8th Annual CCPS Canadian Regional Meeting

Meeting Hosted by Keyera

Thursday September 7, 2023, at 08:30-16:30

Opening

- Fred Henselwood – Manager Process Safety, NOVA Chemicals
- Anil Gokhale – Chief Operating Officer, CCPS

Remembering Brian Kelly

A passionate advocate of Process Safety

- Joined CCPS as Consultant in 2005
  - After 34 years at Imperial Oil & Syncrude
- Key driver behind the 'Foundations of Risk Based Process Safety' (a.k.a. the Process Safety Bootcamp)
- Latest work - Incident Investigation Course

Time	Subject	Speaker
08:30	**Check-in**	
09:00	Opening	Anil Gokhale (CCPS) Fred Henselwood (NOVA Chemicals)
09:05	Welcome Comments	Glen Worobets + Joanna Williams (Keyera)
09:10	Safety Moment – Video (Video has not been released yet)	Robert Waterhouse (Energy Safety Canada)
09:25	Hybrid Mixture Explosions	Anton Schrader (Dalhousie University)
09:45	Quantitative risk assessment of a gaseous hydrogen refueling station in Canada (slides not shared)	Anirudha Joshi (University of Alberta)
10:00	CSA Z662 – Construction of Pipelines CSA Z663 – Land Use Planning for Pipelines	Jyoti Patel (Resolute RMS) Adrian Pierorazio (Jensen Hughes)
10:15	**Break**	

Welcome

- Glen Worobets – Process Safety Manager, Keyera
- Joanna Williams – General Manager Safety and Operational Excellence, Keyera

- A big Thank You to Keyera for hosting us today, and for all their work behind the scenes to make this session happen

Safety Moment

- Robert Waterhouse – Program Manager, Industry Development and Support, Energy Safety Canada

Safety Moment

- Watch the Energy Safety Canada YouTube channel as the video has not been released
- Energy Safety Canada - YouTube

Questions and Comments

- Link to an earlier video done by Energy Safety Canada
  - https://youtu.be/EyVRyP3INss
  - Re-creation of the events that led to the death of an oil and gas worker

Hybrid Mixture Explosions

- Anton Schrader, Dalhousie University

Hybrid Mixture Explosions

1

Anton Schrader
Dalhousie University
Sept. 7th 2023

Contents

Scope

- Dr. Paul Amyotte of Dalhousie University awarded Imperial Oil University Research grant titled *Inherently Safer Transfer of Polymer Particles*
- Funding for a 2-year graduate level research project to study hybrid mixture explosions consisting of dust and gases present at Imperial Oil Limited.

Motivation

- At the IOL facility, the formation of dust and gas clouds is feasible, meaning that hazardous conditions are feasible. The goal of this work is to investigate these mixtures so that proper safety measures may be implemented

Objectives

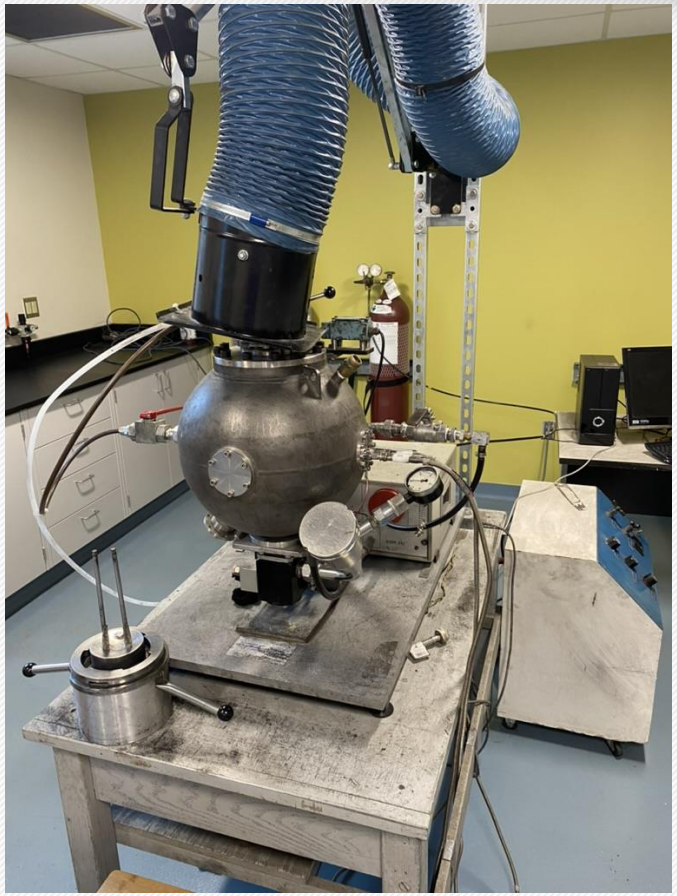
- Apply the principles of inherently safer design to prevention of dust explosions.
- Avoidance of the formation of fine-size dust clouds and hybrid mixtures (combustible dust and flammable gas) will be emphasized by means of experimentally determined explosion regime diagrams.
- Explosion boundaries for inherently safer transfer of polymer particles will thus be made available to process designers and operators.

