8TH CCPS GLOBAL SUMMIT ON PROCESS SAFETY

November 26-27, 2024 | Jio World Centre | Mumbai, India

PROGRAM BOOK

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BECOME A CCPS MEMBER

Achieve a world without Process Safety incidents

An AIChE Technology Alliance
CCPS
Center for Chemical Process Safety

CCPS AT A GLANCE

Books and Monographs

CCPS offers more than 100 book titles to date, providing the latest guidelines for those that produce, store, and handle flammable, explosive and reactive materials. **aiche.org/ccps/publications#books**

Process Safety Incident Database (PSID)

The **CCPS Process Safety Incident Database (PSID)**, is a lessons learned tool, available to most member companies and contains over 830 incident details.

PSID
PROCESS SAFETY INCIDENT DATABASE
From the Center for Chemical Process Safety

RAST and CHEF

Both RAST and the Chemical Hazards Engineering Fundamentals (CHEF) guidance are available to help industry and academia worldwide make better decisions when evaluating and reducing process safety risks.

Process Safety Beacon

The *Process Safety Beacon* is a resource aimed at delivering process safety messages to plant operators and other manufacturing personnel. **aiche.org/ccps/process-safety-beacon**

Process Safety Beacon 20 YEARS ANNIVERSARY

AIChE® Academy

Find an ever-expanding range of educational resources and solutions to help you build the skills process safety demands.

Process Safety Boot Camps

The Process Safety Boot Camp uses the Risk Based Process Safety (RBPS) approach and comprehensively covers the 20 elements of RBPS. Go to **aiche.org/academy/courses/ch900/process-safety-boot-camp** for more information.

CCPS Process Safety Professional Certification

The **CCPS Process Safety Certification (CCPSC)** exam verifies your competency as an expert in the latest process safety tools and techniques. For more information visit **aiche.org/ccpsc**.

CCPSC
CCPS PROCESS SAFETY PROFESSIONAL CERTIFICATION

The **CCPS Process Safety Fundamentals Certificate Program (CCPSf)** is designed for students and early career professionals who have taken the 24 Safety and Chemical Engineering Education (SAChE) courses. For more information visit **aiche.org/ccpsf**.

CCPSf
CCPS PROCESS SAFETY FUNDAMENTALS CERTIFICATE

Global, Regional Meetings and Roundtable Discussions

Share your expertise at CCPS meetings over the world virtually and in-person. **aiche.org/ccps/conferences-events**

NOT A CCPS MEMBER YET?

CONTACT CCPS: EMAIL: ccps@aiche.org • CALL 1.646.495.1371 • WEB: aiche.org/ccps

Welcome Address

Conference Executive Committee Chairs

Yatendra Lodha
Group Head- Safety & Operational Risk
Reliance Industries Ltd.

Shakeel Kadri
Executive Director & CEO
Center For Chemical Process Safety

It is Our pleasure to welcome you to the 8th Global Summit on Process Safety (GSPS) hosted by the Center for Chemical Process Safety (CCPS). This annual event is a gathering of leaders, experts, and practitioners from diverse sectors worldwide, unified in their commitment to advancing process safety and operational excellence across the chemical and energy industries. As the global process safety landscape evolves, this summit serves as a vital platform for exchanging knowledge, sharing best practices, and collaborating on innovative strategies to mitigate risks and safeguard our people and environment.

The conference series started in 2014, with the 1st edition held in Mumbai to commemorate the 30th anniversary of the Bhopal Gas Tragedy. This year's Summit – the 8th edition – will be held to commemorate the 40th anniversary of this tragedy. Our special thanks to Reliance Industries Limited [RIL] for being the main sponsor for this edition.

The 8th edition will feature an exceptional lineup of speakers and sessions designed to address both emerging and persistent challenges in process safety. Our program includes keynote addresses from industry visionaries, a leadership panel focused on the role of senior management in fostering safety cultures, and technical panels exploring the nuances of repeat incidents and innovative preventative measures. In addition, attendees will benefit from over 40 technical presentations, a series of poster sessions, and numerous opportunities to engage in meaningful panel discussions with colleagues and experts. We encourage each of you to engage fully in these sessions and take advantage of the unique learning and networking experiences.

The insights and strategies shared here are critical not only to advancing our respective organizations but also to setting a global standard for process safety. As we reflect on the lessons of past incidents and the advancements in technology and safety practices, may we be inspired to foster resilience, responsibility, and continuous improvement within our industries. Together, let us reaffirm our commitment to CCPS's vision of a "World without process safety incidents," driving forward towards a future that is safer and more sustainable for all.

Thank you for your commitment to a safer, more sustainable future. We look forward to the valuable exchanges that this summit will facilitate and the progress we will collectively make in shaping a stronger, safer industry for all.

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PSRG — Process Safety and Reliability Group — Taking You Further With Safety

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dss+ — Protect. Transform. Sustain.

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FINOLEX PIPES & FITTINGS

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SPECIAL THANKS TO THIS YEAR'S SUPPORTERS

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8TH CCPS GLOBAL SUMMIT ON PROCESS SAFETY

November 26-27, 2024 | Jio World Centre | Mumbai, India

Exhibitor List

Booth	Exhibitor
A1	Acutech Consulting Group Inc
A2	Birtish Safety council
A3	Cholamandalam MS Risk Services Ltd.
A4	Ingenero
A5	IRESC, Inc.
A6	CCPS
A7	PSRG
A8	Indian chemical Council
A9	DSS++
A10	Portgeo
A11	Lalita PPE Mfg
A12	Pragna Consultants
A13	Chemical Weekly

Executive Committee List

Name	Designation	Organization	Country
Chair- Shakeel Kadri	Executive Director & CEO	Center For Chemical Process Safety	USA
Co-Chair-Yatendra Lodha	Group Head- Safety & Operational Risk	Reliance Industries Ltd.	India
Ahmed Shaheen Al-Khaldi	General Manager, EHSS & RC	SIPCHEM	Saudi Arabia
Amir Nabil Gerges	Chief HS&E Officer	ADNOC	UAE
Arun Mittal	Executive Director	OISD	India
Anne O'Neil	Manager, Process Safety Culture & Competency	Chevron	USA
David Moore	President & CEO	AcuTech	USA
Jatin Shah	Senior Principal Consultant	Baker Risk	USA
Ng Chee Wai	General Manager (Plant) Head, Sustainability	PCS PTE. Ltd.	Singapore
Prabhanjan Dixit	Vice President and Head HSEF	Nayara Energy Ltd.	India
Prof. Dongfeng Zhao	Professor	China University of Petroleum	China
Pratap Nair	President & CEO	Ingenero	USA
Patrick Mahan	Staff Vice President and Principal Engineer – Chemical and Pharmaceutical	FM Global	USA
Ramabhadran Srinivasan	Managing Director – Asia Pacific	dss+	Singapore
Saumya Chakrabarti	Director-Technical	Finolex Industries	India
Tetsuya Konno	General Manager EHS Dept	ENEOS Corporation	Japan
Vasun Subanake	Senior Vice President, Production and OE	HMC Polymers	Thailand
Yong Sai Chung	Vice President, Group HSE Petronas	PETRONAS	Malaysia
Yasuji Inoue	Senior Manager	Mitsubishi Chemical Corp	Japan

Technical committee List

Name	Designation	Organization
Chair-Anil Gokhale	COO	CCPS
Co-Chair-Prashanthi Bhupathi	Head-Process Safety	Reliance Industries Ltd (RIL)
Ainor Syahril Kamarudin	Head of PSM, GHSE	PETRONAS
Abdulwahab Al-Shahrani	Manager, Process Safety, Industrial Security	Sipchem
Abdulaziz Al Hamdi	Head, Process Safety	OQ
Balajee Raman	Technical Director – Asia Pacific	Ecolab Limited
Dipal Phukan	Head, PSM	Nayara Energy Ltd.
Dr. Mahesh Murthy	Principal Technical Safety Engineer	Clough Projects
Dhaval Kapadia	Group Head, Process & Plant Safety, APAC (CS)	Bayer India
Khaled A M Hadi	Team Leader Corporate PSM, PSM Group	KOC
Hisashi Shibuya	Lead Safety Engineering, Refining and Manufacturing	ENEOS
Malcolm Pu	Deputy GM of Global HSE Mgmt Center	Wanhua Chemical
Masaki Nakagawa	Manager, Environment and Safety Department	Mitsubishi
Palaniappan Chidambaram	Principal, Operational Risk Management	dss+
Pratik Sharma	Vice President - Corporate Head Health Safety & Sustainability	Aarti Chemicals
Robert Weber	President, CEO & Founder	PSRG
Surya Bhusan Kumar Sinha	Head Process Safety Projects	Tata Steel, India
Sivaneswaran Kamala Kannan	Advisor, Group Health, Safety & Environment	ADNOC
Umesh Dhake	Associate Director, Asia, ME, Africa & Oceania	CCPS

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CCPS Center for Chemical Process Safety

AIChE The Global Home of Chemical Engineers

'Pre-Conference Workshop on Process Safety'

Date: November 25, 2024 (Monday), Time: 9.00 am - 5.00pm
Venue: 206 , Level-2, JWC, Mumbai

Time	Modules	Group Exercise (Workshop)	Facilitator	Affiliation
9.00-9.30	Introduction and welcome to delegates	CCPS activities Tribute to Bhopal – 40 years International Process Safety Week – December 2024	Dr. Anil Gokhale	CCPS/AIChE
9.30-11.00	What Good HAZOP Looks Like	Case studies to engage the workshop participants	Kaushik Jayaraman Dr. Mahesh Murthy	Senior Consultant ExxonMobil
11:00 to 11:15	**Break**			
11.15-12.45	Walk the Line Program	Develop simplified case study for brainstorming-Group exercise	Mohit Gharat	Lubrizol India
12.45-1:45	**Lunch Break**			
1.45-3.15	MoC: Challenges and effective ways to handle MoC Process	Presentation followed by Group discussions	Asad Munshi Chetan Pawade	Bayer India
3:15-3:30	**Break**			
3.30-4.30	How to investigate Process Safety Incidents for Small & Medium size companies	Methodology followed by Case study Group exercise	Mohit Gharat	Lubrizol India
4.30-5.00	CCPS Resources to support PSM	CRW, RAST, PSIE, Vision 20/20 Self-Assessment, SWPs etc.	Umesh Dhake	CCPS

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Day 1 - Keynote Speakers

Chief Guest

Mukesh Kumar Surana
Former Chairman & MD,
Hindustan Petroleum Corporation Limited

Sanjiv Singh
Head-Group Manufacturing Services,
Reliance Industries Limited

Stephen J. Klejst
Executive Director,
US Chemical Safety and Hazard Investigation Board

Dr. Fawaz K Bitar
Senior Vice President-Health, Safety,
Environment & Carbon, BP

Monday November 25

Pre-conference workshop on Process Safety

Venue: JWC Meeting Room-206, Level 2

Day 1- 26 November (Tue)

Registration from 7.00 to 8.30 am | Venue : Jasmine 2

8:30 - 8:35	Welcome & Introduction to **Dignitaries on Dias**
8:35 - 8:50	Conference Inaugural- **Lamp Lighting Ceremony**
Opening Remarks 8:50 - 9:05	**Shakeel Kadri**–Executive Director & CEO, Center for Chemical Process Safety (CCPS), USA **Yatendra Lodha**- Group Head- Safety & Operational Risk, Reliance Industries Limited **D. Sothi Selvam**- Director General, Indian Chemical Council
9:05 - 9:25	Welcome Address- **Shakeel Kadri**, Executive Director & CEO- Center for Chemical Process Safety (CCPS), USA
9:25 - 9:45	Address by Chief Guest- **Mukesh Kumar Surana,** Ex. Chairman & MD of Hindustan Petroleum Corporation Limited
9:45 - 10:05	Keynote Address – **Sanjiv Singh** Head-Group Manufacturing Services Reliance Industries Ltd
10:05 - 10:25	Keynote Address – **Dr. Fawaz K. Bitar** Senior Vice President of Health, Safety, Environment & Carbon at BP **"Too Safe to Fail?"**
10:25 - 10:45	Keynote Address – **Stephen Klejs**, Executive Director, US Chemical Safety and Hazard Investigation Board **"Improving Process Safety Through Lessons Learned"**
10:45 - 11:15	**Poster Session, Coffee & Networking - at Exhibition Space Jasmine 2**

11:15 - 12:45 — Leadership Panel Discussion

Topic: The role of leadership to address challenges in creating effective Process Safety

Moderator: **Mr. Yatendra Lodha**- Group Head Safety & Operational Risk, Reliance Industries Ltd.

Panel Members:

Dr Fawaz K Bitar, Senior Vice President-Health, Safety, Environment & Carbon, BP
Stephen Klejs, Executive Director, US Chemical Safety and Hazard Investigation Board
Mukesh Kumar Surana, Ex. Chairman & MD of Hindustan Petroleum Corporation Limited
Sachin Punekar, Head Site Operations, JMD Cluster, Reliance Industries Limited
Shakeel Kadri, Executive Director & CEO, CCPS
Ramabhadran Srinivasan, Managing Director, Asia Pacific, dss+

12:45 - 1:45 — Lunch break / Poster Session- at Exhibition Space Jasmine 2

1:45 – 4:45 — Leaders' Forum on Process Safety- Theme: Process Safety at Senior Leadership Level – **"How I drive Process Safety in my organization"** Venue: Meeting Room No. 203, Level 2

Moderator: **Shakeel Kadri** – Executive Director & CEO, CCPS

Participating Leaders:

1. **Yatendra Lodha**, (RIL), India
2. **Stephen Klejst**, (CSB), USA
3. **Vivek Bichave**, (RIL), India
4. **Ashish Bhusan**, (OISD), India
5. **Kartik Bharat Ram**, (ICC & SRF), India
6. **David Moore**, (AcuTech) USA
7. **Ramabhadran Srinivasan,** dss), Singapore
8. **Jatin Shah** (Baker Risk), USA
9. **Pratap Nair,** (Ingenero), India
10. **Sanjiv Raina**, (BPCL)
11. **S. N. Soman**, (HPCL)
12. **Ahmed Shaheen Al-Khaldi**, (Sipchem), KSA
13. **Prabhanjan Dixit**, (Nayara Energy) India
14. **Saumya Chakrabarti**, (Finolex), India
15. **Mukul Agrawal**, (Deepak Fertilizers) India
16. **Prof. Sandip Roy** (IIT-Bombay)
17. **Nilay Vyas**, (UPL), India
18. **Vaijanath Kulkarni**, (Galaxy Surfactant)

Parallel Technical Sessions: Day 1

20 minutes presentation by each speaker followed by 5 minutes of Q & A session for each presentation

1:45 - 3:25

Time	Track-1	Track-2	Track-3
	Session 1- Barrier Health Monitoring / Dynamic Risk Session Chair: **Palaniappan Chidambaram,** dss+ Session Co-Chair: **Dipal Phukan**, Nayara Energy	**Session 2–Emerging Technologies and Future of Process Safety** Session Chair: **Balajee Raman,** Ecolab Session Co-Chair: **Shashank Singh** Reliance Industries Ltd.	**Session 3–Essential Practices for Managing Chemical Reactivity hazards** Session Chair: **Pratik Sharma**, Aarti Chemicals Session Co-Chair: **Prashanthi Bhupathi,** Reliance Industries
1:45 - 2:10	**Enhancing Process Safety through Scenario Management** Susan Losavio, ExxonMobil, Malaysia	**Current developments in AI, ML, AR, VR & Industry 4.0** Prof. Rajagopalan, IIT-Madras	**Explosion Prevention and Protection Document (EPPD)** Satyam Somani Bayer India Vapi Pvt. Ltd.
2:10 - 2:35	**Leveraging a Sense of Vulnerability Using Barrier Health Management for Enhanced Risk Reduction** Vadivel Subramaniam, TCI Sanmar Chemicals SAE	**AR/ VR Technologies in Safety Applications** Abhishek Gupta, Reliance Jio	**Learnings from a Reactor Explosion: Catalyst Reactivity Learnings for Energy Transition Processes** Rajiv Srinivasan, Shell India Markets Private Limited
2:35 - 3:00	**Don't Forget Me - I Am a SIF, Your Saviour in the Plant!** Shivendra Kapoor, SIL Consulting Services	**Enhancing Process Safety and Sustainability in Manufacturing through Generative AI** Mayuresh Mokal, Ingenero Inc	**Understanding "Time to Maximum Rate (TMR)" in Chemical Reactions Application, Use and Misuse** Rahul Raman, Kaypear
3:00 - 3:25	**Real Time Visualization of Risk Movement through Barrier Health Monitoring** Ms. Alisha Kumari, Tata Steel Limited	**JioHumsafar Revolutionalizing Road Safety in India :** Anish Jose, Jio Smart Fleet	**Applying Layer of Protection Analysis (LOPA) for Business Continuity Scenarios – Learnings from Large Capital Expense Project** Dr. Mahesh Murthy

