. The first action taken was training and sensitizing the R&D team on process safety management and its significance to them. We have already seen an improvement in reporting of incidents at R&D, including near misses in the months that followed.

After this incident, we took a drive to map all the processes and facilities under R&D and assess the maturity level of their practices of chemical handling, storage and operation. A 7-part checklist for laboratory and chemical safety assessment was developed and more than 60 laboratories at various locations were identified for assessment through the year. Seven key aspects, namely layout and siting of laboratories, storage of chemicals with consideration of reactivity of various chemicals, equipment maintenance, secondary containment and spill/leakage control, disposal of used samples and expired chemicals, standard operating procedures (SOPs) and risk assessment, and emergency response, were identified for focused improvement.

A new PSM framework specifically designed to cater to the process safety requirements of R&D according to the nature of trial was developed and implemented in trial projects at four levels: laboratory trial, scale-up trial, pilot trial and plant trial. Under this framework, we first categorize projects based on the availability of chemicals or energy, irrespective of their quantity. If there is some chemical or energy involved, the projects are further classified into high hazard trials and low hazard trials using a trial hazard evaluation check sheet which takes into account the hazards of the individual substances, the reactions involved and reactivity of various substances with each other and with other substances like air, water, materials of construction, etc. The requirements of different analyses like PHS-1 (Project Hazard Study-1), HAZOP, facility siting and consequence analysis at each stage of trial have been defined according to the above classification and hazards present.

Another important finding from the investigation of the above incident was the lack of knowledge of the working agencies on the reactivity and decomposition characteristics of hydrogen peroxide and their low risk perception for the possibility of explosion. As a result, ever since then, special focus has been laid on the competency of employees as well as vendors working in areas where process safety hazards are present, even if the facility is not classified as a high hazard operation as per the process selection criteria for PSM deployment. In the context of R&D, this has been covered using tools like HAZID (Hazard Identification), HIRA (Hazard Identification and Risk Assessment) and training with records being verified during PSSR.

Periodic audits focused on chemical and process safety enable us to identify any gaps in the system and correct them. The learnings are communicated across all levels of the organization in forums facilitated by Central Safety team as well as internal communication forums of R&D, to ensure their fast dissemination and implementation.

This paper discusses in detail the methodologies and practices adopted by us for process safety management in R&D and their effect on the safety performance of the organization.

Prevention of Breakouts in Slab Caster at Tata Steel Kalinganagar

Manjunathan M, Tata Steel Ltd, India

Continuous Slab casting, also called strand casting, is a process whereby molten metal is solidified into a "semifinished" slab for subsequent rolling in finishing mills. It has been widely accepted as the most important production process in the steel industry. In the casting process, molten steel from the ladle flows through tundish into a mould. Within the mould, the molten steel freezes against the water-cooled copper mould walls forming a solid shell. The steel melting shop (SMS) unit in Tata Steel Kalinganagar has twin strand caster for slab casting. One of the worst catastrophic process failures that can occur during the process of continuous casting is the breakout of strand. Breakout occurs when solidifying strand steel shell ruptures or tears leading to loss of containment of liquid steel beneath the mould. There are several reasons due to which the solid shell of the strand breakouts. This event not only results costly damage but also a serious process safety risk scenario for the operators presents in continuous casting area as it may lead to major secondary fire in shopfloor. Breakout leads to a major shutdown of the strand and results in the loss of production time along with significant drop in the yield. While operating with single twin strand caster, it becomes the bottleneck post each breakout and causes a significant direct production loss. For the restoration of the continuous casting (CC) machine strand, it creates lots of hazards & typically requires an extended turnaround involving removal of the spilled liquid steel material within the strand equipment by lancing operation and/or replacement of the damaged segments of the machine. At Tata Steel Kalinganagar, we studied all the previous breakouts incidents of steel melting shops and took necessary corrective and preventive actions to eliminate these breakouts during casting operations. After analysis it was found that major reasons for breakouts in the shop are due to Strand shell puncture by Al_2O_3 inclusions, edge bleeding of shell after tundish fly operation, taper loss during ramming for width change operation in mould, longitudinal crack formation in shell and sticker phenomenon. Each of the reason requires different prevention mechanism, hence, to reduce the Al_2O_3 inclusions from puncturing the shell, modified stopper flushing practice was adopted to ensure sufficient shell strength of strand before exit of mould. Tundish fly operational practices were modified to reduce the probability of fins formation in the corners of the mould and thereby reduction of edge bleeding in the shell. To reduce the sticker breakouts, breakout detection system was further strengthened by introducing AI algorithm-based detection along with pattern-based voting logic. For reduction of longitudinal crack breakouts maintenance practice were improved and segments were changed after standard life and operation practice were adopted according to the Mn/S of grade. These different innovative practices were quite effective in reducing the total breakouts by 90%, from total 10 noâ€™s of breakout in FY'21 it have been reduced to 6 noâ€™s in FYâ€™22 and only 1 no in FY'23. These measures have resulted in reduction f loss of containment of liquid steel incidents, improved productivity at caster shop and savings of approx.1.3 million USD in last two years