3:25 - 3:45 **Tea, Coffee & Networking Break / Poster Session- at Exhibition Space Jasmine 2**

Parallel Technical Sessions: (Continues) Day 1

20 minutes presentation by each speaker followed by 5 minutes of Q & A session for each presentation

Time	Track-1	Track-2	Track-3
3:45 - 6:05	**Session 4 – Human Factors with Focus on 'Best Practices and Lessons Learned'** Session Chair: **Subba Rao NV,** Chola MS Risk Session Co-Chair: AcuTech	**Session 5 – Intentional Competency Development in Process Safety** Session Chair: **Ajaykumar Kakkanattu,** PSRG Session Co-Chair: **Dr. Mahesh Murthy**	**Session 6 – Managing Asset Integrity** Session Chair: **Kaushik Jayaraman**, ExxonMobil Session Co-Chair: **Khalid Al Beshr**, ADNOC
3:45 - 4:10	**The impact of decision-making on the occurrence of process safety incidents:** Filip Coumans, Krauss Bell Group	**Ecolab Process Safety Foundations Hypercare:** Balajee Raman, Ecolab	**Learning from IOGP Global Upstream Process Safety Event Data** Dave Fargie, BP UK, IOGP
4:10 - 4:35	**Quantified Human Factors Risk Assessment:** Ian Travers, British Safety Council	**Responsible Care in India: Enhancing Process Safety in the Chemical Industry:** Dr. Pranav Tripathi, Indian Chemical Council	**An overview of "100 Largest Losses globally, recent trends and learnings"** Arun Negi & Nick Holland, Marsh
4:35 - 5:00	**Understanding Human Reliability Analysis (HRA): Concepts, Applications, and Case Study in High-Risk Industries:** Ashley Craig, PSRG Inc, USA	**How to Leverage CFD to Improve Hazard Assessment and Enhance Safety?** Sharad Gupta, IRESC	**Roles of SCE and Ops Performance Standards in preventing MAH:** Girada Raminaidu & Gottimukkala Chaitanya, Shell India
5:00 - 5:15	**15-minute Break**		
5:15 - 5:40	**Proactive Management of Human Factors in Accident Prevention: Case Study and an Innovative Approach at HMEL:** Anshul Kumar Tiwari, HPCL-Mittal Energy Ltd	**Competency Development in Process Safety:** Sudhir Narkhede, LyondellBasell (LYB)	**Managing Asset Integrity with Effective Management of Change (MoC) Program:** Ashit Dalal, eDelta Consulting, Inc
5:40 - 6:05	**Understanding Human Factors - Key to Effective Safety Barrier Management in Chemical Industries:** Rekha Sharma, GRIP Global Pte. Ltd.	**Building Competence for Effective Process Safety Management: Strategies and Approaches:** Kevin Chothani,Sekura India Management Limited (Edelweiss)	**How Many Detectors Are Optimal for a Hazardous Facility?** Akshat Khirwal, IRESC

End of Day 1

Day 2 - Keynote Speakers

Sanjay Roy
President E&P,
Reliance Industries Limited

Arun Mittal
Executive Director,
OISD

Amar Kumar
Head of Refinery,
Nayara Energy

Pawan Mundhra
Partner at McKinsey & Company,
Global Energy & Metals

Ranjit Kulkarni
Vice President &
General Manager, Honeywell
Energy & Sustainability Solutions

Day 2- 27 November (Wed) Venue: Jasmine 2

8:30 - 8:40	**Recap of Day-1 by Co-Chairs of Technical Committee of 8th GSPS** **Dr. Anil Gokhale**, Chief Operating Officer (COO), Center for Chemical Process Safety (CCPS) **Prashanthi Bhupathi**, Reliance Industries Ltd.
8:40 - 9:00	Summary of Leadership Forum from Day-1 (Call for Action)
9:00 - 9:20	Keynote Address – **Sanjay Roy**, President E&P, Reliance Industries Limited
9:20 - 9:35	Keynote Address – **Pawan Mundhra**, Partner at McKinsey & Company, Global Energy & Metals **"Digital & Analytics led Improvement for Process Safety"**
9:35 - 9:50	Keynote Address – **Arun Mittal**, Executive Director, OISD **"Key Challenges in Driving Process Safety to Zero PSIs"**
9:50 - 10:05	Keynote Address – **Amar Kumar**, Head of Refinery, Nayara Energy **"Process Safety Culture- A Crucial Pillar for an Effective PSM"**
10:05 - 10:20	Keynote Address – **Ranjit Kulkarni**, Vice President & General Manager, Honeywell Energy & Sustainability Solutions **"Improving Process Safety Through Lessons Learned"**
10:20 - 10:45	Poster Session/Exhibition/Networking Break

10:45 - 11:15 Tea, Coffee & Networking Break / Poster Session - at Exhibition Space Jasmine 2

Technical Panel Discussion

11.15 - 12.45

Topic: Reflection on repeat incidents and way forward
Moderator: **Mr. Jatin Shah** - Senior Principal Consultant; Baker Risk, USA

Panel Members:

Arun Mittal, Executive Director, OISD (Oil Industry Safety Directorate)
Filip Coumans, Managing Director, EMEA, Krause Bell Group
PS Murthy, Executive Director – HSE Corporate, Hindustan Petroleum Corporation Ltd.
Arun Negi, Chemical, Risk Engineering & North Energy Leader, Marsh India
Shariq Abbasi, Manager Learning Safety, Shell India Markets Pvt. Ltd

12.45 - 1.45 Lunch

Parallel Technical Sessions: Day 2

20 minutes presentation by each speaker followed by 5 minutes of Q & A session for each presentation

1:45-3:25

Time	Track-1	Track-2	Track-3
	Session 7 – Operational Excellence through Leadership, Culture and Innovations	Session 8 – Process Safety and Alternate Energy Sources	Session 9 – Hydrogen Safety
	Session Chair: **Vivek Bichave,** RIL Session Co-Chair: **S. N. Soman,**HPCL	Session Chair: **Pavan K Jain**, RIL Session Co-Chair: **B N Jadhav** Finolex Industries Ltd	Session Chair: **Nick Barilo**, Center for Hydrogen Safety Session Co-Chair: **David Moore**, AcuTech Consulting Group
1:45 - 2:10	**Determining and Managing Safe Operating Limits to Critical Operating Parameters at Major Hazard Installations:** Karthikganesh Senthilvelan, Asahi Kasei Synthetic Rubber Singapore Pte. Ltd.	**Process safety in Solar, Battery and Hydrogen manufacturing:** Dr. Peter Fath, RCT Solutions GmbH	**CHS Overview:** Nick Barilo, Center for Hydrogen Safety
2:10-2:35	**Catastrophic Warning Signs and Symptoms in Engineering Projects - Be Aware & Beware!':** Palaniappan Chidambaram, dss+	**Inherently Safer Designs in New Energy Technologies:** Adish Joshi, Worley	**Process safety for H2 industry:** David Moore, AcuTech Consulting Group

Time			
2:35 - 3:00	**A Model for Winning Hearts and Minds to Enhance Process Safety:** Keng Yong Chan, AcuTech Consulting Group	**Essential Elements of Process Safety in Solar Manufacturing Value Chain:** Dr. Milind Kulkarni, Renaissance Solar and Electronic Materials (RSOLEC)	**H2 safety in Filling applications** Omprakash Mall, Reliance Industries Limited
3:00 - 3:25	**Novel Automated Visual Management Board to Monitor Clusters Performance in Process Safety Fundamentals:** Sakeena AL Lawati, Petroleum Development Oman LLC	**Incorporating Process Safety into Energy Transition, Lessons Learned from US' Journey:** Jatin Shah, Baker Risk	**Risk Assessment of Hydrogen for Use in Hazardous Process:** Abhineet Raj, Tata Steel Limited

3:25 - 3:45 **Tea, Coffee & Networking Break / Poster Session- - at Exhibition Space Jasmine 2**

Parallel Technical Sessions: (Continues)Day 2

20 minutes presentation by each speaker followed by 5 minutes of Q & A session for each presentation

3:45 - 5:00

Time	Track-1	Track-2	Track-3
	Session 10 – Process Safety Incidents Case Studies-1 (Emphasis on Recent Incidents/High potential Near Misses)	Session 11 – Refining, Chemicals and More (1)	Session 12 – Refining, Chemicals and More (2)
	Session Chair: **Shailesh Nigam,** RIL Session Co-Chair: **Dr. Mahesh Murthy**	Session Chair: **Dhaval Kapadia,** Bayer India Session Co-Chair: **Shreedatta Albur,** Finolex	Session Chair: **Sayantan Bhowmik,** RIL Session Co-Chair: **Abdulaziz Al Hamdi,** OQ
3:45 - 4:10	**Process Safety Lesson- Case Studies from the Oil Industry-** Ram Goyal, ioMosaic Corporation	**Walk the Line - An Effective Program to Avoid LOPC Due to Line-up Errors:** Mohit Gharat, Lubrizol, Head PSM	**Marine Terminal Risk Assessment in Japanese Refineries Based on International Maritime Safety Guidelines:** Kiyoshi Ujimine, ENEOS Corporation
4:10 - 4:35	**Process Safety Incident Happened in Petroleum Refinery:** Sanjay Raj Kishor Singh, Oil Industry Safety Directorate	**Aveva UOC- Achieve Safe and Optimized Operations with Integrated Operations Center:** Rajesh Grandhe, Aveva	**Highly skilled, competent and versatile workforce for Disciplined Safety Culture.** Avinash Shinde, Galaxy Surfactants
4:35 - 5:00	**CSB Case Studies: Learning from Process Safety Investigations :** Stephen Klejs, US Chemical Safety and Hazard Investigation Board (CSB)	**Vulnerability Index (VI) - A New Innovative Tool for Job Risk Management:** Manoj Singh, HPCL- MR	**You Have "Safeguard" in Place, Sounds Promising; Have You Tested It? Act before It Is Too Late!!** Hari Gopal Attal

5:00-5:15 **Award Ceremony**

Best Presentation Award Ceremony
Category-1: Best Technical Presentation [Three prizes]
Category-2: Young Professional best technical Presentation [One prize]
Category-3: Best Poster Presentations [One Prize]

5:15 - 5:30 **Closing comments [CCPS & RIL]**

Poster Presentation

Poster Author	Affiliation	Poster Topic
Joy Shah	Innov8 ProTech Solutions	Developing Process Safety Competency Management System in High Hazards Industries
Sumesh Nair	Xantray Consulting	Enhancing Cognitive Aspects of Risk Management Leading to Safer Hot Work Management
Wafa Al Shizawi	Petroleum Development Oman	Enhancing Petroleum Process Safety through Organizational Restructuring and Continuous Improvement
Srikanth Sindhanur	Hetero Labs Limited	Cultural Transformation Journey – an Integrated Process Safety Approach
Arpan Panchal	Kaypear Engineering LLP	Paper: Guidelines for Storage and Handling of Reactive Chemicals
Rahul Mishra	Acutech Consulting Group Inc	Ensuring Process Safetythrough Intentional Competency Development
Devang Asher	hubergroup india p ltd	Human Factors in Process Safety: Best Practices and Lessons Learned
Ajay Kakkanattu	PSRG Inc	Achieving Excellence in Process Safety: A Guide to Successful PSM Implementation for Global Companies
Anurag Mishra	IRESC	Design Challenges in Meeting SIF Barrier Reliability Target in Complex Hazardous Scenarios

Abstract Description

Session 1 - (1)

Invited Speaker: Abstract not available

Session 1 - (2)

Leveraging a Sense of Vulnerability Using Barrier Health Management for Enhanced Risk Reduction

Presenting Author- Vadivel Subramaniam, President and COO, TCI Sanmar Chemicals SAE

Abstract Text:

SANSAFE is an ambitious Culture Transformation program with a vision to achieve Safety and Operational Excellence at TCI Sanmar in partnership with dss+. It seeks to embrace Felt Leadership, cultivate Risk Based Thinking, inculcate line ownership, and help establish robust processes built on a firm foundation of 'Commitment to Zero'. Collaborating with dss+, the site has introduced the concept of Barrier Health Management (BHM) to create an enhanced sense of vulnerability and risk containment. A Process Safety Risk Register was developed, and the top 5 risks were identified and taken up for a BHM study.

The 10-step BHM process considers the management systems and processes required to monitor and reduce risks by keeping each barrier healthy and functional. This approach has significantly improved senior management's understanding of process safety risks and site vulnerabilities and helped the team understand that 'OK' in the past is no longer acceptable.

10-step BHM process is depicted below:

S. No BHM Steps

01 Scope and Context Setting - Team Formation

02 Determining the Top Event

03 Identifying initiating Events

04 Understand the risk levels without Barriers

05 Listing of Preventive & Mitigative Barriers

06 Identifying the barrier validity

07 Determining the severity and likelihood

08 Recommendations

09 Implementation

10 PACA for existing and new barriers and performance through KPIs

Table 01: BHM process

INTRODUCTION

In mid-2022, TCI Sanmar initiated BHM on the top 5 high-risk scenarios identified at the site. This initiative was complemented by a culture transformation initiative to create a line-led, Risk-based approach supported by dss+.

SCOPE, CRITERIA, CONTEXT & GOVERNANCE:

A 3-layered Sansafe Integrated Governance structure was put in place. Apex Committee was chaired by MD, Subcommittees chaired by functional heads, and task teams led by respective departmental heads.

1. **Scope & Context Setting: Forming teams Consisting of Risk & Barrier Owners**

A site risk register was developed by considering the potential consequences of the site's processes. A cross-functional team (Table 02) comprising operations, technical, maintenance, safety, and inspection personnel was formed to conduct the BHM study for each identified scenario.

BHM Team

Risk Owner - HOD

Barrier Owner - Operations_Manager

Barrier Owner- Mechanical

Barrier Owner - Electrical

Barrier Owner - Instrumentation

Barrier Owner - Civil

Barrier Owner - Inspection

Barrier Owner - Fire & Safety

Process EngineerOperations Engineer

Table 02: Cross-functional Team (CFT)

2. **Determining the Top Hazardous Event (top event) to identify the undesirable scenario**

With the BHM team in place, the site focused on identifying the top event associated with potential undesirable scenarios. The following 5 out of the 86 identified top risk scenarios were taken up for the initial BHM study:

1. LOPC of Liquid Chlorine Storage resulting in toxic exposure and multiple fatalities
2. LOPC of Vinyl Chloride Storage resulting in fire and explosion and multiple fatalities
3. LOPC of Polymerization Reactor resulting in fire and explosion and multiple fatalities
4. LOPC of Ethanol Storage resulting in fire and explosion and multiple fatalities
5. LOPC of Propylene Storage resulting in fire and explosion and multiple fatalities

Abstract Description

RISK IDENTIFICATION:

3. Identifying Valid Causes / Threats / Initiating Events

The team identified the relevant causes, threats, and initiating events that could potentially lead to undesirable scenarios. This involved assessment of deviation from design, operations, and maintenance. A total of 102 initiating events identified across the 5 BHM Studies.

RISK ASSESSMENT:

4. Significance of Consequence & Risk Level Without Barriers

The BHM CFT evaluated risk through potential consequences and likelihood using the TCI risk matrix. what could happen in the absence of healthy and functional barriers, the team was able to decipher and highlight the vulnerability of the site - should this scenario materialize.

5. Listing of Available Preventive & Mitigative Barriers - To Reduce the risk from inherent levels

The BHM Team identified preventives and mitigative barriers for each scenario (and initiating event) to minimize its frequency and impact. The site was then able to establish proactive measures for managing these barriers. We've listed 257 barriers against the 102 initiating events across the 5 BHM Studies.

RISK EVALUATION

6. Determining Severity and Likelihood using TCI Risk Matrix & Identifying the Risk Category

The 5x5 TCI Sanmar Risk Assessment Matrix (RAM) uses a semi-quantitative, barrier-based approach to estimate likelihood (based on the number & type of barriers available) and arrive at a well-defined consequence.

1. Risk category based on risk ranking (in reference to TCI Sanmar RAM)
   Extreme (>15)
   ii. High (7 < Risk < 15)
   iii. Moderate (3 < Risk < 8)
   iv. Low (<4)
2. Identifying whether listed Barriers are Valid /Invalid based on the Barrier Guidelines

Once all the preventive and mitigative barriers for each scenario were listed, they were classified as valid or invalid using barrier guidelines. The barrier guidelines used were as follows:

1. Shall be designed to prevent an event by effectively addressing the threats or mitigating its consequences
2. It shall be independent of the initiating causes/events / threats
3. It shall be designed to prevent an initiating event from progressing to a top event or from a top event to an impact
4. It shall remain auditable

Based on the provided guidelines, we assessed a total of 257 barriers for validity. The findings indicated that 72% of these barriers are valid, while the remaining 28% are deemed invalid.

RISK TREATMENT

8. Generate Recommendations to Reduce the Risk Levels

Based on the risk evaluation, recommendations to reduce the overall risk levels were developed. These recommendations were with the intent of reducing the probability of occurrence and mitigating the impact. Total of 150 recommendations out of which 132 new and 28 actions for bridging gaps in the existing barriers.

RISK REDUCTION, RECORDING & REPORTING

9. Generating Action Plans for Implementing Recommendations

Based on the recommendations, a comprehensive risk-prioritized implementation plan was developed along the following lines.

1. **Type of Execution**
   Shutdown requirement - partial or complete
   ii. Non-shutdown requirement - with or without load reduction
2. **Resources Required**
   Funded - in-house or third-party (Around 2.75 MUSD budget Estimated)
   ii. Non-funded

CONTINUOUS BARRIER HEALTH MONITORING & IMPROVEMENT

10. Health Check for Existing and New Barriers and Follow-Up Through KPIs

To ensure that existing barriers remain healthy (and fully functional on demand), a routine health check process was established by adopting the PACA strategy. As a part of barrier health assurance, SOPs (Safe Operating Procedures) and SMPs (Safe Maintenance Procedures) are either developed or upgraded and routinely reviewed for adequacy. Accountability, Competence, and Assurance processes are incorporated into the relevant procedures. SOPs / SMPs also define the frequency of ITPM that must be performed.

An illustrative Barrier Health Checklist is provided below:

Barrier description	Operator action on parameter > SP (Alarm + SOP + training + competent operator + action within process safety response time)
Type of Barrier (Admin / Active / Passive)	Administrative Barrier
Credit of barrier for risk reduction:	1
Valid/Invalid	Valid
Preventive / Mitigative	Preventive
Risk owner	Plant manager
Barrier Owner Name	Shift engineer - operations
Frequency of ITPM defined? (Y/N)	NA
Is Procedure Available (Y/N)	Y
Is Accountability Defined (Y/N)	Y
Is Competency defined (Y/N)	Y
Is Assurance Process Defined (Y/N)	Y
Observations/ Finding/ Gaps found during audits	Refresher training for every 6 months
Health of the Barrier (Good/Bad)	Good
Audit Date	Identified date
Status of audit observations	Completed
Action identified post audit	Refresher training is to be conducted and documented

Table 03: PACA health check for barriers

An illustrative list of Key Performance Indicators (KPIs) are provided below for reference:

S.No.	BHM - Management review KPI	Target
1	Initiating Events (IEs)	
1.1	IEs Identified for the completed scenarios	NA
1.2	IEs without a single preventive barrier	0%
1.3	Impacts without single mitigative barriers	0%
2	Recommendations identified to bridge the gaps (Existing barriers)	
2.1	Identified actions to bridge the gap	As per study
2.2	Completed actions to bridge the gap	Actual
2.3	Identified actions vs. Closure to bridge the gap	100%
3	The new barrier was Suggested (Based on risk mapping on RAM)	
3.1	New barriers suggested	As per study
3.2	New barriers implemented Vs. suggested	100%
4	Health check audit for barriers (for the month)	
4.1	Health checks planned	As per plan
4.2	Health checks completed	Actual

Table 04: Key Performance Indicators

CONCLUSION

Applying the BHM approach has enhanced our understanding in multiple ways e.g., the importance of ensuring the validity and healthiness of barriers, improved resulting in the reporting of barrier-related events in the Process Safety Performance Indicator (PSPI) etc. Over time, barrier failure event reporting, investigation, recommendation tracking, closure, and sharing of lessons learned have considerably improved, resulting in the reduction of a. Defeated alarms, interlocks, and emergency shutdown systems / devices; b. Relief system isolation (Temporary) and overdue calibrations; c. Fire and gas detectors becoming overdue for calibrations; d. The BPCS operating in manual mode; e. Barrier failure through detailed RCFA, etc. Also, BHM study recommendations resulted in around 2.75 million US Dollars budget estimation to achieve desired risk reduction. The heightened 'Sense of Vulnerability , once again goes to emphasize that good past performance does not guarantee good future safety outcomes.

Abstract Description

Session 1-(3)

Don't Forget Me - I Am a SIF, Your Saviour in the Plant!

Presenting Author- Shivendra Kapoor, SIL Consulting Services

Abstract Text:

Do we leave our kids after they are born or leave growing kids midway and allow them to wander aimlessly and helplessly? We don't. Right?

Then why this step-motherly treatment to a **'barrier'** that's automated, preventive, active and highly reliable and that can **'prevent'** an unwanted consequence from happening; which otherwise may lead to loss of life, destruction to the environment, severe financial and reputational impacts?

Yes, I am talking about that one barrier called as the 'Safety Instrumented Function **(SIF)**' that is currently trapped within the limits of so-called **LOPA, SIL verification** and maybe little bit of **Validation**.

Sorry, I forgot to mention about Safety Requirements Specification (SRS), but it's because most don't know that it is required to be prepared or even those who do so either ignore it or get it superficially done to mark the completion of a deliverable. Well, who will study, understand, and truly write those details to comply with the 29 requirements from the functional safety standards?

In my personal experience as well, I have seeing clients with raised eyebrows when they hear **29 requirements** to be written and complied to, and that too for every Safety Instrumented Function!

Well, many do not know the actual journey that this SIF must undertake [from concept through to decommissioning] and that would really make it the most effective barrier; more so when it is expected to work as **SIL 3** [surprisingly- highly desirable by many managers as the ultimate defense to protect their plant!]?

But who conceptualizes it and how? Who designs and implements it? Who manages and nurtures it? and most importantly who ensures that it is alive and healthy in a real operational plant?

We want SIFs to function like the superhero "He-Man" but we know that without the power of his magical sword, even He-Man cannot kill 'Skeletor-the devil'.

So, without the correct strategy, know-how, competency and understanding of the functional safety standards (IEC-61511 for the process industry) how can we expect that the SIF would work and stay alive in real operational environment?

This paper focusses on the SIF as a barrier and not only takes you through the current chemical industry scenario [highlighting practices being predominantly followed in Indian industries] but it will also help you to actually understand the overall journey that the SIF must undertake [more focused on monitoring the SIF's health] in terms of what is expected from the standard IEC 61511, global practices being followed and how this would help improvise overall functional and process safety in the chemical plants.

Session 1- (4)

Real Time Visualization of Risk Movement through Barrier Health Monitoring

Presenting Author- Ms. Alisha Kumari, Tata Steel Limited

Abstract Text:

Process Safety Management focuses on preventing catastrophic incidents to improve organizational process safety standards by effectively managing risks in process. A firm foundation in Process Safety Management (PSM) has been established across the Tata Steel but in pursuit of making process safety a 'way of life', the Centre of Excellence (COE) concept was undertaken has been implemented in all High Hazard Departments of Steel Plant

Process safety risks are managed well when the processes operate within Standard Operating Condition and PSCE are maintained as per recommended and defined maintenance practices. So, it was the need to capture the deviations on a real-time basis, maintain the healthiness of barriers and to take the corrective measures as early as possible to prevent process safety incidents. The data of all the barriers and their status must be collected from various sources ranging from Control room logbooks to SAP PM & also IT based Safety Management system -Ensafe and GDCS. Previously barriers were monitored through the PSM dashboard, which is prepared department wise and is reviewed monthly. The whole process of collecting data is manual and it takes a lot of time and effort to prepare a single dashboard for each department. As there were no real time barrier status available, it was very difficult to ensure the safeguards of our system to be available all the time, especially when needed.

Approach for digitalization of Barrier Management- Enterprise level Tableau based Barrier Health monitoring dashboard.

To overcome the above listed challenges and to get the real benefit of 'Centre of Excellence' approach to a standard platform having better view, tools, business rules with real time information and alerts was required for variety of users.

For this, integration of three different system was required. The approach and solution were based on knowledge that make use of big data. Data for all the element of Process Safety Dashboard was pulled from different platforms like Level 1 control systems, IT based Safety management system- Ensafe, GDCS and SAP PM.

To achieve this, a Cross functional group comprising all relevant stake holders like, Central IT team, Automation, Central Process Safety, respective department COE, members, local electrical maintenance group, was created for brainstorming and a Strategy & Consulting partner was brought on-board to run this program alongside other stakeholders.

2.1 Steps for Online Dashboard implementation & responsibility

1.Syndication with team on dashboard features, logic & functionality

2.Identification of process safety critical parameters , equipment and risks

3.SOC and SOL limits for each parameter

4.Identify exception conditions for preventing false alarms

5.Understand data architecture L1-L2-GCP

6.Get list of L1 tags from OPC server (server to be identified from previous step)

7.If any intermediate server is present between L1 and L2, get the tags from intermediate server (mediation server, PHD, AMDS, etc.)

8.Validate OPC tags, configure missing L2 tags from previous 2 steps

9.Identify server for GCP

10.Load data from L2 to GCP

11.Identify data from SAP PM to be uploaded

12.Configures and upload SAP PM data to dashboard

13.Identify and upload Ensafe & GDCS data to dashboard

A core team was formed to ensure

• Syndication with each plant by organizing workshop sessions.

• Experience of Strategy & Consulting partner working on other enterprise initiative is used to help in creating an infrastructure required for this task.

• That implementation is carried out in agile way to deliver the system quickly and then with the help of departments, sanitize the data and add more features under continuous improvement.

• Bi-weekly meetings are organized with users to take feedback and improve the system as per requirement.

2.2 Development of Architecture for Online Dashboard

Having a larger goal for a TRUE ENTERPRISE SOLUTION, architecture is the most important element. The data architecture should not just support the current need but the data Analytics need for the future as well.

The architecture was developed inhouse by team to ensure integration and availability of all the required system and data in online process safety dashboard.

The application has already been deployed in four Blast Furnaces, three Steel Making Shops and in one of the Mills areas. This initiative has also encouraged other plants to have an enterprise operational data system to smooth transfer of process data.

2.3 Tableau Based Digitalization of Barrier health monitoring & its benefits

Process parameters and alarm data is received automatically (via OPC or similar system) and processed rapidly to extract crucial risk information, thus creating leading indicators of potential performance issues such as accidents, incidents, and operational problems by ensuring the barriers health. The information from other IT platforms is collected and put in dashboard.

The key features of the IT based dashboard are

• Insights of deviation of parameters of a plant/facility - by harnessing big data (process and alarm data)

• Evaluation of deviation on a periodic basis (daily, weekly, monthly) for different barriers

• Actionable leading indicators to point out risky conditions/unhealthy barriers at their developing stages (lacking in current operations management/analytics tools)

• Maintenance plan records for identified PSCEs (barriers)

Abstract Description

• User-friendly dashboard, easy charting, reporting, and blogger options

The online barrier health monitoring dashboard gives single integrated platform for real-time & centralized view of all departments & associated risk. Remote monitoring of critical deviation is now possible.

Online digital barrier health monitoring is helping in real time information & systematic analysis of process parameters, asset/barrier management, and timely control measures along with various process safety management initiatives and guidelines to achieve operational excellence & preventing process incidents

Keywords: Digitalization, Generic Document Control System (GDCS), Process Safety, Process safety critical equipment (PSCE), SOC (Standard operating condition), SOL (Safe operating limit), Steel Plant

Session 2- (1)

Invited speaker. Abstract not available.

Session 2- (2)

Invited speaker. Abstract not available

Session 2- (3)

Enhancing Process Safety and Sustainability in Manufacturing through Generative AI

Presenting Author: Mayuresh Mokal, Ingenero Inc

Abstract Text:

The advent of Generative Artificial Intelligence (AI) offers a transformative approach for process manufacturers to achieve process optimization, sustainability, reliability, and enhanced process safety within condensed timeframes. This abstract explores the critical role of generative AI in enhancing asset sustainability and reliability, focusing on energy optimization, process optimization, reliability improvement, and safety enhancement, targeting 2030 and 2050 objectives.

Generative AI technologies, leveraging advanced machine learning algorithms powered by first principle models, enable process manufacturers to revolutionize process optimization, reliability, energy management, and safety practices. By analyzing vast streams of real-time data from systems and soft-sensors, AI-driven solutions provide actionable insights into energy consumption patterns, identify process anomalies, and highlight asset performance inefficiencies and optimization opportunities, significantly improving safety protocols.

Moreover, generative AI supports the development of predictive and prescriptive maintenance models that enhance asset reliability, longevity, and safety. By examining historical performance data and identifying anomalies indicative of potential failures, AI algorithms facilitate preemptive interventions, reducing downtime, mitigating operational risks, and preventing safety incidents.

The synergy of generative AI with energy optimization and safety strategies holds significant potential for advancing sustainability and safety initiatives. Through scenario simulations and optimization algorithms, AI systems enhance energy utilization across manufacturing processes, cut carbon emissions, minimize environmental impact, and improve safety measures by anticipating and mitigating potential hazards.

A notable use case demonstrates the transformative impact of generative AI. A process manufacturing company utilized AI-driven predictive and prescriptive recommendations to prevent costly equipment breakdowns and safety incidents while implementing energy optimization strategies to align with 2030 and 2050 sustainability and safety targets. As a result, the company significantly reduced energy consumption, improved process efficiency, enhanced safety protocols, and achieved greater operational reliability, steering towards a more sustainable and safe future.

In conclusion, integrating generative AI in energy monitoring, management, optimization, and safety enhancement is vital for process manufacturers aiming to meet their 2030 and 2050 sustainability, reliability, and safety goals. Continuous innovation and collaboration enable the industry to harness AI's full potential, driving meaningful change, fostering sustainability, ensuring operational resilience, and enhancing safety amid evolving challenges.

Session 2- (4)

Invited speaker. Abstract not available

Session 3- (1)

Invited speaker. Abstract not available.

Session 3- (2)

Learnings from a Reactor Explosion: Catalyst Reactivity Learnings for Energy Transition Processes

First Presenting Author Rajiv Srinivasan, Shell India

Markets Private Limited

Abstract Text:

An explosion of a Shell hydrogenation unit led to the realization that there were significant process safety risks associated with catalyst and adsorbent operations in Shell manufacturing assets during unit start-ups, where catalyst/adsorbent and process conditions are in less defined transient reactivity states. One of the main causes of this incident was the reaction of ethylbenzene with active oxygen present in the catalyst, which generated large amounts of heat and gaseous molecules (such as CO_2 and H_2O) leading to the overpressure and catastrophic failure of equipment.

The challenge in effectively addressing these safety issues lies not only in technically recognizing transient reactivity states, but also to develop and implement a fit-for-purpose approach combining the knowledge of subject matter experts within Shell, focusing on catalysts and adsorbents risks. The Catalyst Safety Assessment (CSA) Team was created to address this need.

The objective of a CSA is to increase focus on risks during transient phases of start-ups with fresh catalysts and adsorbents within and from Shell. Conducting the CSA, which is a team exercise involving cross-functional technical experts (the CSA team), enables Shell to learn from upsets during start-ups and reduces the risk of safety incidents.

A focused approach is increasingly important as the world around us is moving faster every year resulting in-

- quicker responses to market,
- shorter catalyst and adsorbent development times
- new processes and feeds for the energy transition

The new energy transition processes and feeds bring many unknowns, that need to be understood and mitigated. The CSA methodology can help in this, especially around start-up of catalytic or adsorbent systems.

The anticipated presentation will include:

• Short recap of the main catalyst learnings of the explosion

• Explanation of the Catalyst Safety Assessment process and its main criteria

• Some actual examples of CSA learnings for energy transition processes

Key questions for the lecture audience to think about:

• Do you understand exactly when which reactions takes place during start-up on a loaded catalyst/adsorbent in your reactor?

• Can these reactions lead to high temperature and/or pressure?

• Do you see the loaded catalyst/adsorbent as inert facilitator or reactant?

Session 3- (3)

Understanding "Time to Maximum Rate (TMR)" in Chemical Reactions Application, Use and Misuse

First Presenting Author- Rahul Raman, Kaypear Consulting

Abstract

This paper explores the concept of Time to Maximum Rate (TMR) in chemical reactions, highlighting its importance in ensuring safety in chemical processes. TMR, also known as TMR adiabatic (TMRad), indicates the time required for a reaction to reach its maximum rate under specific starting temperatures and adiabatic conditions. This parameter provides the time available to take critical corrective actions in abnormal events. This paper will delve into the mathematical representation of Time to Maximum Rate, how to determine the Arrhenius equation constants, the use and misuse of calorimetry report, and emphasize the significance of understanding TMR in preventing runaway reactions.

Introduction

One critical aspect of process safety in chemical plants is understanding and controlling runaway reactions, which can lead to catastrophic failures. Time to Maximum Rate (TMR) is a key parameter that helps in predicting and preventing such scenarios. By understanding TMR, scientists and engineers can design safer processes and implement effective safety measures.