Essential Practices for Sustaining Integrity of Safety Instrumented Systems throughout Facility Lifecycle

Efiok Ekanem, Saudi Aramco, Saudi Arabia

Safety Instrumented Systems (SIS) plays a vital role ensuring the safety of process facilities. In several facilities' process safety systems, Safety Instrumented Systems function as the last preventive layer of protection against the occurrence of serious process incidents. SIS detects out of limit conditions and acts to bring the process to a safe state. SIS implements specified Safety Instrumented Functions (SIF) and may be made up of simple or complex combination of sensors, logic solvers and final elements executing different integrity functions. Examples of SIS include automatic Emergency Shutdown (ESD), High Integrity Protection System (HIPS), Burner Management System (BMS) etc. A typical SIF is an ESD loop that detects overpressure upstream of a rated pipeline and close a downstream isolation valve to prevent propagation of overpressure to the de-rated pipeline sections downstream of the isolation valve. A reliable SIS is an important means for achieving the objectives of maintaining asset integrity through its life cycle to protect people, property, the environment and company reputation. Considering the essential function of Safety Instrumented Systems, integrity of the system is critical to ensure that the system functions as intended to prevent the occurrence of process safety incidents. The performance requirement expected for a specific Safety Instrumented Function is qualified as Safety Integrity Level (SIL) of the specified safety function. SIL is specified in discrete levels (1-4), corresponding to a range of safety integrity values, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest. Attaining and maintaining the required integrity level for SIFs is achieved through proper design specification, correct installation practices and effective operation and maintenance practices. During design, care is taken to specify key parameters like hazardous process conditions and their potential consequences, the hazardous event frequency, independent protection