To understand TMR, it is essential to represent a chemical reaction mathematically. The Arrhenius equation, introduced by Svante Arrhenius in 1889, provides a way to describe the rate of a typical chemical reaction is expressed as:

Equation (1)

Where:

- Î"H is the heat of reaction
- kA is the pre-exponential factor
- Cp is the average heat capacity
- Ea is the activation energy
- R is the gas constant
- C1 and C2 are the concentrations of species 1 and 2, respectively

- n1 and n2 are the orders of the reaction

In industrial settings, one reactant is often in excess, simplifying the reaction rate to depend on the limiting reactant and added in either a batch or semi-batch reaction. The concentration of the reactant can be related to the temperature of the system by the following relationship and the conversion can be denoted as the following

Equation (2)

Equation (3)

Tf is the final temperature measured by the calorimeter

To is the onset temperature measure by the calorimeter

T is the temperature measurements recorded by the calorimeter

Î”Tb = Tf - To is the temperature rise measured by the calorimeter

Equation (2) provides the nth order generalized equation for determining the self heat rate as a function of temperature.

Detecting Chemical Reactions Using Calorimetry

Calorimetry instruments, such as DSC, ARC, ARSST, and VSP2, play a crucial role in detecting chemical reactions. These instruments measure the temperature rise rate, allowing for the determination of the onset temperature, denoted as To. In other words, the onset temperature is the temperature at which a reaction is detectable by a temperature control system. An Accelerated Rate Calorimeter (ARC) has a detection rate of 0.02 °C/min, an ARSST has a detection rate of 0.1 °C/min. This is often confused as the temperature where the reaction starts and should be considered as the temperature at which a reaction can be detected. In a large-scale commercial reaction, the reaction proceeds even below the onset temperature as it will be in adiabatic condition, however, it may not be measurable by the control system. Figure 1 shows a graph between temperature vs time and temperature rise rate, also known as self-heat rate vs time. Self heat rate will be used in this paper to denote the temperature rise rate. The detected self heat rate at the onset temperature is denoted as ro and is typically a constant and measurable. As the temperature increases exponentially the self heat rate reaches a maximum limit where kinetics and consumption of the limiting reactant is high. The self heat rate slows down above the maximum self heat rate curve even though the temperature keeps increasing. As the limiting reactant is consumed and this results in the slowing down of the reaction once it goes past the maximum temperature rise rate.

The temperature rise rate at the onset temperature can be denoted as ro and at very small conversion the concentration equals 1 which gives the following equation

Equation (4)

Re-arranging the terms we get

Equation (5)

Substituting (5) in nth order generalized equation (2), and simplifying the equation to obtain a generalized nth order reaction rate as a function of temperature and detected rate of calorimeter.

Equation (6)

The data from the calorimeter needs to be modelled using equation (6) and activation energy and the order of the reaction can be computed by trial and error. This is the first step in determining the kinetic parameters and the Arrhenius constant Ea/R which enables to determine the time to maximum rate. However, equation (6) is providing the self heat rate for the thermal inertia of the calorimeter. This needs to be scaled up using the simplified scale up procedure proposed by Harold Fisher and more detailed discussion is available in the DiERS website. This paper denotes the adjusted adiabatic temperature with an apostrophe and the onset temperature needs to be adjusted using the Arrhenius constant and onset temperature measure by the calorimeter with the following equation

Equation (7)

Where,

, adjusted onset temperature

Î¦, phi factor of the calorimeter

mc, mass of calorimetry bomb / container

Cp,c, heat capacity of calorimetry bomb / container

ms, mass fraction of sample

Cp,s, heat capacity of sample

The adjusted onset temperature is then used for scaling up the calorimetry data as the adiabatic temperature rise is given by

Equation (8)

The temperature measurement and onset temperature of the calorimeter is substituted in equation (9) to obtain the adjusted onset temperature

Equation (9)

The adjusted onset temperature from equation (7) and adjusted adiabatic temperature from equation (9) can be substituted to obtain the adiabatic self heat rate

Equation (10)

The second derivate of adiabatic self-rate calculated in equation (10) reaches a maximum and therefore can be obtained

Understanding TMR

TMR provides insight into the time required for a reaction to reach its maximum rate from a given starting temperature under adiabatic conditions. The equation for TMR is:

Equation 11

Where,

Tref, Reference temperature

dT/dt@Tref, The self heat rate at reference temperature

TMR, Time to maximum rate

The activation energy that is estimated by kinetic fitting is used in the TMR equation. It is observed in India, that the TMR values are often assumed or use a software to draw a straight line. These often are going to either underestimate or overestimate the TMR values as they do not account for the kinetics of the reaction.

This equation is valid for temperatures between the onset temperature and the temperature at which the maximum temperature rise rate occurs. The TMR is sensitive to activation energy, influencing the reaction rate significantly.

Case Study: Reactions with Different Activation Energies

Consider two reactions with the same onset temperature but different activation energies. Reaction A has a higher activation energy than Reaction B. Consequently, Reaction A's rate doubles every 10°C increase, while Reaction B's rate increases by 1.5 times. At temperatures 50°C below the onset, Reaction A's rate reduces to of its original rate, while Reaction B's rate reduces to.

From the figure the activation energy (slope) of reaction A is going to be higher than activation of reaction B. Therefore, the TMR at 50 deg C for Reaction A will be significantly greater than Reaction B. The TMR24, is defined as the temperature at which the reaction reaches the maximum rate in 24 hours. Based on an iterative calculation the Temperature @ TMR24 of reaction A will be higher than the Temperature @ TMR24 of reaction B.

Conclusion

Understanding TMR is vital for maintaining safety in chemical processes. It helps predict the time to take corrective action before a reaction reaches its maximum rate, preventing runaway reactions. Engineers can design effective safety measures and optimize reaction conditions by understanding the reaction kinetics and the factors influencing TMR. It is often misused by assuming the activation energy or by drawing a straight line when there may be parallel or multiple reactions. Engineers responsible for scale up should perform an analytic kinetic fit for the calculating the activation energy and then estimate the TMR. Additional testing may be warranted if the reaction are having different activation energy during the calorimetry run.

Session 3 - (4)

Applying Layer of Protection Analysis (LOPA) for Business Continuity Scenarios ‘Learnings from Large Capital Expense Project

Presenting Author - Mahesh Murthy, Freelance Consultant

Abstract Text:

Layer of Protection Analysis (LOPA) is a structured study methodology evaluating Independent Protection Layer (IPL). As general industry practice, high Consequence Health/Safety/Environment scenarios identified in Process Hazard Analysis (PHA) are subject to Layer of Protection Analysis for evaluating adequacy of Independent Protection Layer to achieve a target risk level. This paper describes a unique approach where in a Hazard and Operability (HAZOP) scenario resulting in financial losses more than 80 million US dollars triggered a LOPA. The findings of applying LOPA based approach for financial loss scenarios for large capital projects resulted in many key learnings, which are presented in this paper. The learnings can be grouped in the following main categories: a. Identifying and describing worst case plausible credible scenario b. Selection of appropriate financial loss criteria c. Estimating asset and production losses (Mean Time To Restoration) d. Establishing sufficient independence while determining Independent Protection Layers LOPA applied to financial losses for large and complex projects, many good lessons were learnt. Scenario description played a crucial role, where the HAZOP scenario for losses were thoroughly scrutinized for being ‘plausible credible scenarios. Documenting the scenario in details also

led to enhanced quality of the report and subsequently resulted in good action close outs. Financial loss criteria played a crucial role in arriving at the gaps. Low financial threshold resulted in excessive automation and vice a versa high financial losses resulted in minimal automation related recommendations and hence subsequent costs across project safety lifecycle. The financial loss criteria had to be adjusted and a benchmark study was also conducted to arrive at 80 million US dollars as a trigger for LOPA. This was a fine balance between a safe and reliable plant. Arriving at a mechanism to estimate the financial losses resulted in discussions on single sourcing versus multiple sourcing options, lead times, installation preparedness, regulatory impacts to ensure realistic mean time to restoration and business continuity. This also triggered the review of sparring philosophies for critical spares. Basic Process Control System (BPCS) failure triggering a scenario which often had credits taken as an IPL. LOPA guidelines and ISO 61511 standards do allow for credits to be taken, however, careful evaluation followed post study sessions revealed several scenarios where credit for independence was not correct, which lead to additional gaps in the LOPA. Defining Independence was found to be critical along with identifying allowable Beta factors for common mode failures. In summary, LOPA applied for financial losses identified in PHAs resulted in better understanding of business continuity risks, process safety risks and thereby optimizing sparring philosophies for better Process Safety Management.

Session 4- (1)

Invited Speaker. Abstract not available

Session 4- (2)

Quantified Human Factors Risk Assessment

Presenting Author Ian Travers, British Safety

Council

Abstract Text:

Human error is an underlying cause in many process safety incidents. We have well developed risk assessment techniques such as HAZOP, LOPA and QRA covering the technical risks of hardware or control systems failure in major hazard plant and equipment but there is a gap when it comes to assessing human failures. Pioneering work by the British Safety Council and Asian Paints Limited now provides a simple method of systematically assessing the potential for an error when performing safety critical tasks.

This paper presents an overview of this technique and highlights significant improvements to reduce the chance of human error. For the first time Asian Paints is able to risk rank safety critical tasks and highlight those which require improvement in design or execution to reduce risk of error to an acceptable level.

The technique relies on the clear identification of safety critical tasks using Bow Tie analysis to identify high criticality tasks which must be undertaken correctly on every occasion to avoid initiating a major incident. Scores are assigned to the tasks based on the chance of error when performing the task and countered the opportunity to recover from that error before it results in a major incident. The combined scores provide a risk rating for the task which can then be used to rank tasks within process activities and to target improvements to reduce the chance of error to an acceptable level.

The paper highlights a range of human error risk reduction measures and shows examples of improvements which reduce the chance of human error.

Session 4- (3)

Invited speaker. Abstract not available.

Session 4- (4)

Proactive Management of Human Factors in Accident Prevention: Case Study and an Innovative Approach at Hmel

First Presenting Author Anshulkumar Tiwari, HMEL

Abstract Text:

Managing human factors is central to accident prevention. Typically, companies identify human performance issues only after an incident has occurred. In contrast, HMEL employs a proactive mechanism to address human factors. This paper provides an in-depth look at how HMEL addresses these issues using an innovative methodology focused on identifying error-producing conditions.

At HMEL, human factors have been recognized as a major concern, contributing significantly to workplace injuries. Despite running various programs such as safety culture transformation, digitalization and automation of systems, and the use of enhanced technology, human errors persist at various points of interaction with machines, processes, and equipment. To tackle this, HMEL adopted a novel approach by identifying human error-producing conditions. The following activities were undertaken:

1. Sensitizing Personnel: Multiple sessions, including case studies, were conducted to educate employees about human factors and error-producing conditions. These sessions aimed to raise awareness and understanding of how human errors occur and how they can be prevented.

2. Developing In-House Checklists: Custom checklists were created for both console and field conditions that have the potential for human error. These checklists serve as a preventive tool to ensure

all critical points are monitored and managed appropriately.

3. Publishing a Handbook:A comprehensive handbook on human error-producing conditions was developed and published. This handbook serves as a reference guide for employees, providing detailed information on how to identify and mitigate potential errors.

4. Promoting Reporting:A reward and recognition program was introduced to encourage employees to report potential human errors. This initiative aims to create a culture of transparency and continuous improvement by recognizing and rewarding proactive reporting.

5. Forming Multidisciplinary Teams: Unit-specific teams comprising members from various disciplines were formed to identify and address human error-producing conditions. These teams work collaboratively to analyze and mitigate risks in their respective areas.

6. Developing an Analytical Dashboard: An analytical dashboard was developed to identify trends and patterns in human errors. This tool helps in monitoring performance, identifying recurring issues, and developing targeted action plans to address them.

This proactive program has enabled HMEL to identify and mitigate human performance issues before they lead to incidents. By addressing human factors systematically, HMEL has made significant strides in improving process safety. The paper will present a detailed case study and the success story of HMEL's methodology in managing human factors, highlighting the effectiveness of this innovative approach in accident prevention and safety management.

Session 4- (5)

Understanding Human Factors - Key to Effective Safety Barrier Management in Chemical Industries.

Presenting Author - Rekha Sharma, GRIP

Global Pte. Ltd.

Abstract Text:

The chemical and oil & gas industries are considered safety critical due to the significant inherent and intricate risks involved. These risks necessitate robust safety management to protect workers, the public, and the environment. Despite technological and engineering advancements, the interplay of human factors with technical aspects poses challenges in maintaining process safety performance. Various safety barriers, including engineering, operational, procedural, and administrative controls, have been implemented by organizations. However, uncertainty persists regarding human response during emergencies.

Historically, the concept of human factors in safety management focused on the behaviors of workers, supervisors, and employees. This led to the implementation of behavior-based safety (BBS) programs in industries, assuming that modifying behavior alone could prevent accidents. However, it became evident that this perception is flawed as it overlooks systemic issues such as poorly designed equipment, inadequate training, lack of effective communication channels, and ineffective safety management systems. Furthermore, it was observed that while BBS programs can enhance communication and reporting, they do not significantly reduce risks.

The oil & gas and chemical industries are currently undergoing a significant transition to align with environmental, social, and governance (ESG) goals. This shift is driven by advancements in manufacturing methods, operations, and technology, promising sustainable production and operations while introducing new risks due to human failures. The rapid pace of technological evolution could outstrip the workforce's ability to adapt, leading to a skills gap compromising safety and operational integrity.

Human failures in this context can manifest in several ways. Workers accustomed to traditional processes may struggle to adapt to new systems, heightening the risk of operational errors. Inadequate training and understanding of new technologies can lead to improper equipment handling, execution of procedures, and data misinterpretation. The transition phase itself can also pose risks, as parallel operations involving both old and new systems may create confusion, increase cognitive load, and lead to mistakes. Changes within an organization, such as alterations in structure, facilities, personnel, or policies, significantly impact the effectiveness of safety systems, posing higher risks to hazardous industries.

The significance of safety barriers in the chemical and oil and gas sectors cannot be overstated. These barriers are vital for preventing accidents and ensuring the safety of workers and the environment. However, human error significantly contributes to safety barrier failure when not designed considering Human Factor Principles and Behavioral Science. Understanding how human factors might influence safety barrier performance necessitates recognizing the broader range of elements influencing human performance, including psychological, physiological, organizational, and environmental aspects. Addressing human factors requires action on multiple fronts, rather than solely relying on behavior modification.

Incorporating human factors as safety barriers entails recognizing these influences and systematically addressing them within the safety management framework. Key components include Human Error Management, which embraces the understanding that errors are an inherent part of human activity. By

incorporating design elements into the initial engineering phase, plant, equipment, and procedures can be optimized to mitigate the occurrence of human errors during both regular operations and emergency situations. Fostering a robust Safety Culture is equally important, where a commitment to safety is deeply ingrained. Instead of simply addressing surface-level behaviors, a comprehensive approach involves examining the reasons behind unsafe and at-risk employee conduct. Creating a supportive atmosphere that encourages employees to report potential hazards and near-misses without fear of reprisal is essential. Implementing continuous and comprehensive training programs to manage risks effectively and stay abreast of technological advancements and operational changes is also crucial in minimizing errors. Lastly, establishing reliable communication channels for all critical operations and activities is pivotal to ensure the accurate and timely exchange of information.

This paper advocates a transformative approach to safety management in high-risk industries, emphasizing the crucial role of a robust safety culture, comprehensive training programs, effective communication channels, and human-centered design of equipment and processes. These proposed changes are not only desirable but also imperative for establishing resilient risk assurance programs in safety-critical sectors. The paper emphasizes the necessity of integrating comprehensive human factors principles into safety barrier management. By addressing systemic issues and enhancing safety culture, training, ergonomics, communication, and leadership, industries can significantly reduce human errors and enhance safety outcomes. Recognizing human factors as an interconnected system rather than isolated behaviors is pivotal for fostering a safer and more resilient operational environment.

In summary, the paper highlights the paramount importance of addressing human factors in safety barrier management. It reaffirms the commitment to fortifying safety measures in safety-critical industries and underscores the ongoing need for improvement and learning from past incidents. The ultimate aim is to cultivate a safer and more secure working environment in these industries, safeguarding not only the workers but also the public and the environment.

Session 5- (1)

Ecolab Process Safety Foundations Hypercare Preferred

Presenting Author- Balajee Raman, Ecolab Inc

Abstract Text:

Ecolab Process Safety Foundations Hypercare : Executive Summary

Ecolab, a global petro/chemical manufacturer, had experienced a major increase in Process Safety events over the past 18 months. It was discovered that a majority of major Process Safety Events occurred at just seven of the global plant sites (75 global sites total across organization) Many of these events had a root cause of high employee turnover and low Process Safety Competency. Ecolab also recently acquired a new business, Purolite, which specializes in pharmaceutical resin manufacturing. It was quickly observed that Purolite had very little Process Safety knowledge, and low level Process Safety culture. These two situations lead to the deployment of Process Safety Foundations Hypercare process

Hypercare Phased Approach:

1. Training Steering Team: Learning Gap Assessment

2. Content Planning

1. Focus Sites in-person workshops

2. Train the Trainer

3. Global eLearning deployment: Ecolab + Purolite

4. Sustainable Program: Digital on-demand training

Global leadership pulled together a Training Steering Team of experts to complete a learning gap assessment. The Process Safety Qualification Process (PSQ) had been deployed over the past 4 years at all global plant sites, however, it was determined that PSQ was too advanced for new hires and recent university graduates starting with the company. Data showed that high employee turnover at a majority of sites was a major contributing factor to the increase in PSEs. The gap assessment findings also showed the Purolite sites to be lacking Process Safety standards, policies, procedures, and competencies.

The Process Safety Foundations (PSF) training workshops were developed to build foundational, basic awareness of Process Safety for hourly production teams at the seven focus sites. The workshops used Process Safety Event (PSE) data and PSQ training resources as a starting point for development. Topics included:

1. Process Safety Culture

2. Process Safety Standards; Metrics/ Managing Leading Indicators

3. Chemical Compatibility

4. Open Ends

5. Incident Investigation

6. Management of Change

7. Critical Equipment Standard

The PSF workshops were deployed across all seven focus sites, as well as all global Purolite sites over the course of three months. Approximately 300 employees completed the training. It was the expectation of leaders to continue leading Process

Safety training at their sites to ensure knowledge and competency continued to grow (Train the Trainer).

After launching the PSF workshops, the Training Steering Team did further gap analysis, and found secondary root cause findings for Management of Change (MOC). The team developed an eLearning module based on the internal MOC policy. The eLearning was deployed across global regions, and was a required training for hypercare. Over 1000 employees completed the eLearning in the first month.

The intensive PSF workshops have begun to pay off: Process Safety Events have consistently started to drop throughout 2024. The Training steering team determined the best strategy for a sustainable program is using digital options. This includes redeveloping PSF workshop content into online videos and eLearnings that will become part of new employee onboarding/Induction.

The digital training process was started in Q3, 2024, and will continue into Q2, 2025. Continued PSE data analysis will continue to adjust the hypercare process as needed.

Session 5- (2)

Invited speaker. Abstract not available.

Session 5- (3)

How to Leverage CFD to Improve Hazard Assessment and Enhance Safety?

Presenting Author- Sharad Gupta, IRESC

Abstract Text:

Computational Fluid Dynamics (CFD) has emerged as a crucial tool in risk and safety studies across various industries. Its ability to simulate and analyse fluid flow behaviour, coupled with advanced mathematical models, allows for precise prediction of potential hazards and the assessment of safety measures. This presentation explores the use of CFD in risk and safety studies, highlighting its applications, benefits and challenges.

CFD is widely used in the chemical, process, and oil and gas industries to model complex fluid flow phenomena that are often difficult or impossible to study experimentally. By creating detailed simulations of fluid dynamics, CFD helps in understanding the dispersion of hazardous materials, fire and explosion dynamics, ventilation and smoke control, and the impact of external factors like wind on hot air recirculation.

The use of CFD in risk assessments enables engineers and safety professionals to accurately predict the behaviour of gases, liquids, and particulates under various conditions including wind, terrain, actual 3D plant geometry, which is essential for identifying potential risks and implementing effective safety measures. For example, CFD can simulate accidental releases of toxic or flammable gases to evaluate their dispersion and identify areas at risk. In the context of fire safety, CFD models can predict fire growth, smoke movement, and temperature distribution, aiding in the design of fire protection and suppression systems and evacuation plans. CFD based explosion analysis can help determine the appropriate overpressure rating for the blast wall.

Despite its advantages, the use of CFD in risk and safety studies also presents challenges. The accuracy of CFD simulations is highly dependent on the quality of input data, the selection of appropriate models, and computational resources. Additionally, interpreting CFD results requires expertise to ensure that the simulations are correctly aligned with real-world scenarios.

Overall, CFD has proven to be a powerful tool for enhancing safety and minimizing risks in various industries. Its ability to provide detailed insights into fluid dynamics and potential hazard scenarios makes it an indispensable component of modern risk and safety management practices.

Session 5- (4)

Competency Development in Process Safety

Presenting Author-Sudhir Narkhede, LyondellBasell (LYB)

Abstract Text:

Process Safety is the most critical function to keep your Operations safe and running. When not adhered to, there can be one or more implications.

The impact of process safety incident can be significant and multifold, it can be limited to Plant but can get extended to the Society at large. It can be of temporary nature or permanent. Company's reputation is at stake, may need to re-built the plant or shutdown forever, will need to pay compensation.

Hence, process safety focuses on preventing and mitigating operational risks to protect personnel, communities, and the environment.

"Keep the Hydrocarbons inside Equipment's, Pipes and Storage"

This abstract examines how Companies can prevent loss of primary containment with the application of process safety. Loss of primary containment refers to the failure of equipment or systems designed to prevent the release of hazardous substances into the environment, posing risks to personnel, communities, and environment.

Developing Competency in Process Safety Function

Being critical to the Companies, it is necessary to develop Competency to continuously assess and manage process safety for the plant life cycle. The key aspects are;

• Organization culture shall be driving the approach (like Goal Zero)

• Recognize Process Safety as Core Competency from Project phase to Operational phase

• Focus on developing Own Team to the extent possible while leveraging on the external Expertise as needed

• Having own Team can help the continuity and address changes, modifications, keeping the knowledge

• It provides the ownership

• Having own Team can have cost benefits also

• Technology specific things handled in efficient way without worrying for IP Security

• Develop own Standards, Practices to guide the Team

• Learning to address similar or different issues across similar Technologies within the Company

• Bring the synergy in terms of solutions across the Company

• Critically select available commercial proven tools

Process Safety Outsourced

At times organization believe that manufacturing is their core competence and hence they outsource process safety study

• This results in one way approach, owner provides just the data requested without knowing its importance.

• No involvement during execution hence final report does not find ownership.

• If the staff changes, then continuity is lost.

• At times, study results may suggest some further iterations and time/cost may not permit.

• It may be limited to scope given to external agency and no relation to other aspects if any.

In our experience a full-fledged engineering team with competency and resources to perform lot of Process Safety Functions inhouse has yielded great results

• Relief system analysis (RVs, Flare), New, Revalidation, DBN

• Relief valve inspection frequency

• Dispersion of atmospheric vents

• IPL Validation to make sure that system will work as designed.

• Emergency isolation valve requirement for higher inventory.

• Process Hazard Analysis

• SIF verification

• Quantitative Risk Assessment

It involves many aspects to know, analyze and implement making the asset safe. Key Elements to achieve a high level of 'Process Safety' are;

• Selecting the right proven Technology and Process

• Initial Design following the Codes, Standards and Best Practices

• Design Review and Risk Analysis (HAZOP) Steps during the Project phases

• Positive closure of the action items from the reviews

• Adherence to 'Management of Change' process during Project phases

• Alignment during the Procurement phase

• Control during the FAT, Construction and SAT phases

• Control during pre-commissioning and Commissioning phases

• Adherence to 'Management of Change' process during Operations

• Maintaining the Assets for the life cycle

Hence, through this extract, we would put forward the point that the organization must have an intentional competency development plan in Process Safety to meet the 'Goal Zero' performance.

Session 5- (5)

Building Competence for Effective Process Safety Management: Strategies and Approaches

Presenting Author- Kevin Chothani, Sekura India

Management Limited (Edelweiss)

ABSTRACT

Objective:

This paper aims to elucidate the essential competencies required for effective Process Safety Management (PSM) and to present a range of

strategies and approaches for developing these competencies within organizations. The goal is to provide a framework that enhances the ability of professionals to manage process safety and improve overall safety performance.

In process safety management Hazard identification, risk assessment, layers of protection, preventive & recovery barriers, process safety controls and incident investigation require in depth competence to manage process safety effectively.

Background:

Process Safety Management is vital in preventing and mitigating industrial accidents involving hazardous processes and materials.

To effectively manage these risks, process team personnel must possess a robust set of competencies as follows:

1. Process Safety Knowledge

2. Understanding the principles and practices of process safety management.

3. Techniques for identifying hazards and assessing risks associated with hazardous processes.

4. Design, implementation, and maintenance of safety instrumented systems.

5. Critical to safety, health and environment equipment inspection, testing, maintenance and calibration requirements

6. Knowledge of safe process design, including materials of construction, process control, and hazard analysis.

7. Application of engineering principles to ensure safety in process operations and protecting environment.

8. Management of process safety information including data on chemicals, process equipment, and operating procedures.

9. Understanding of relevant process safety regulations and standards.

10. Techniques and practices for investigating and analyzing incidents to prevent recurrence.

11. Preparation and execution of emergency response plans and procedures.

12. Processes for managing changes in processes, equipment, and personnel.

13. Effective leadership strategies for managing and enhancing process safety programs.

14. Training and Development

15. Methods for performing quantitative risk assessments to evaluate and mitigate potential hazards.

16. Conducting HAZOP studies to identify and address potential hazards in process operations.

17. Development and monitoring of key performance indicators for process safety.

18. Implementing strategies for continuous improvement based on performance data and incident analysis.

As industrial processes become increasingly complex and regulatory expectations grow stricter, there is a pressing need for structured competency development to ensure effective PSM practices.

Methodology:

Process safety competence identification, assessment and assurance are done through following steps:

1. The competency requirements specified in job description can be specified based on defined competency framework for each role. It must include knowledge, skill and competence assessment requirements.

2. Reporting manager can use checklist designed based on process safety competency framework to identify competence gaps and additional trainings requirements based on role and activities to be performed.

Training needs assessment can be done by his/her supervisor and identify additional trainings.

Training needs assessment sample questions:

• Will the employee be involved in operation and maintenance of process plant?

• Will the employee be involved in using, storing, or disposing hazardous chemicals used for process plant (flammable, reactive, toxic, corrosive etc.)?

• Will the employee work for emergency response team to manage process safety incidents?

3. Training Delivery and Evaluation

Conducting mandatory and additional training requirements to achieve required level of competence using training needs assessment, competence gap assessment.

Mandatory:

Following trainings are mandatory programs based on role:

• Site Technical Team (managers, engineers, O&M technicians)- Process Safety Passport Program

• Other Staff (administration and other support staff) - Process Safety Basics

Process Safety Passport Training program methodology content and evaluation:

• Each training module consists of 5-10 topics, each presented in under 5 minutes with a focus on high visual content to enhance engagement. Upon completing a module, participants must pass a qualified assessment. Qualified score can be set based on Angoff method be qualified for the program.

• Modules are designed to be flexible and can be adapted into computer-based formats, virtual reality (VR) modules, or other digital learning management systems for those who are unable to attend in-person sessions.

1. Process safety management basics

2. Human Factors

3. HAZOP

4. BOWTIE

5. Layers of protection

6. Management of change and PSSR

7. Critical to SHE equipment-inspection, testing and maintenance

8. Incident investigation

9. Industrial hygiene

10. Fire prevention and protection

11. Emergency preparedness and response

12. Permit to work

13. Other high risks activities -Electrical safety, Lock Out & Tag Out, Working at height safety, Confined space safety,

• Classroom sessions shall be developed and delivered by process safety expert (CCPS Process Safety Professional Certification, Certified Process Safety Auditor, Certified Safety Professional) capable to deliver training using interactive methods.

• LOTO (Lock Out & Tag Out), Vehicle driving, Fire Fighting etc. can be evaluated through hands on demonstration/ practical assessment through defined checklist

• Refresher sessions: This program has one year validity. Refresher of this program is done through refresher qualified assessment or entire modules with qualified assessment

Additional:

• Quiz based microlearning: It can help for retaining process safety knowledge. It can be implemented through RapL Learning Mobile based application. The purpose of implementing this initiative is to enhance process safety knowledge retention, to increase active participation and to strengthen refresher training requirements. It is an advanced quiz based microlearning initiative launched to solve the limitation of conventional training methods and enables employees to stay focused on their key objectives

• Certification Exams:

1. CCPS Process Safety Professional Examination (CCPSC) . Rather it is a rigorous certification process that verifies your competency in the latest process safety tools and techniques. Each candidate will be rigorously screened and tested to ensure their professional knowledge and commitment to staying current with the latest developments in process safety.

2. The Certified Professional Environmental Auditor (CPSA) credential demonstrates one's practice of today's auditing procedures, processes, and techniques related to process safety

Conclusion: Effective process safety management is contingent upon a deliberate and structured approach to competency development. By adopting the strategies and approaches discussed in this paper, organizations can enhance their process safety practices, reduce risks more effectively.

Session 6- (1)

Invited speaker. Abstract not available

Session 6- (2)

Invited speaker. Abstract not available

Session 6- (3)

Invited speaker. Abstract not available

Session 6- (4)

Managing Asset Integrity with Effective Management of Change (MoC) Program

Presenting Author - Ashit Dalal, eDelta Consulting, Inc

Abstract Text:

Asset Integrity and Management of Change (MoC) processes are very critical components of effective and robust Process Safety Management (PSM) program. There are several incidents reported and investigated by CSB, where lack of managing Asset Integrity and ineffective MoC processes have been one of the key reasons for such incidents and near misses.

Both these are also considered as essential 'Operational Control' for several ISO standards like ISO 14001: 2015, ISO 45001: 2018, RC-14001 and so on.

This presentation covers excerpts from two reported and investigated actual incidents as also actual used cases from my audit clients. Two incidents that are referenced here are:

• Wacker Polysilicon chemical release

• Philadelphia Energy Solutions (PES) Refinery Fire and Explosions

Abstract Description

The presentation would cover the following:

• Brief overview of Asset Integrity and Management of Change (MoC) processes

• Interdependence between Asset Integrity and MoC

• Brief overview and analysis of Wacker Polysilicon and PES incidents

• Recommendations of CSB on Asset Integrity and MoC to improve Process Safety

• Used cases discussion based on Process Safety audit of other chemical companies.

• Lessons learnt

• Summary and next steps including use of Ai and Gen Ai in Asset Integrity and MoC process.

• Q & A

Session 6- (5)

How Many Detectors Are Optimal for a Hazardous Facility?

Presenting Author -Akshat Khirwal IRESC

Abstract Text:

The intent of Fire & Gas Detection System (FGDS) is to provide timely detection of any fire scenario or gas release and to raise alarms and/or initiate appropriate control action. The main purpose is to minimize catastrophic damage associated with escalation events due to undetected and thereby unmitigated fire/gas release scenarios. To ensure that the above objectives of the FGDS are achieved, a fire and gas layout is developed with the target equipment to be protected. However, there could be gaps in the target equipment considered for detector provision, reliance on conventional approaches for development of preliminary detector layout or in ensuring all hazards have been accounted for properly even when 3D Fire & Gas Mapping tools are used for the coverage assessment. Using practical examples and case studies (using 3D mapping tools), some key questions regarding FGDS will be reviewed and insights will be provided on best practices or way forward in maximizing the performance of FGDS:

• Which equipment should be provided with Fire and/or Gas detection?

• Process stream handles both flammable and toxic material, which type of detection should be provided? What to do when process streams handle both hydrogen and hydrocarbons or multiple toxic components?

• Can the same detector layout handle a change in voting logic i.e. 1ooN vs 2ooN?

• What parameters to select to best match actual detector performance? How to identify the optimal grade/area for detector coverage?

• Can detector layout from one project be used for another project if the facility type is same?

• Are risk based and scenario based approaches the same?

• How to ensure the credit taken for successful detection for activation of isolation and/or blowdown in risk assessment is matching the FGDS performance?

• When can CFD based gas detection study help?

Session 7- (1)

Determining and Managing Safe Operating Limits to Critical Operating Parameters at Major Hazard Installations

Presenting Author- Karthikganesh Senthilvelan, Asahi Kasei Synthetic Rubber Singapore Pte. Ltd.

1. Introduction

Defining safe operating limits of critical operating parameters, reviewing its validity periodically, and recording its exceedance (if any) are indeed vital for safe operation of the chemical plant, especially for Major Hazard Installations. Despite this fact, most often the users either do not know their limits precisely or the process of determining it or, keep their limits too close to or very far from its normal operating or mechanical design limits of equipment. This in turn would potentially lead to curtaining its operational flexibility or raising safety concern of not having enough safety margin. This paper briefly discusses about different industrial methods adopted for determining safe operating limits, potential reasons for its variance, local and international guidelines, regulatory requirements, typical challenges foreseen to close this scientific gap. As an outcome, it recommends a suitable methodology and approach for determining and managing safe operating limits for critical operating parameters of major hazard installations.