layers available and the level of risk reduction they provide. Installation of SIF components is required to follow strict procedures in accordance with manufacturer's specification. Continuous maintenance of the integrity of the SIS depends largely on the implementation of good maintenance practices including adequate inspection, proof testing of the SIFs, Management of Change, effective data collection and record keeping, as well as sufficient investigation of unexpected occurrences in the system and functional safety process auditing. Design of Safety Instrumented Functions to achieve its assigned Safety Integrity Level requires meeting three key design constraints – Equipment Suitability of each device, redundancy of each equipment set (architectural constraints or hardware fault tolerance), and average probability of failure on demand for the entire SIF loop. However, even with the development of suitable design to meet the assigned safety integrity level, sustenance of the assigned integrity level during the facility lifetime depends on other important activities that will take place during the lifecycle of the SIS starting from correct installation and commissioning of the system Installation including initial calibration and validation testing of the system. Following initial commissioning and testing of the safety instrumented system, suitable operation and maintenance planning including repair procedures and availability of spares needs to be addressed within the overall facility asset integrity management plan. Additionally, competency of personnel involved in the safety lifecycle activities of the SIS must consider not only specific knowledge of the equipment/devices, but also the overall intent and objective of functional safety, including the details and objectives of the different types of testing and maintenance activities planned for the SIS, such as functional testing, proof testing, preventive and corrective maintenance etc. One of the most important activities for maintain the integrity of a safety instrumented function is Proof Testing. Proof Testing is an essential element in the continuous maintenance of safety integrity level of a safety instrumented function within a SIS. It is a test that is designed to reveal the 'undetected/ unrevealed' failures which the device may be harboring. Proof Test Interval has a significant contribution to Average Probability of Failure on demand (PFDavg) of Safety Instrumented Systems, especially for final elements where automatic diagnostic coverage is zero or quite minimal. Due to design and operational constraints as well as the extensive nature of proof testing procedures, it is not always possible to conduct the test with the equipment online, except full redundancy is provided for the safety instrumented function devices for the purpose of proof testing. Where such redundancy is not possible, due to the constraints of impractical online testing for some SIFs, proof test for some SIFs are specified to occur during regular shutdown maintenance for the facility. Wherever, such shutdown schedule is required to be deferred, facility management needs to consider additional measures to ensure that the integrity of the affected safety instrumented functions is maintained throughout the period of the shutdown deferment. Changes in SIS Design or Operating/ Maintenance Practices needs to go through Management of Change (MOC) process. It is important to understand that changes impacting the SIS goes beyond changes directly affecting the SIS equipment/ devices. Changes affecting other layers of protection could impact the risk gap covered by those layers of protection, and can invariably affect the overall SIL target. Hence changes affecting other layers of protection can lead to a need to change the SIF design if the SIL target is affected in such a way that the risk gap assign to the SIF is increased. Additionally, MOCs will need to be applied not only to equipment changes, but also to changes in process safety variables such as trip set points, changes to maintenance or proof test procedures, changes to proof test intervals, utilities configurations, or applicable software changes. Effective data collection and analysis cannot be overemphasized as an important factor in the maintenance of SIS integrity. Among other functions, data collection, verification and analysis help to determine how the actual demand rates for the SIS compare against the data assumed during the system design, and also how failure rates of SIS equipment compare against that assumed during the system design. This is very important during the revalidation process of SIS design. Significant amount of data is required for effective analysis; hence data collection may not be limited to one site but may be collected across different sites with similar operational practices and equipment sets. Standardized data capturing and documentation system is essential to ensure verifiability and comparability of data. Also, determination of clear objectives for the data collection and competence of personnel conducting the data collection and analysis are important factors in ensuring high quality data, and useful results from the data analysis. Application of Artificial Intelligence (AI) is expected to play a significant role in Safety Instrumented System data collection and analysis in the coming years. Similar to other important processes, auditing of functional safety systems helps to ensure that the system is meeting set objectives with regards to risk reduction expectations, and also helps to identify gaps in the management of the safety instrumented system. Results for functional safety audits helps to identify ways improve the management of safety instrumented systems not only to ensure acceptable risk reduction but ensure to ensure cost effectiveness of the overall process.

Session 13: Intentional Competency Development-2

Knowledge Retention for Continuous Workforce Competency- A Case Study: (93)

Benjamin Tan, PCS Pte. Ltd, Singapore

PCS Pte. Ltd. (formerly known as Petrochemical Corporation of Singapore (Private) Limited) operates two ethylene plants. The first of its two plants, PCS-I, was started up in 1984 while the second, PCS-II, was commissioned in 1997. Since the initial start-up of PCS-I in 1984, PCS has operated its ethylene plants smoothly and safely, and have had no major process safety incident to-date.

One of the key reasons for the strong process safety record is that PCS has enjoyed a relatively stable workforce. Many of its pioneering batch of employees, recruited during the 1980s for the commissioning of PCS-I, have remained in the company for the entirety of their careers. These pioneers have amassed much experience over the years and now form a strong core of the operations, maintenance and project engineering teams.

PCS management has recognised that its people has been a key asset to the success of PCS, and that as the workforce begins to age, succession plans have to be put in place to ensure the continuity of this success factor. Particularly for technical roles where there is extensive specialised knowledge, there is a need to provide for an extended handover period to better facilitate knowledge transfer between those who are retiring from key positions and those who have been identified to succeed them. To that end, PCS initiated an Advanced Transition Manning (ATM) programme beginning in 2018 to bring forward the anticipated recruitment necessary to replace those who will be retiring.

With the increase in new hires as part of the ATM programme and in view of an increasing proportion of experienced staff retiring over the next 5~10 years, PCS also convened a Process, Operation and Equipment Knowledge Training (POnEK) taskforce. The purpose of the taskforce is to put in place a systematic approach and framework to capture valuable knowledge from the very experienced workforce that PCS currently has. This taskforce is made up of experienced members from the various operation sections and other functions. Since its convening in 2020, the taskforce has reviewed and gone through existing documentation from various sources, such as training material, past incident reports, technical reports, with the objective to compile these material and information into a comprehensive set of training material. The experience of the members in the taskforce has been invaluable in making judgment on what is salient and important to be captured from the mass of past documentation reviewed.

While this effort is ongoing, training has commenced in parallel, and has been carried out as and when sections of the training material have been completed. The training is conducted by members of the POnEK taskforce and is delivered to not only the less experienced staff, but also to the experienced members of the operation section. During the conduct of the training, these experienced members then also share from their experiences and knowledge, adding on to the material that has been prepared.

While the retention of knowledge from such classroom training is likely to be less effective than the experiential learning gained from incidents and mistakes made, it is neither practical nor desirable for newcomers to â€œlearn the hard wayâ€ . By the effort of the POnEK team in putting together the material, it is hoped that lessons learnt in the past can remain within the body of organisational knowledge, so that as much as possible, we can avoid repeating mistakes from the past.

Competency Development through Process Safety Knowledge Management

Dr. Tekin Kunt, PSRG Inc., USA, Avanna Tan, PSRG Asia Pacific Pte Ltd.

The aim of a Process Safety Knowledge Management (PSKM) system is provide the right process safety knowledge to the right people at the right time to improve process safety in an organization. Competency development is an important portion of PSKM system so that teams can be productive in capturing, organizing, maintaining, and provided the essential process safety knowledge whenever it is needed. In this paper, we will present lessons learned in building a successful competency program based on a PSKM approach.

Utilizing Videos for Technical Heritage and Work Procedures

Kazuhiro Koyama & Yasuhiro Kawakata; Maruzen Petrochemical Co. Ltd. Japan

In recent years, various safety initiatives in manufacturing sites, such as facility improvements and leveraging incident reports and best practices, have contributed to a declining trend in accidents year by year. However, on the other hand, young employees are experiencing fewer opportunities for non-routine tasks and trouble handling, leading to a decline in the accumulated experience of operators. Moreover, measures to prevent recurrence of past incidents have been implemented with certain effectiveness, but to proactively prevent new troubles that may arise in the future, it is essential to apply the accumulated experience of veteran employees.

Work in the field does not always proceed as per the standard operating procedures, and there are always unforeseen risks and challenges that are not documented in the procedures. In our company, in addition to the existing safety measures like work procedures and best practice collections, we are utilizing videos that combine visuals and audio to create a sense of presence, as if the trainees were on the actual work site. This approach allows us to impart a deeper understanding of the intuitive aspects of the tasks and the essence of the plant, which cannot be fully expressed through documents, enabling the acquisition of skills to handle potential risks that may occur in the future. Furthermore, the process of creating these videos provides an excellent opportunity to review work procedures and explore the design philosophy of equipment and processes, contributing to the overall enhancement of skills within the workplace.

Loss Prevention Eyes on the Field

Naif Aldakhayel, Saudi Aramco, Saudi Arabia

The purpose of the presentation is to share a best practice in promoting the application of the lessons learned and enhancing the safety performance in the hydrocarbon industrial facilities. Eyes on the Field program was initiated in 2022 after the analysis that showed an uptick in the number of total recordable cases happened outside the normal working hours and remote areas. Eyes on the Field is a safety program that intensifies the field presence by providing a proactive field support to all organizations during normal working hours, after hours, and holidays and capitalizes on capturing lesson learned. The program constitutes three main pillars: stopping activities that has the potential to injure personnel, damage equipment, or harm environment; Reporting & communication these findings through SafeLife system; and Conducting deep-dive analysis for all captured data. In promoting and enhancing the applications of lessons learned, loss prevention conducts periodically a deep-dive analysis on the work stoppages trends and shared the outcomes with all organizations through a comprehensive report and several technical sessions. This is intended to identify area of improvements where the organization can exert more focus to address systematic root causes and enhance the safety performance.