1.1. Industrial and Regulatory Requirements

All identified Major Hazard Installations (MHI) should have a system in place for determining, recording, and reviewing Safe Operating Limits to describe how adequate control measures have been provided to protect the plant against excursions beyond design conditions per Safety Case (Workplace Safety and Health Act, 2017). Determination and documentation of Safe Operating Limits is required per OSHA-PSM regulation 1910.119 (Process Safety Management of Highly Hazardous Chemicals, 2015). Exceeding Safe Operating Limits are considered a Tier 3 Process Safety Management Leading Indicator per API RP-

754 (Process Safety Indicators for the Refining and Petrochemical Industries, 2021)

1.2. Methods and variations

Industry guidelines and methods are widely inconsistent (https://doi.org/10.1002/prs.12163) and different industrial sectors seem to adopt a different basis such as based on equipment mechanical design limits, mechanical integrity limits, process dynamic consideration, alarm or instrumented protective system set points or a combination of the above. Some of the common reasons cited for these inconsistencies are Industry variation, i.e., what is considered safe operating limit in one industry may not be directly applicable to another; Regulatory Variation as different regions/-countries may have distinct requirements and standards for defining safe operating limits; Lack of standardization due to not having widely accepted guidelines, organizations may develop their own methods; Inadequate training and knowledge of personnel responsible for establishing safe operating limits; Changing conditions when organizations fail to adapt and update their methodologies to reflect changes in their process, equipment and technologies evolve over time.

1.3. Significance and benefits

This study would help to standardize and be consistent with the established process by developing industry specific guideline for determining and managing SOL, performance indicators and exceedance management. Further, its success is expected to benefit the industry to close the knowledge gaps based on science-based evidence and provide greater transparency and consistency in regulatory requirements to enable better decision making and reduce opportunity costs by enabling them to pursue more cost-effective options. The goal is not only to address safety issues (for example, drive SOL as far from design limits), but also to explore for opportunities to optimize and expand normal operating limit to the extend not compromising on safety from sustainability standpoint

2. Methodology and Approach

This study uses mixed method that involves qualitative and quantitative approach, and the methodology comprises of eight (8) different steps split into two (2) phases for determining and managing safe operating limits.

2.1. Phase-1

This phase comprises of team workshop and data collection for identifying main hazards, critical operating parameters, understanding the process and its design limits, followed by process dynamic study (lab-scale) to recognize the hazard and its characterization, additionally industrial-wide survey/-regulatory alignment to determine safe operating limits (raw SOL-value).

Step-1-Identify main hazards

Identification of main hazards could be extracted from existing safety reports/-safety cases or relevant risk assessments. However, in the case of new facility where such documents do not yet exist, determination of Safe Operating Limits (SOL) should be scheduled to start once the main hazards become clear. This step is likely to involve consultation with process safety specialists, site personnel and authors of risk assessments, to ensure that all correct and most up-to-date documentation has been received and that the identification of major hazards is comprehensive. The resulting list of higher risk units should be the starting point to identify Critical Operating Parameters (COP) in Step-2.

Step-2-Identify critical operating parameters (COP)

Critical Operating Parameters (COP), such as level, pressure, temperature, concentration, flow, and other process variables that have the potential to cause unacceptable risk to health, safety and environment or property damage are typically determined through as combination of engineering analysis, process hazard analysis, industrial standards, and experience. Process Safety Information which includes documentation related to the design, operation, and hazards of a process, is one of the valuable sources. Standard Operating Procedures (SOP) and Process Hazard Analysis (PHA) are other valuable resources where COP are discussed widely when operating parameters upon process or human deviations could lead to accident.

Step-3-Understand the process and its design limits

SOL workshop to be conducted with multidisciplinary team to review and confirm the following,

• Mechanical Design Limits (MDL), this defines SOL basis and operating beyond this range (min and max) is potential for catastrophic failure of process equipment and loss of containment

• Normal Operating Limit (NOL) and controls/-monitoring ways to maintain operating parameter within NOL, this defines SOL pre-alarm and operating beyond this range (min and max) is potential for SOL deviation, steps that are predefined/-taken to avoid such deviation

• Safety alarms/-interlocks, this defines Independent Protection Layers (IPL) value and operating beyond this value is potential for MDL excursion, automatic/-operator actions that are pre-defined to correct deviation and avoid such excursion

Step-4-Recognize the hazard and its characterization

Study of consequence of deviation is necessary for operator knowledge and awareness to know the potential severity and risk associated upon exceeding any safe operating limits or design limits. Study on process dynamics (laboratory/-computational) would help to understand the speed of development of scenario between the point of failure occurring in the process or basic process control system (with the potential to give rise to a hazardous event) and the occurrence of the hazardous event if the safety functions/-actions failed to perform in the way or within the time it is designed.

Step-5-Determine safe operating limits to control COP deviations

Based on the results obtained from step-3 (SOL basis, SOL Pre-alarm) and step-4 (Process Safety Time), safe operating limits can be determined assessing response actions, estimated time taken for operator response (detect, diagnose, respond) AND process response (process deadtime, reaction time) is less than the estimated process safety time to protect the equipment against excursions beyond conditions. This raw SOL value (lab-scale) shall be assigned to actual process and monitored for any opportunity to expand its operating window in step-6 (for example, driving SOL away from normal operating range) and for any changes required to predefined actions

2.2. Phase-2

This phase comprises of data analysis and variability analysis to optimize and validate SOL value based on likelihood and consequence of exceedance (industrial scale). Also, to address process of implementation, monitoring effectiveness of SOL and its determination.

Step-6-optimize and validate safe operating limits and its actions

To extract actual process data (industrial-scale) and conduct variability study to assess actual maximum and minimum value, normal operating envelope, SOL (raw value obtained in step-5) exceedance, response/-pattern of multi-variables interdependent to each other to optimize and validate SOL based on likelihood and consequence of exceedance (risk-based approach), also addressing any possible limitation in the lab-scale that is typically not captured during experimental set-up, for example, scenarios which develop quickly/-sensors with a high level of inertia.

Step-7-implement and monitor effectiveness of safe operating limits

The output from step-6 will be a set of safe operating limits for all critical operating parameters. Implementation should follow through MOC process (for existing plants) and may include updating Process Hazard Analysis that provides engineering and administrative controls applicable to the hazards; Operational Procedures that provide Operator actions required to avoid SOL deviations, Safe Operating Limits (SOL), actions required to correct any SOL deviation and avoid design excursion; Process Safety Information corresponding to 'technology': Safe upper and lower limits for critical operating parameters; and Mechanical Integrity Plan that is used to correct deficiencies in equipment that are outside acceptable limits (defined in step-6) to assure safe operation

Step-8-Review effectiveness of determining safe operating limits

As the process becomes established, regular reviews shall be carried out to check that the process of determining safe operating limits for major hazard installations is producing effective results (improves safety and productivity) and the benefits obtained (reduced safety incidents, improved knowledge on process safety time and response time/-actions, mechanical integrity programs) justify the resources used. It is likely that various optimizations will be possible as experience is built-up, and it may be possible to develop an industry-based (for example, Petrochemical or Pharmaceutical) or process-based (for example, batch or continuous) SOL methodology that could be reused across the site or multiple sites across the organization.


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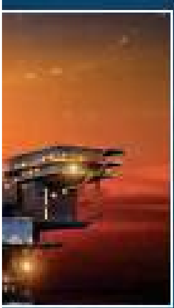

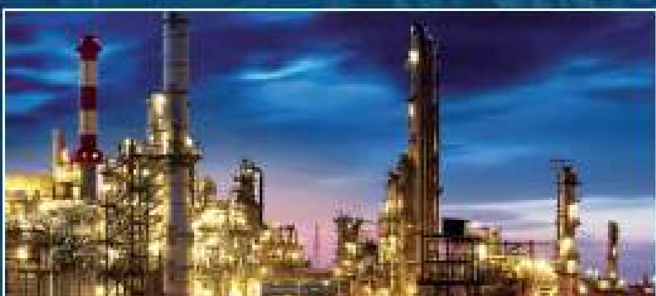

Process Safety and Reliability Group

Session 7- (1)

Determining and Managing Safe Operating Limits to Critical Operating Parameters at Major Hazard Installations

Presenting Author- Karthikganesh Senthilvelan, Asahi Kasei Synthetic Rubber Singapore Pte. Ltd.

1. Introduction

Defining safe operating limits of critical operating parameters, reviewing its validity periodically, and recording its exceedance (if any) are indeed vital for safe operation of the chemical plant, especially for Major Hazard Installations. Despite this fact, most often the users either do not know their limits precisely or the process of determining it or, keep their limits too close to or very far from its normal operating or mechanical design limits of equipment. This in turn would potentially lead to curtaining its operational flexibility or raising safety concern of not having enough safety margin. This paper briefly discusses about different industrial methods adopted for determining safe operating limits, potential reasons for its variance, local and international guidelines, regulatory requirements, typical challenges foreseen to close this scientific gap. As an outcome, it recommends a suitable methodology and approach for determining and managing safe operating limits for critical operating parameters of major hazard installations.

1.1. Industrial and Regulatory Requirements

All identified Major Hazard Installations (MHI) should have a system in place for determining, recording, and reviewing Safe Operating Limits to describe how adequate control measures have been provided to protect the plant against excursions beyond design conditions per Safety Case (Workplace Safety and Health Act, 2017). Determination and documentation of Safe Operating Limits is required per OSHA-PSM regulation 1910.119 (Process Safety Management of Highly Hazardous Chemicals, 2015). Exceeding Safe Operating Limits are considered a Tier 3 Process Safety Management Leading Indicator per API RP-754 (Process Safety Indicators for the Refining and Petrochemical Industries, 2021)

1.2. Methods and variations

Industry guidelines and methods are widely inconsistent (https://doi.org/10.1002/prs.12163) and different industrial sectors seem to adopt a different basis such as based on equipment mechanical design limits, mechanical integrity limits, process dynamic consideration, alarm or instrumented protective system set points or a combination of the above. Some of the common reasons cited for these inconsistencies are Industry variation, i.e., what is considered safe operating limit in one industry may not be directly applicable to another; Regulatory Variation as different regions/-countries may have distinct requirements and standards for defining safe operating limits; Lack of standardization due to not having widely accepted guidelines, organizations may develop their own methods; Inadequate training and knowledge of personnel responsible for establishing safe operating limits; Changing conditions when organizations fail to adapt and update their methodologies to reflect changes in their process, equipment and technologies evolve over time.

1.3. Significance and benefits

This study would help to standardize and be consistent with the established process by developing industry specific guideline for determining and managing SOL, performance indicators and exceedance management. Further, its success is expected to benefit the industry to close the knowledge gaps based on science-based evidence and provide greater transparency and consistency in regulatory requirements to enable better decision making and reduce opportunity costs by enabling them to pursue more cost-effective options. The goal is not only to address safety issues (for example, drive SOL as far from design limits), but also to explore for opportunities to optimize and expand normal operating limit to the extend not compromising on safety from sustainability standpoint

2. Methodology and Approach

This study uses mixed method that involves qualitative and quantitative approach, and the methodology comprises of eight (8) different steps split into two (2) phases for determining and managing safe operating limits.

2.1. Phase-1

This phase comprises of team workshop and data collection for identifying main hazards, critical operating parameters, understanding the process and its design limits, followed by process dynamic study (lab-scale) to recognize the hazard and its characterization, additionally industrial-wide survey/-regulatory alignment to determine safe operating limits (raw SOL-value).

Step-1-Identify main hazards

Identification of main hazards could be extracted from existing safety reports/-safety cases or relevant risk assessments. However, in the case of new facility where such documents do not yet exist, determination of Safe Operating Limits (SOL) should be scheduled to start once the main hazards become clear. This step is likely to involve consultation with process safety specialists, site personnel and authors of risk assessments, to ensure that all correct and most up-to-date documentation has been received and that the identification of major hazards is comprehensive. The resulting list of higher risk units should be the starting point to identify Critical Operating Parameters (COP) in Step-2.

Step-2-Identify critical operating parameters (COP)

Critical Operating Parameters (COP), such as level, pressure, temperature, concentration, flow, and other process variables that have the potential to cause unacceptable risk to health, safety and environment or property damage are typically determined through as combination of engineering analysis, process hazard analysis, industrial standards, and experience. Process Safety Information which includes documentation related to the design, operation, and hazards of a process, is one of the valuable sources. Standard Operating Procedures (SOP) and Process Hazard Analysis (PHA) are other valuable resources where COP are discussed widely when operating parameters upon process or human deviations could lead to accident.

Step-3-Understand the process and its design limits

SOL workshop to be conducted with multidisciplinary team to review and confirm the following,

• Mechanical Design Limits (MDL), this defines SOL basis and operating beyond this range (min and max) is potential for catastrophic failure of process equipment and loss of containment

• Normal Operating Limit (NOL) and controls/-monitoring ways to maintain operating parameter within NOL, this defines SOL pre-alarm and operating beyond this range (min and max) is potential for SOL deviation, steps that are predefined/-taken to avoid such deviation

• Safety alarms/-interlocks, this defines Independent Protection Layers (IPL) value and operating beyond this value is potential for MDL excursion, automatic/-operator actions that are pre-defined to correct deviation and avoid such excursion

Step-4-Recognize the hazard and its characterization

Study of consequence of deviation is necessary for operator knowledge and awareness to know the potential severity and risk associated upon exceeding any safe operating limits or design limits. Study on process dynamics (laboratory/-computational) would help to understand the speed of development of scenario between the point of failure occurring in the process or basic process control system (with the potential to give rise to a hazardous event) and the occurrence of the hazardous event if the safety functions/-actions failed to perform in the way or within the time it is designed.

Step-5-Determine safe operating limits to control COP deviations

Based on the results obtained from step-3 (SOL basis, SOL Pre-alarm) and step-4 (Process Safety Time), safe operating limits can be determined assessing response actions, estimated time taken for operator response (detect, diagnose, respond) AND process response (process deadtime, reaction time) is less than the estimated process safety time to protect the equipment against excursions beyond conditions. This raw SOL value (lab-scale) shall be assigned to actual process and monitored for any opportunity to expand its operating window in step-6 (for example, driving SOL away from normal operating range) and for any changes required to predefined actions

2.2. Phase-2

This phase comprises of data analysis and variability analysis to optimize and validate SOL value based on likelihood and consequence of exceedance (industrial scale). Also, to address process of implementation, monitoring effectiveness of SOL and its determination.

Step-6-optimize and validate safe operating limits and its actions

To extract actual process data (industrial-scale) and conduct variability study to assess actual maximum and minimum value, normal operating envelope, SOL (raw value obtained in step-5) exceedance, response/-pattern of multi-variables interdependent to each other to optimize and validate SOL based on likelihood and consequence of exceedance (risk-based approach), also addressing any possible limitation in the lab-scale that is typically not captured during experimental set-up, for example, scenarios which develop quickly/-sensors with a high level of inertia.

Step-7-implement and monitor effectiveness of safe operating limits

The output from step-6 will be a set of safe operating limits for all critical operating parameters. Implementation should follow through MOC process (for existing plants) and may include updating Process Hazard Analysis that provides engineering and administrative controls applicable to the hazards;

Abstract Description

Operational Procedures that provide Operator actions required to avoid SOL deviations, Safe Operating Limits (SOL), actions required to correct any SOL deviation and avoid design excursion; Process Safety Information corresponding to 'technology': Safe upper and lower limits for critical operating parameters; and Mechanical Integrity Plan that is used to correct deficiencies in equipment that are outside acceptable limits (defined in step-6) to assure safe operation

Step-8-Review effectiveness of determining safe operating limits

As the process becomes established, regular reviews shall be carried out to check that the process of determining safe operating limits for major hazard installations is producing effective results (improves safety and productivity) and the benefits obtained (reduced safety incidents, improved knowledge on process safety time and response time/-actions, mechanical integrity programs) justify the resources used. It is likely that various optimizations will be possible as experience is built-up, and it may be possible to develop an industry-based (for example, Petrochemical or Pharmaceutical) or process-based (for example, batch or continuous) SOL methodology that could be reused across the site or multiple sites across the organization.

Session 7- (2)

Catastrophic Warning Signs and Symptoms in Engineering Projects – Be Aware & Beware!'

Presenting Author: Palaniappan Chidambaram, dss+

With growing demand for products, brown field and green field expansion projects continues to grow both in terms of size and complexity. Debottlenecking projects and plant modifications in existing facilities to improve operational performance is common to most organizations. While projects get completed and commissioned, it does not mean that all process safety considerations have been reviewed and integrated by competent personnel during the different stages of the project. Activities such as an audit or an incident investigation might reveal any gaps or latent issues that existed from design stage, and root causes associated with it.

The 1974 Flixborough incident investigation highlighted gaps such as lack of quality assurance checks on fabrication or installation except for leak check, absence of mechanical engineer to provide critical technical review related to design and lack of reference to RAGAGEPs for expansion bellows [1]. The 1984 Bhopal incident investigation revealed diminished design specification including use of low-quality construction material, cutting down on protection measures, lack of redundancy for critical safety measures and other gaps such as absence of emergency planning at local level prior to commissioning given the hazardous nature of the facility, not leveraging best practices from within the organization and application of lessons learnt from past incidents in new project [2].