Session 14: Multifaceted Session–Disasters and Emergency Response + Asset Integrity Management & Aging Facilities

Performance Monitoring of Rotating Machinery, Electrical, and Instrumentation Equipment for Achieving Condition-Based Maintenance (CBM)

Kotaro Morikawa; Idemitsu Kosan Co., Ltd., Japan

Idemitsu Kosan Co., Ltd. is exploring the implementation of an advanced process safety system utilizing smart technologies such as IoT. As part of this initiative, we are considering mechanisms for “Collect,” “Connect,” and “Inspire”? gathering data through integrated databases, establishing connections via wireless infrastructure development, and facilitating awareness and aiding decision-making through AI or related technologies. A key aspect of this effort involves the in-house agile development of a system named Smart Digital Maintenance (referred to as SDM-kun), which serves as the user interface for these mechanisms.

SDM-kun has various features for data integration. In this context, I will introduce the “performance management” function. This function systematizes the monitoring of indicators that have a large impact on plant operation like catalytic lifespan, U-values of heat exchangers that were traditionally conducted every few months using Excel. It enables real-time monitoring through integration with Historians. Previously, performance management was limited to only process and stationary equipment, focusing solely on process values like temperature and pressure. However, due to the increased number of field devices, such as HART devices like Smart Positioners, and wireless vibration sensors, handling data related to devices has become easier. Consequently, performance management for rotating machinery, electrical systems, and instrumentation assets has also become achievable, leading to Condition Based Maintenance of these assets.

In this presentation, I will introduce a case study where the condition monitoring of control valves, which previously depended on valve diagnostic services from various vendors, has been internalized.

Benefits of Planning for Black Swan Events

Chan Keng Yong, Manager & Principal, AcuTech Consulting Pte. Ltd. (Singapore)

Companies should include consideration of very low probability and high consequence events (Black Swan Events) when assessing risk and planning for residual risk management to improve readiness and performance of the process safety management system. These events could include compound incidents, highly disruptive and sudden events, cascading events, domino effects, or larger releases than considered in the typical process hazards analysis studies. Often, they are discounted as not credible. Are they really such rare events that they should have been dismissed? Are the assumptions used to reach those conclusions valid? Are there benefits to be gained by considering this unique perspective? Have there been technological advances that can help assess these risks?

Such events, usually considered extreme outliers, collectively play vastly larger roles than more common occurrences due to the potential for more severe consequences than was considered in the design, operation, risk management, and emergency response plans. The largest losses that drive the industry’s quest for improved process safety management are often based on events of this magnitude. Considering these events may lead to knowledge of gaps that support that a larger event was, in fact, credible, and should have been included in the scope of the design basis and not simply in the purview of crisis management.

Impacts from Black Swan Events may include process safety considerations and operational impacts such as:

- Damage or injury well beyond the expected outcome of a sequence of events where barriers were assumed to be adequate
- Unusual operational conditions or upsets leading to loss of primary containment

- Logistics and interdependency complications, including supply chain impacts
- Mass casualties
- Lack of preparedness to properly manage high-level emergencies due to inattention to the needs of managing complexities of a large- scale event
- Overconfidence that the public responders or government assistance will be highly effective
- Failure to consider internal resources required for business continuity

All these possible impacts must be considered in advance, as well as, during the developing situation. The emergency and crisis management planning cycle offers a valid model to ensure Black Swan Events have been adequately risk assessed, planned for and mitigated, using the phases shown below:

1. Hazard Identification and Risk Assessment
2. Planning and Preparation
3. Training and Exercising
4. Review and Improvement

Facing the worst impacts of low probability, high consequence events is a healthy exercise in that it improves the overall resilience and robustness of the systems, including emergency management and supply chain systems. Further, it highlights the organizational support that promotes the right culture of process safety. Overconfidence in traditional assumptions may be detrimental to the health of the organization. AcuTech believes a focus on certain Black Swan Events will prove to be an invaluable means of achieving excellence in process safety management (PSM).

Elevating Process Safety in Steel Plants: A Comprehensive Case Study on Mitigating Unconfined Vapor Cloud Explosions (UVCEs) in Coke Oven Gas Pipelines

Abhinav Sharma, Viralkumar Gheewala, JSW Steel

Event Description:

Dt. 11th June 2022, at 5:45 Hrs., Un-confined Vapor Cloud Explosion(UCVE) took place at Coke Oven gas (COG) Vent pipeline (pusher car track is placed beneath of pipeline outlet) of Battery A due to failure of the rupture disc installed in the COG pipeline at cellar area and at the same time hot surface (Pusher car was passing through the gas accumulated area with hot oven door) come in contact with vapor cloud resulting into Un-confined Vapour Cloud Explosion(UVCE).

The victim was descending from the staircase of the pusher car (distance from vent line approx. 15mtr.) and came in contact with flame, resulting in burn injury.

Event Root Cause:

Technical reliability barriers (facility design, equipment failure, redundancy, fault sensors, automated protection systems, interlocks, etc.)

1. Isolating the Coke Oven Plant -1 flare system.
2. Change in rupture disc original specification.
3. Operating at a higher pressure than the original pressure condition due to choking in line.
4. Temporary operation of Coke Oven Plant (COP) with inadequate functioning of gas cooler.
5. No design basis available to validate that Coke Oven Plant -2 flare stack with 10% throttled valve will take care of pressure increase in Coke Oven Plant-1.
6. Safety Management Systems (procedures and rules, safety system activities, etc.)
7. RD position changed without risk assessment.
8. No Process Hazard Analysis for Coke Oven Plant operation.
9. Lack of operational discipline.
10. Relying on human intervention for quick and critical action.
11. No system in place for planned routine shutdown to address process /equipment-related issues.

Lessons Learnt:

1. Process Technology Package should be made available for Higher Hazard Process & Lower Hazard Operations.
2. Detailed Process Hazard Analysis for each Higher Hazard Processes (HHPs) & Lower hazard Operations (LHO) to be conducted.
3. Any changes with respect technology or facility should be routed through Management of Change system.
4. Mechanical Integrity & Quality Assurance Program should be ensured for Process Safety critical equipmentâ€™s.
5. Standard Operating conditions (SOCs) & Safe Operating limits should be defined in Standard Operating procedure (SOP) and it should be communicated to concerns.

Corrective Action Taken:

1. Performed de-choking of the battery lines to restore the original working pressure & also took the critical safety system like flare back in line as per the original plant design.
2. Installed correct specification Rupture disc based on Standard Operating Conditions (pressure, temperature, chemical compatibility etc.)
3. Provided interlock to cut off gas supply on detecting High pressure in the system (PT in upstream of rupture disc)
4. Incorporated sensing system for flammable /toxic gases to detect any gas release at the early stage.

i.e. Tell-tale indicator for rupture disc/ gas sensor with audio alarms.

Preventive Action Taken:

1. Defined formal SOCs at each process step and incorporated in Process Technology package.
2. Any deviation/ decision which are deviating the SOCs recognized as case for Management of change- technology and conducted formal risk assessment with respect to the changes.
3. All current as built situations incorporated in P&IDs and performed a detailed design review/HAZOP to address unauthorized changes in the last few years.
4. Incorporated system to recognize facility related changes and ensure that such changes are bring to facility post adequate risk review & formal approval from management.
5. Identified Process Safety critical equipment's for Coke Oven Plant.
6. Defined Mechanical Integrity program for required test & inspection at defined frequency.
7. Planned shutdown practice Incorporated for Coke Oven Plant at predefined frequency and predefined Preventive Maintenance plan, so that operation team do not need to deviate SOC to continue operation and take unaccounted process risk.
8. Defined policy for process vents/ emergency vent to release of hazardous gases. Reviewed location of all process vents/ emergency vents for all hazardous chemicals/gases and diverted them to safe location as per the defined policy.
9. Defined policy for eliminating potential ignition (including hot surface) source from hazardous/ flammable zone and corrected them if any deviation from the defined policy.