Only several well established large multi-national organizations with extensive experience in operating hazardous facilities have their internal framework (what, when, who and how) to integrate HSE/Process safety in capital projects at different stages. CCPS Guidelines for integrating Process Safety into Engineering Projects is intended to help smaller and inexperienced organization with details on what needs to be addressed when and by whom. A common response in the industry to the question of whether you have integrated process safety considerations in projects is that we have planned for or completed the hazard analysis and risk assessment studies (e.g., HAZOP/SIL). While the need for integration of Process safety in projects is acknowledged, breadth and depth of integration at different project stages, ambit of process safety considerations varies with project.

For achieving excellence in process safety integration in capital projects, it is vital to focus on governance, processes, competencies, mindset and behaviors at different stages of the project. It is critical for an organization embarking on engineering projects to be aware of any warning signs and symptoms that could lead to catastrophic incident in future if it is not addressed systematically. This paper intends to highlight such warning signs/symptoms with examples based on observations in select areas (process hazard analysis, management of change, quality assurance, readiness to operate, project leadership and governance, project staffing, project documentation) made in different engineering projects as well as facilities transitioned to operational stage in diverse industry sectors (Oil & Gas, Refining, Mining & Metals,

Chemicals, Waste management) in Asia Pacific.

Common Warning Signs and Symptoms

- Incomplete and poor quality of hazard analysis and risk assessment studies
- Inadequate time and resource allocation
- Poor quality PSI or design that is not frozen used as basis
- Absence of Operations involvement and inadequate team participation
- Insufficient competency and process safety experience among team members
- PHA outputs not integrated effectively into operating procedures, emergency response plan

Abstract Description

• Poor understanding of the assumptions, boundaries and limitations stated in the

reports resulting in ineffective implementation (e.g., conditional modifiers in

LOPA studies, Test interval in SIL verification studies, QRA assumption register)

• PHA conducted without consideration to both major internal and external

incidents

• Increased reliance/trust on

contractors/vendors/licensors/consultants.

• Inadequate oversight in selection of facilitators

• Reliance on vendor or technology providers experience instead of specific study

involving them

• Use of contractors/vendors risk matrix resulting in inconsistent risk decisions

• Use of facilitators without right set of facilitation skills along with relevant

process and operational knowledge and experience

• Owner requirements and expectations related to hazard analysis and risk

assessment studies at different stages not included as part of contractual

requirements

• Risk assessments not completed or conservative and recommendations proposed primarily focused on training, procedures, alarms and preventive maintenance

• Absence of baseline PHA immediately after initial months of operations

Ineffective management of change

• Inadequate level of competency among project team to assess the risks associated with

change

• Poor understanding of importance of MOC process and understanding of what constitutes change among EPC and Project team

• Management of change limited to cost/schedule impact

• Assessment of impact of cost/schedule

• Major changes with impact on cost/schedule

• Owner' Management of change process not defined and included as requirements for

• Contractor to comply with

• Reliance on contractors to define and drive MOC process according to their

• Standards without review of its relevance and appropriateness

• Absence of Change register for documenting changes

• Weak ownership of MOC process by the project team

• Incomplete update of relevant process safety information and project documentation

• Lack of Participation of multi-disciplinary team or critical roles from vendors, technology or licensors or operation/Maintenance team

Mindsets and Behaviors – Underpinning strong reliance and trust on contractors/consultants/vendors and technology licensors-

It is important to be aware of the prevailing mindsets and behaviors in the project team and implications it might have on the project execution and process safety integration. Some common mindsets and behaviors observed are listed below:

• "We do not see the need to conduct FEED HAZOP as technology provider has completed the hazard evaluation and has incorporated the best practices and safeguards based on their operational experience of plants built in the past."

• "We have appointed experienced PMC to support our lean and inexperienced project team in reviewing the work and ensuring safe execution of the project on our behalf who has executed similar projects before."

• "Our bidders have confirmed that they will comply with the requirements specified in the instructions to bidder."

• "We believe that the EPC will provide all the relevant design basis information upon project completion."

• "The EPC contractors have extensive experience executing similar or bigger mega projects in the industry sector and they are operating reliably and safely without any incidents"

• "The EPC has provided us with the quality assurance process that will be implemented in the project."

• "The EPC has agreed to provide Independent PHA facilitators and QA inspectors."

• "The EPC contractor has a very good LTIR and LTIFR."

In the presentation, observations related to quality assurance, readiness to operate, project

leadership and governance, project staffing, project documentation will be included along with

overarching recommendations.

Abstract Description

Session 7- (3)

A Model for Winning Hearts and Minds to Enhance Process Safety

Presenting Author- Keng Yong Chan, AcuTech Consulting Group

Abstract Text:

Process safety management (PSM) has been focused primarily on technical and management ˜systems' that must be implemented that are essential to organize and implement process safety elements. But a clearly defined process for focusing on the underlying PSM culture is necessary to facilitate the management system to be effective and to have a breakthrough to the next level of performance. CCPS recognized this and formed a committee to understand the issues and recommend an approach. This culminated in 2014 in the start of a new CCPS guideline project Essential Practices for Developing, Strengthening and Implementing Process Safety Culture - Project # 249â€ led by AcuTech. However, even today there is an insufficient understanding of how' to create and sustain a culture that makes process safety enthusiastically followed.

Essential to the success of process safety management is an underlying culture that facilitates and motivates the entire workforce to place process safety in the right priority and context, and to have the principles become second nature to day-to-day activities. Often called winning hearts and minds, it is the concept of leading the group toward a common goal through positive example, motivation, and persuasion. Senior leadership through group supervisors must be focused on this effort and work continuously to demonstrate process safety leadership.

Natural leaders possess the ability to lead effectively even if not necessarily the designated structural leadership of the group. They can be encouraged to stand up and show their leadership through coaching and mentoring. These ambassadors of process safety help illustrate that process safety commitment permeates the entire organization and it is real and meaningful.

In an effort to create an objective measure of culture performance, AcuTech mapped key PSM culture references and helped frame a model of essential elements of a PSM culture initiative for the CCPS guidelines. These formed the basis of a holistic model including the most important factor of a principle addressing Leadership and Process Safety as a Core Value.

AcuTech developed a set of measurable attributes for each of the elements and then assessed the management, group, and individual level to determine the degree of variation from these principles. This was used to develop a workplan for improvement based on a scoring system to allow for the site to benchmark their performance with others.

periods to cost of repairing as well as coaching agreements of the young professionals in PDO.

This tool has proven its effectiveness in reporting the key areas of improvement and is part of the company journey towards Goal Zero in Process safety incidents as well as a key performance indicator in the step change program in Asset Integrity Process Safety Management (AIPSM). In addition to that, it serves as a vital check to quickly identify the high-risk issues in each cluster, for the management to allocate the right support and required resources. Due to the dynamic nature of business challenges, the tool can be easily enhanced and optimized to capture the new day to day issues.

Session 8- (1)

Invited speakers. Abstract not available.

Session 8- (2)

Invited speakers. Abstract not available.

Session 8- (3)

Invited speakers. Abstract not available.

Session 8- (4)

Incorporating Process Safety into Energy Transition, Lessons Learned from US' Journey

Presenting Author- Jatin Shah, Baker Risk

Abstract Text:

India other nations are in a race towards saving our planet from climate change, by finding ways to diversify our energy needs through no carbon and low carbon sources. USA is in this same journey and is spending substantial government and private funding to achieve the carbon reduction goals. While a lot of focus goes on different technologies to produce these sources, relatively less attention is given to producing, transporting and using them safely. This not only results in safety incidents, but also reduces public confidence in these energy sources. One bad incident can impact the whole industry. This paper aims to share lessons learned from various projects in the US where process safety has been incorporated successfully in the project life cycle, while meeting the schedule and budgetary requirements of the project. By incorporating process safety early and with proper due diligence, the project implementation goes much smoother both from compliance and safety perspective, but also increases employee and public confidence in the project thereby allowing for a quicker adoption of the technology. The paper will share a case study of various studies for a hydrogen facility and it's overall impact.

Session 9- (1)

Invited speakers. Abstract not available.

Abstract Description

Session 9- (2)
Invited speakers. Abstract not available.

Session 9- (3)
Invited speakers. Abstract not available.

Session 9- (4)
Risk Assessment of Hydrogen for Use in Hazardous Process

Presenting Author- Abhineet Raj, Tata Steel

Abstract Text:
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 H_2 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 H_2 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 1 to inject such large volume of hydrogen in any Blast Furnace st

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

Abstract Description

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 furnace's injection systems.

Session 10- (1)

Invited speakers. Abstract not available.

Session 10- (2)

Process Safety Incident Happened in Petroleum Refinery

Presenting Author- Sanjay Raj Kishor Singh, OISD

Abstract Text:

Incident: Fatal Incident due to fire in wet slop oil pump house.

Loss/ Outcome: Property Damage and One fatality

BRIEF OF INCIDENT

Fire occurred in the wet slop pump house due to accumulation of hydrocarbon vapor. Electrical cables in the wet slop pump building were damaged and a contract employee suffered burn injuries in the fire. He was admitted in a hospital and succumbed to his injury after seven days.

OBSERVATIONS

1. The complete workforce in ETP, including maintenance, was outsourced.
2. A single storied building housed the two wet slop pumps. The two wet slop pumps were situated in basement of the building at 5.7 meter below ground level.
3. Pump building was provided with windows on three sides with entrance on south side. Four flame proof exhaust fans were provided just below the roof of the building.
4. Due to low discharge flow from both the wet slop transfer pump, strainer cleaning job was planned.
5. A work permit was issued for wet slop transfer pump suction strainer cleaning job.
6. Since no low point drain was available in circuit hence practice was followed to drain the suction and discharge line hold up material by partially opening the strainer end cover.
7. On the day of incident, the pump suction strainer end cover was loosened.
8. The dripping of the Class -A hydrocarbon continued even after 15 minutes due to probable passing of the pump suction valve. The area operator tried closing the valve further, but no improvement was observed.
9. Despite running all four exhaust fans, the area operator sensed hydrocarbon smell and requested electrical supervisor to provide a portable exhaust fan.
10. Electrical technician had provided temporary electrical connection for portable exhaust fan in pump building.
11. Temporary connection was taken from Flame proof distribution board located at the ground floor inside the building, however the distribution board cover was not closed after providing the connection.
12. Fire occurred on switching on the portable exhaust fan, and area operator sustained burn injury.

ROOT CAUSE

Source of Hydrocarbon: The pump and pipeline holdup material, being emptied on the pump floor for strainer cleaning job, may have created a pool of slop on the floor. The liquid pool on the pump floor must have created a vapour cloud well above the LEL level.

Source of Ignition: Source of ignition was likely the electrical plugin for the temporary exhaust fan that may have generated spark while switching on, leading to ignition of the hydrocarbon/ air mixture.

SHORTCOMINGS

1. No bridging document defining the roles and responsibilities of involved parties was prepared.

2. Handover of document or imparting of any instructions related to safety norms and work practices, being followed by organization, was not done.

3. No practices related to confined space were being exercised for the pump house including permit issuance.

4. It was observed that the circulation of the air was restricted to the grade level only because of the entrance opening/ windows/ other openings. The exhaust system was ineffective in providing any draft in the basement side.

5. Permit did not cover risk associated with the job. Job safety analysis was not evident.

6. No permit was issued to provide temporary electrical connection at pump house building.

7. Temporary portable exhaust fan was not flameproof.

8. No near-miss/ unsafe-act/ unsafe-condition reporting or safety audit was being conducted by the contractor.

9. No participation of contractor personal in the safety committee.

10. Awareness related to plant related hazards among contractor personnel was inadequate.

Abstract Description

RECOMMENDATIONS

1. Develop proper draining facility for pumps.
2. Electrical equipment integrity shall be ensured
3. Confined space entry permit supplemented with a hot or cold work permit shall be followed as per the type/ nature of work inside the building.
4. Bridging document shall be made to ensure defined roles and responsibilities of all the involved parties.
5. Necessary modification to ensure proper ventilation of basement area.
6. Training to the contract manpower shall be ensured before taking charge and subsequently at defined periodicity.
7. Risk assessment shall be revisited to adequately cover fire scenario in ETP area.
8. Hydrocarbon gas detectors shall be installed.
9. Conduct safety meeting with contractors at defined intervals.

Session 10- (3)

Invited speakers. Abstract not available.

Session 11- (1)

Walk the Line - an Effective Program to Avoid Lopc Due to Line-up Errors

Presenting Author- Mohit Gharat, Lubrizol

Abstract Text:

Analysis of several process safety incident data indicated that at least half of the Loss of Primary Containment (LOPC) incidents occurred due to line-up errors during either startup or while taking equipment back in service after maintenance activity. Causes would be valves left open, open-ended lines on energized pipe and vessels.

Incident case study 1: Corrosive material splashed on the body of Maintenance Contractual worker

Work for the replacement of part of drain header behind Clevage product circulation pump in the Phenol plant was in progress. Maintenance contractual worker was carrying out the activity of bolt changing as a part of preparation of actual work. Authorized work permit was issued for the job, drain header was isolated, drained and decontaminated. While changing the bolts of flange joint of isolated part of drain header, spanner of contractual worker accidently hit to the handle of ball valve on the bleeder of pump discharge line. Bleeder valve got opened and as there was no end plug, Clevage product containing 40% Phenol and 30% Acetone at the pressure of 5.5 - 6 Kg/Cm2 got splashed on the body of contractual worker. He got chemical burn injury on the left leg and right arm. While removing contaminated clothes it got spread to some portion of abdomen.

Incident case study 2: H2S gas release at effluent pump station

While unloading Sodium Hydrogen Sulphide (NaHS) tanker, bleeder on unloading line remained open due to oversight of operator. Around 6000 Kgs of NaHS spilled and went to process sewar. Process sewer valve in the area was open so spilled material went directly to effluent pump Station. Effluent pump station was having acidic material which reacted with NaHS and resulted in the release of reportable quantity of Hydrogen Sulphide gas and Tier 1 process safety incident. The investigation found that the operator forgot to close the bleeder valve, causing the release.

Incident case study 3: Tier 3 Significant LOPC from GAF (Sock filter)

Area operator began circulation through recently changed GAF (Sock filter). After the operator left the area, the filter began leaking through the improperly tightened lid, remaining undetected by all four area operators on shift for approximately 3 hours. Total 320 Kg material was lost. Investigation indicated that only 2 out of 4 nuts of the filter housing were tightened.

Does these scenarios sound familiar? It likely will. In all such cases, corrective action includes Safety stand downs, disciplinary action or terminate the operator. Blaming an operator when line-up errors occur seems easy but doesn't address the underlying problem. We never will eliminate these human-error causes of process safety incidents until we go beyond simply noting operator left valve open and answer the question Why did the operator leave the valve open?

Fundamental questions could be:

- Did the operator intend to leave the valve open?
- Was an expectation set for performing work?
- Did the operator understand their role in the activity?
- Did the operator possess the skill to perform the role?

Walk the Line Program

In 2015, the American Fuel & Petrochemical Manufacturers (AFPM) launched Walk the Line program in partnership with member companies as part of the AFPM and American Petroleum Institute (API) Advancing Process Safety Program.

Walk the Line is a practices-sharing program designed to help prevent operator line-up errors that cause approximately 20% of all process safety

events. This program is successfully raising awareness of operator line-up errors and providing simple solutions to prevent these types of mistakes in the future. Walk the Line materials include scenarios, training, conduct of operation practices, operational discipline practices, and operational readiness practices.

Walk the line addresses errors and mistakes, using a conduct of operations management systems model consisting of tools enabling operators to understand with 100% certainty where material / energy flows each time, they make a change in the manufacturing unit. The model introduces discipline not only for operators, but for leaders and technical people too. It can change behavior by providing a culture of setting the expectation for accuracy in line-up and giving operators the tools to ensure accuracy in line-up.

Human error consistently accounts for about 30% of process safety incident causes. To understand why 30% of process safety incidents involve people making mistakes, we first must improve our incident investigation cause charts and causal factors. Expanding human factor causes reveals that we can categorize these incidents in simple familiar terms. Walk the Line addresses these causes.

A further breakdown of the human factors reveals five key conduct of operations causal factors:

• **Process safety culture** and intentional competency development - As a leader, we might have missed to enable operators with the right tools and competencies to prevent line-up incidents.

• **Operational continuity** - Many times plant line-up is changed, and operators are not aware of the change. In this context, continuity refers to the things that operators do not understand the current line-up of the plant both between and among shifts, since the last time worked.

• **Open bleed valve management** - It either occurs because an operator energizes a line with an open end or bleed valve, or another operator or craft opens the valve without communicating to the equipment owner.

• **Unit line-up** - simple mistakes in making a piping line-up to an unintended destination.

• **Operational readiness** - The data reveals that while line-up errors occur during all phases of operation, many occur during transient operation; particularly, equipment start-up and return to service. This phase of operation may involve frequent line-up changes and affords the opportunity for mistakes. Examination of these incidents usually reveal that an inadequate level of commissioning is performed by the equipment owner.

Walk the Line considers the Substitution Test corrective actions for unintentional errors and combines with a conduct of operations management system model for sustainability.

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Operational Continuity - The tools operators use to understand the operational line-up of a plant between and among shifts.

- Shift handover, shift instructions, shift change meetings
- Operators shift notes
- Unit walk through / P&ID walk down
- Independent verification
- Evaluation rounds
- Bypass boards
- Open bleeder management tools
- Line up tools
- Operational readiness tools - Pre-start up Safety review
- Pressure hold test / soap testing

Final words:

Adopt a belief that all process safety incidents are preventable and start with a goal of zero LOPCs caused by operator line-up errors. Of all LOPC incidents, those related to incorrect line-ups and open ends seem easiest to correct.

Recognize which operating discipline and operational readiness tools operators require to understand the current operating state of the processing unit. Set the expectation that an operator must know with 100% certainty where energy will flow each time a change is made to the process. If that person doesn't know with 100% certainty, then walk the line!

Implement the Tools, Implement Discipline. **The Most Effective Tool to Consider... Walk the Line!**

Session 11- (2)

Invited speakers. Abstract not available.

Session 11- (3)

Invited speakers. Abstract not available.

Session 12- (1)

Marine Terminal Risk Assessment in Japanese Refineries Based on International Maritime Safety Guidelines

Abstract Description

Presenting Author - Kiyoshi Ujimine, ENEOS

Abstract Text:

Marine terminal facilities for receiving and shipping petroleum products have specific hazards related with large amount of flammable material handled, potential miscommunication between terminal and tankers, limited evacuation routes from a berth in case of emergency event, etc. Once a severe accident occurs, such as major spill or fire/explosion, negative impact on personal safety, assets, and environment could be extremely high. In fact, there have been serious accidents in the world, such as an explosion on a berthing tanker, personnel injury or death due to the sudden release of a broken mooring line generally called 'snap-back' Since these factors are not typically incorporated into process safety knowledge used in refining industries, process hazard analysis (PHA) with specific safety guidance for marine terminals needs to be performed.

Safety requirements for marine terminals handling petroleum products are described in guidelines by the Oil Company International Marine Forum (OCIMF) and the International Safety Guide for Oil Tankers and Terminals (ISGOTT). In our company, there was little experience of marine terminal risk assessment except for some sites which had had international review opportunities. In addition, we don't have internal experts of process safety in maritime facilities and operations who understands safety guidelines shown above very well.

Therefore, we started risk assessments of marine terminal facilities in refineries with an external consultant who is familiar with safety guidelines as a leader, applying OCIMF Marine Terminal Baseline Criteria (MTBC) and ISGOTT 6th Edition as the assessment criteria. This activity consists of preparing answers to MTBC questionnaire with reference documents to be reviewed by the consultant in prior to the site visit, staff interviews and field survey at the site. The results of the site-self assessment using the MTBC questionnaire showed that compliance with the MTBC requirements at refineries with no past experiences of marine terminal assessment was just under 90%, whereas at those with several times of the assessment, compliance was above 95%.

During the first assessment, the external consultant identified several areas for improvement, including:

- Vessel acceptance criteria of the terminal are not based on the displacement which affects mechanical strength limitation of the berth, instead the deadweight tonnage (DWT) is used in the criteria.

- There is no backup power supply to gangways in the event of a primary power failure, making it difficult for a vessel alongside to leave a berth.

- A mooring line is neighboring to ship/shore access routes, potentially causing personnel injury or death in event of a snapback.

- Insulation flange is not installed on loading arm. Although bonding cable is connected as required by domestic regulation, the International Maritime Organization (IMO) recommendations urge port authorities to discourage use of ship/shore bonding cables and to adopt the recommendation concerning the use of an insulating flange.

- Some types of valves that are important to process safety are not present, such as check valves in cargo unloading lines to prevent product from flowing back into the ship, or isolation valves at the shore end of cargo transfer lines to limit the amount of spillage.

- There is only one access route between the berth and the shore and no firewall in the evacuation route, making it difficult for personnel on the berth to escape in the event of fire. If a boat is used as a secondary means of evacuation, it is necessary to make a formal evacuation procedure and mark the boat evacuation route/area on the berth.

- Some emergency scenarios (e.g., major leakage of flammable/toxic materials, vessel collision to the jetty, vessel breaking away from berths, etc.) are not included in the emergency response plan.

Potential risk scenarios for each improvement item are to be assessed and controlled in the site risk management system. In addition, some of these comments has been reflected into company standards of marine facility design.

Session 12- (2)

A Highly Skilled Workforce, Competent and Versatile Work Force Will Make a Vital Contribution to Enable Disciplined Safety Culture in Avoiding Process Safety Incidences

Presenting Author- Avinash Shinde, Galaxy Surfactants Ltd.

Abstract Text:

Title: Enhancing Process Safety through Intentional Competency Development: A Structured Approach

Introduction

Why Competency Assurance Program is important criteria ?

As per shell study

71% of incidences are due to Lack of Competence

50% are related to not following Procedure.

Major process Safety incidences happened would have been avoided or consequence would have been minimised with better approach of competency assurance program.

A highly skilled ,competent and versatile work force is highly essential which ensures Operational discipline across all sections helping to build

Abstract Description

Process Safety culture to avoid Process Safety Incidences.

In the pursuit of excellence in process safety, intentional competency development is fundamental to managing risks effectively and ensuring operational reliability. This abstract explores a structured approach in competency development, informed by a detailed competency matrix and training framework. It provides insights into the required competencies for various roles within an organization and how these competencies can be developed and maintained through a combination of classroom training, field-specific experience, and regular evaluations.

Step 1 - Identifying Key Roles

Its critical to identify key roles and train them on the requirement of Process Safety Management

1. Corporate Senior & Top Management
2. Factory Manager
3. Manufacturing In-Charge
4. Site Safety Lead
5. Site Process Safety Lead
6. Site Mechanical Lead
7. Site Electrical Lead
8. Site Instrumentation Lead
9. Site QA Lead
10. Site NPT Lead

Step 2 - Identifying Key Competencies

The required competencies are grouped in two basic Elements Risk Identification & Risk Management. Following skills/tools were kept in the group.

1. Risk Identification
1. Process Hazard Identification
2. Process Safety Information
3. Job Safety Analysis
4. Behaviour Based Observation/Safety Interaction

5. Aspect/Impact & HIRA
6. Auditing
2. Risk Management
1. Management of Change
2. Asset Integrity
3. Permit System
4. Standard Procedures
5. Decision Making

Step 3 - Building Training and Development Framework

The development of competencies is supported by a structured training and development framework, which includes classroom training, field-specific experience, evaluation certifications, and refresher training. This framework is categorized into various levels, each with specific training requirements and expectations as per the given table.

Name of Level		Classroom training	Field Specific Experience	Evaluation Certificate	Refresher Training	What is Expected?
Level - 1	Awareness	2 hour - Overview Training topic Wise	NA	Yes	Years	1. General Knowledge of subject area. 2.Able to conduct assigned task with guidance & Monitoring
Level - 2	Knowledge	7-8 hours of specific Topic	NA	Yes	Every Year	1.Apply specific knowledge to subject area 2. Able to work with direction and supervision
Level - 3	Skill	7-8 hours of specific Topic	More than 2 years on specific topic	Yes	Every Year	1. Advance Knowledge about subject area 2. Able to work independently 3. Applies procedure consistently and understand the concept.
Level - 4	Expert	7-8 hours of specific Topic	More than 5 years on specific topic	Yes	Every 2 Years	1. High level knowledge of subject area 2. Able to work independently 3. Develop new procedures and changes 4. Able to troubleshoot.
Level - 5	Mastery	7-8 hours of specific Topic	More than 10 years on specific topic	Yes	Every 3 Years	1. Is recognised authority in subject area and Mentor 2. Develop new procedures, modify exiting method and sets policy 3. Able to troubleshoot process and develop others.

Step 4 - Building Competency Matrix

The competency matrix delineates key roles and their associated competencies across elements of risk identification and management. Each role, from Corporate Leaders to Shop Floor team has defined expectations and competency levels under two categories Risk Identification & Risk Management in areas such as Behavioral-Based Safety (BBS), Process Hazard Analysis (PHA), Process Safety Information (PSI), Auditing, Job Safety Analysis (JSA), Asset Integrity, Permit Systems, Standard Procedures, and Decision Making. The roles are categorized by hierarchical levels, each with distinct competencies necessary for effective process safety management.

Conclusion

Intentional competency development is a strategic approach to enhancing process safety through targeted training and development. By systematically addressing the competencies required for various roles and implementing a structured training framework, organizations can improve their risk management practices and achieve higher safety standards. The competency matrix and training levels outlined provide a comprehensive guide for developing a robust safety culture, ensuring that every role contributes effectively to process safety and operational excellence. Through ongoing development and evaluation, organizations can build a resilient and knowledgeable workforce, capable of navigating the complexities of process safety and driving continual improvement.

Session 12- (3)

You Have Safeguard in Place, Sounds Promising; Have You Tested It? Act before It Is Too Late !!
Presenting Author- Harigopal Attal, Freelance Consultant

Abstract Text:

You have safeguard(s) in place; Sounds promising, but have you tested it? Act before it is too late.

Risk Management is an integral part of everyday life... The biggest risk is not taking any risk. In a world that is changing quickly, the only strategy that is guaranteed to fail is not taking risks, said Mark Zuckerberg.

In other words, life and risk are the two sides of the same coin, and you cannot escape them. Whether you like it or not, life is a series of events and trade-offs, with challenges from birth to death. You are considered successful if you navigate and manage the risk adequately. Managing the risk adequately, be it in adverse life situations or at work in an industrial situation, fundamental concepts are the same, and it implies that identifying adequate safeguards corresponding to the risk is a crucial step.

Applying Process Hazard Analysis (PHA) techniques is a widespread practice in the Risk Management process to reduce the risk to a tolerable level. One of the critical features of these varied techniques (HAZID, HAZOP, What-If, etc.) is to identify an adequate safeguard(s) corresponding to the level of risk in the avoidance of significant catastrophes be it Oil and Gas, Petrochemical, Chemical, Pharmaceutical, Power or any other industry. Looking at any major or minor incident report, you will find the causal and root cause of any incident is centered around failing to properly appreciate the role of an adequate safeguard which could be Plant (physically engineered controls), Process (practices and procedures), and People (competency and training). However, the root cause of any incidence is a lack of understanding and application of the nuances of risk management techniques at the organization various levels, which can yield potentially undesirable situations.

Suppose your goal is to improve Process Safety culture and you are concerned about preventing incidents. The focal point of any organization Process Safety and Occupational Safety initiatives should be the SAFEGUARD Other terms, such as independent Protection Layer (IPL) and Barriers, denote a safeguard.

This paper will explore what safeguards are and why they are needed, the hierarchy of safeguards, the criteria for validation, why safeguards fail, how to audit safeguards, and how to address safeguards in any incident investigation.

Keywords: Process Safety Competency, Auditing, Safeguard.

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- Develop safety procedures, emergency plans, incident protocols.
- Build process safety capabilities in organisations post collaboration.

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Day 1	Day 2	Day 3
Remembering Seminal Events & Learning **Anne O'Neal**, Chevron **Part 1**	European Way of doing Process Safety **Tijs Koerts**, EPSC	Interview with **Hugues Bourgogne**, Executive Vice President Safety, Environment & Asset Management, Shell Quantitative Risk Analysis Methods [build on CCPS guidelines] **Dr. Nazmul Rahmani**, Professor of Safety
Lessons learned via the Loss Prevention Bulletin – 50 years of publications **Fiona McLeod**	Interview with CSB Board Members Informal Discussion on CSB Learning and Knowledge Sharing	Senior Leader Interview P66 and Chevron **Marissa Badenhorst,** Chevron and **Todd Denton,** P66
Historical review of explosion research and incidents **Mike Johnson**, DNV	Step change for safety barrier assurance videos **Step Change in Safety**	Case study on culture change **Vahid**, BCECA My journey towards process safety **Ron Stockfleth**, Shell
2025 Calendar of Process Safety Incident Case Studies **Peter.Davern**, UL	Interview with **Dr Fawaz Bitar**, Senior Vice President Health, Safety, Environment & Carbon, bp	Panel: CPI Operations Senior Leaders' views on how they drive Process Safety Excellence" **Dennis Hendershot** et al
Process Safety Education Introduction Dr. Faisal Khan, Director, MKOPSC, Texas A&M	Understanding the Canadian Standard **Adrian**	
PS Education – UPSLI: Faculty Workshops, Students Boot Camp, and SAChE Modules **Tracy Carter,** Northeastern University	Process Safety Fundamental implementation at Mol-Group **Devecseri Mate Tamas**, Mol-Group	Gas explosion modelling - Looking back **Kees van Wingerden**, Vysus Group
Introduction to Process Safety & Risk Engineering **Dr. Faisal Khan**, Director, MKOPSC	Progress in Understanding Process Safety Culture -No More, No Less **Dr. Kenichi Uno**, Japan Industrial Safety Competency Center	
Effective learning from incidents **Tijs Koerts**, EPSC	Improving Process Safety Knowledge **Murphy Steven**, Syngenta	Useful Probability Distribution and their use in Risk Analysis **Dr. Tanjin Amin**, Lecturer of Safety & Risk Engineering
Senior leader interviews **Dame Judith** Hackitt, **Ken Rivers, Gus Carroll** Improving communication- **Traci**	Lessons in good design – OPERA risk engineers **OPERA**	
Research into Deflagration to Detonation Transition (DDT) **Scott Davis**, Gexcon	Historical review of fire research **Ian Bradley**, PFPNet & **John Evans**, Thornton Tomasetti	Human Performance in Process Safety **Hans Schwarz**, EPSC
Industry collaboration to improve Process Safety awareness **Safety Together**		Foundation of Process safety **Pete Lodal**
Remembering Seminal Events & Learning **Anne O'Neal**, Chevron **Part 2**	Elements of Risk, Uncertainty and Risk Analysis **Dr. Nazmul Rahmani**, Professor of Safety CCPS Global Summit in Mumbai	2023 IOGP stats **Luca** Introduction to Human Factors **Chartered Institute of Ergonomics and Human Factors**
Nimrod video **ACT Auatralia**		

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Day 4	Day 5
Interview with **Michel Charton**, Senior Vice President Health, Safety & Environment, TotalEnergies	Review of Probability Basics **Dr. Edison Sripaul**, Manager Lab Safety
ONR culture survey **Nick Shaw** Process Safety Fundamentals **Dirk Roosendans**, TotalEnergies	A look back on developments in fire modelling and where to go next **Bjørn Erling Vembe, DNV**
Advances in structural design against fires & explosions **Dr Ramsay Fraser**, bp & **Dr Ali Sari**, Omega Risk	Understanding management systems – a university students perspective **Pierre LeClech**, UNSW Hazard screening using RAST/CHEF and OBRA **Pier-Jan Hettema**, dsm-Firmenich
Evaluation of Human Error Probability in Responding to Safety Alarms (HEPIRA) **Els Janssen**, TotalEnergies	Evaluating and Protecting Liquids That Burn: Understanding the Hazards and Paths to Providing Protection **FM Global**
To Err is Human, to Forget is Disastrous **B. Karthikeyan**	Chemical Hazard Analysis **Annik Nanchen**, TuvSud
Empowering Process Safety Hazard Awareness and Technical Learning in Energy Operations **Laurence Ledrut**, Origin Energy	Asphyxylation Hazards **Dan Benton**, GSK
Digitalization **Tijs Koerts**, EPSC Leak detection - early warning **Xavier Watremez**, TotalEnergies	Application of Dynamic Risk Analysis as tool for safer Digitalization **Dr. Zaman Sajid**, Research Engineer
Supercharge your HAZOP **Louise Whiting**	Management of battery hazards **Dirk Roosendans** & **Antoine Dutertre**, TotalEnergies
Explosion Hazards and Structural Response **Darren Malik and Travis Holland,** BakerRisk	Process Safety and the Energy Transition
Validation of the health of critical safeguards **David Kelly**, ExxonMobil	Energy Transition **Dirk Roosendans**, TotalEnergies
Basics of Electrostatics. Self heating in Silo's **Luke Matchett**, Cargill	Process safety and the energy transition: Strength of knowledge in risk assessments **Trygve Skjold,** University of Bergen
tbd **Matthias Rizzi**, Arxada Probabilistic modelling in risk analysis - Strengths and weaknesses **Ingar Fossan**, Safetec	Artificial Intelligence in Process Safety **Dr. Rajeevan Arunthavanathan**, Research Associate
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