A Comparative Study: Various Modeling (Empirical, Integral, 3D CFD) Approach for Accurate Consequence Analysis and Risk Management of Accidental Release of Ammonia

Govind Patil, Sastry Mangipudi; Gexcon India & Middle East

Ammonia and hydrogen play significant roles in a net zero economy because they produce no carbon emissions during production and consumption. The global shift towards a hydrogen economy has made ammonia an excellent choice for hydrogen storage and transportation due to its favorable characteristics and thermodynamic feasibility. With a substantial hydrogen weight fraction, anhydrous ammonia is particularly promising for hydrogen storage, boasting high volumetric (0.105 kg/liter or 3.6 kWh/liter at 25°C) and gravimetric (17 wt.% or 5.8 kWh/kg) energy densities. In spite of the ease of storage and transportation of ammonia, it's crucial to recognize that ammonia is highly toxic and explosive, and historical accidents involving ammonia leakage and subsequent toxic dispersion and explosions have caused numerous fatalities and serious injuries worldwide. As ammonia use in various industries increases, the rise in severe accidents related to ammonia leakage is alarming. Notable incidents include the 1992 Dakar accident, resulting in 129 fatalities and over 1100 injuries, as well as a 2013 incident in China, where a fractured ammonia pipe caused the death of approximately 120 individuals and infected over 60 others. More recently, in December 2020, 2 people died and 16 were injured in an incident at IFFCO in India. A case study by Technical Safety BC reported 59 ammonia leakage accidents between 2007-2017 in British Columbia, involving various ammonia units such as storage and refrigeration. To prevent and mitigate these incidents and effectively manage risks, urgent research and understanding of the consequences and risks associated with ammonia storage and handling are essential. Enhanced research and understanding during the early stages of projects (concept stage) are crucial in implementing adequate safety and loss prevention systems as part of the design, minimizing the likelihood and consequences of incidents, and enabling effective risk management. Various tools and techniques, including Gaussian models, empirical models with 2D & 3D-CFD tools, and experimental testing of incidents like fires and explosions, are available for this purpose. Although experiments on ammonia dispersion and explosions can provide accurate results, their associated costs and risks make them impractical. Empirical models with 2D codes have limitations and cannot precisely simulate the actual turbulences generated by unknown quantities of environmental geometric bodies and congestion from process plant equipment and structures. In addition, consequence analysis of releases from complex process arrangement such as cascade systems and interconnected storage banks and operating conditions (high pressure and low temperature) using empirical 2D tool is likely to be inaccurate due to the approximation and assumptions involved. On the other hand, the use of 3D-CFD numerical modeling has proven to accurately simulate actual turbulences, predicting gas behavior in various situations from accidental inventory release to real-world conditions. Computational Fluid Dynamics (CFD) techniques have been widely adopted for conducting consequence analysis and risk assessments in Chemical and related industries, as well as the oil and gas sector, for over a decade. These simulations help predict potential accident scenarios, calculate risk levels, and prevent future losses to assets, human life, and the environment's simulations offer detailed consequence analysis of accident scenarios, allowing for the analysis of various variables that directly and indirectly affect sensitive receptors. The accurate assessment of consequences and risks, without assumptions and approximations related to geometry and environmental conditions, would help minimize capital expenses (capex)

for safety systems such as toxic zoning, active and passive fire protection, blast-resistant building design, and emergency systems, while maintaining 100% HSE and effectively managing potential risks to assets, humans, and the environment. This paper presents a hypothetical case study of accidental ammonia dispersion from storage system. The study offers detailed outcomes on the extent of gas dispersion and explosion, employing a 3D-CFD approach to investigate various parameters like obstacles, crosswinds, terrain, and low wind effects on fluid flow paths. The consequence analysis counter plots using 3D CFD (Figure 1) illustrate that the ammonia plume disperses downwind direction and covers maximum horizontal downwind distance when there are no obstacles. However, in the presence of obstacles, the ammonia plume disperses in an orthogonal shape around the obstacles with about one third of the Horizontal downwind distance compared to the no obstacle scenario. *(Additionally, the figure will be sent via email for your review.) Figure 1: FLACS 3D CFD Consequence Analysis Counter Plots for Ammonia Dispersion with and without Obstacles, Cross wind and Terrain. The presence of obstacles causes eddies and gas agglomeration near the wall surface, directly impacting the orthogonal dispersion distance (both horizontal and vertical) of the toxic plume. During the crosswind dispersion analysis, it was observed that the toxic plume initially moves parallel to the leak direction due to high exit leak velocity. Once it comes into contact with the crosswind, it disperses in the opposite direction to the leak, covering the upwind area. Moreover, a comparison between 2D and 3D modeling tools (Figure 2) indicates that the 3D CFD analysis considers disturbances caused by obstructions and environmental conditions and covered less distance in downward (111 m) and more in orthogonal (46 m) due to obstruction, whereas the 2D code/Gaussian model does not account for obstacles, congestion, terrain, low wind, and crosswind in the dispersion path and covered more distance in downward (200 m) and less in orthogonal (14 m) mentioned in Table 1. *(Additionally, the figure will be sent via email for your review.) Figure 2: FLACS 3D CFD Vs Empirical 2D Consequence Analysis Counter Plots for Ammonia Dispersion with Obstacles. Sr no. Consequence Analysis Tool Downwind Distance (Length) m Orthogonal Distance (Length) m 1 3D CFD 200 14 2 Empirical 2D 111 46 Table 1: Downward and Orthogonal Distances comparison for FLACS 3D CFD Vs Empirical 2D Consequence Analysis study The findings of the 3D CFD analysis and comparison with empirical 2D tools indicate that selection of appropriate tools (3D CFD vs Empirical 2D tools) is critical considering the geographical and environmental conditions while applying the results for the design of the facilities. The selection of the correct consequence analysis tool is also key in implementing inherently safer design principles, effective risk reduction measures in achieving ALARP, and emergency response planning systems and procedures. Keywords: 3D CFD, Risk Management/Assessment, Process Safety, Emergency Response Planning, Ammonia, Hydrogen


In the morning, a child waits for the bus.
Another begins a 10-kilometer walk to school.
Beneath neon lights, a young man awaits his sweetheart.
And a love letter is written by candlelight.
If energy had a face, it would be smiling on them all.
If energy had a face, it would be ours.

Code of Conduct

AIChE Volunteer and Meeting Attendee Conduct Guidelines

AIChE's volunteers are the core of the Institute and make all of its programs, conferences and educational efforts possible. These offerings provide excellent opportunities for AIChE members and meeting attendees to gain greater technical expertise, grow their networks, and enhance their careers. AIChE events provide engineers, scientists, and students a platform to present, discuss, publish and exhibit their discoveries and technical advances.

At all times, volunteers and meeting attendees should act in accordance with AIChE's Code of Ethics, upholding and advancing the integrity, honor and dignity of the chemical engineering profession. AIChE's Board of Directors has developed these guidelines to foster a positive environment of trust, respect, open communications, and ethical behavior. These guidelines apply to meetings, conferences, workshops, courses and other events organized by AIChE or any of its entities and also to volunteers who conduct other business and affairs on behalf of AIChE.

Specifically

1. Volunteers and meeting attendees should understand and support AIChE's Code of Ethics.

2. Volunteers and meeting attendees should contribute to a collegial, inclusive, positive and respectful environment for fellow volunteers and attendees, and other stakeholders, including AIChE staff.

3. Volunteers and meeting attendees should avoid making inappropriate statements or taking inappropriate action based on race, gender, age, religion, ethnicity, nationality, sexual orientation, gender expression, gender identity, marital status, political affiliation, presence of disabilities, or educational background. We should show consistent respect for colleagues, regardless of discipline, employment status, and organizations for which they work, whether industry, academia, or government.

4. Disruptive, harassing or other inappropriate statements or behavior toward other volunteers, members, and other stakeholders, including AIChE staff, is unacceptable.

5. Volunteers and meeting attendees should obey all applicable laws and regulations of the relevant governmental authorities while volunteering or attending meetings. Volunteers and meeting attendees taking part in any AIChE event, including the ChemECar CompetitionTM, should also comply with all applicable safety guidelines.

Violations of this conduct policy should be reported promptly to the AIChE President or Executive Director.

Read AIChE's Code of Ethics


The future can change for the better.
Our imagination is the agent of change.
Mitsui Chemicals is driven by relentless curiosity and the wealth of imaginationthat comes from it.
A more diverse future can be built through the power of the human imagination and chemistry to create something from nothing.
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Notes


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