Past Work

- In a previous research grant, effect of particle size and gas admixture to dust were investigated
- Decrease in particle size leads to an increase in dust explosibility
  - Minimum explosible concentration decreases (MEC)
  - Maximum rate of pressure change increases $((dP/dt)_{max})$
  - Minimal impact on maximum explosion pressure (P_{max})
- Addition of hydrocarbon gas increased explosibility
  - Explosions possible under MEC of dust and LFL of gas
  - Maximum rate of pressure change increases $((dP/dt)_{max})$
  - Minimal impact on maximum explosion pressure (P_{max})
  - Leaner dust mixtures have higher values for both $(dP/dt)_{max}$ and P_{max}

Apparatus

- Siwek 20L Chamber
  - P_{max}
  - K_{St}
  - Minimum explosible concentration

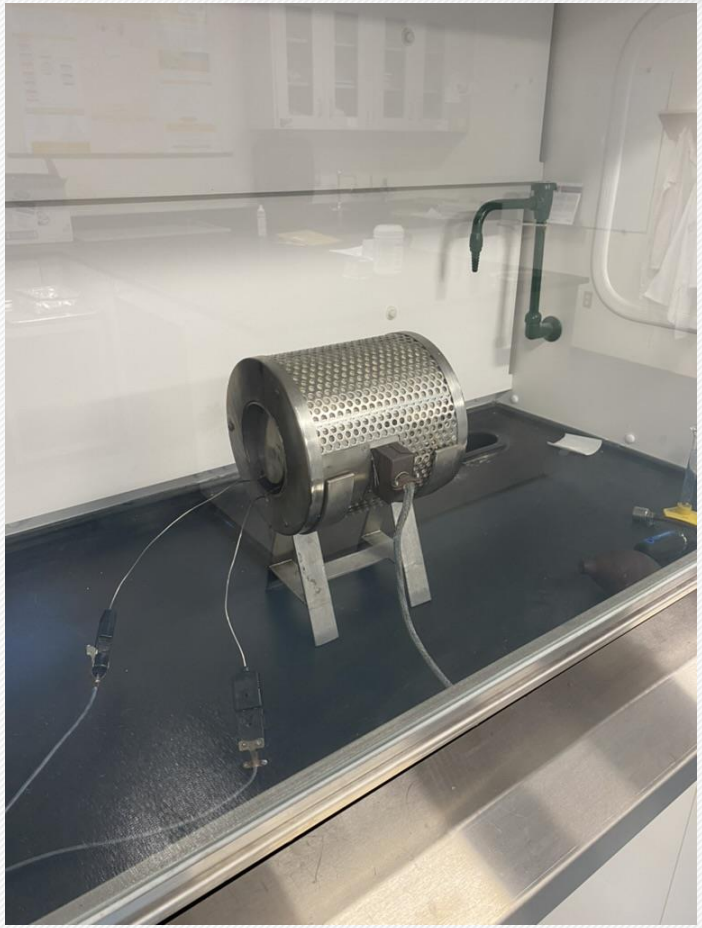


Apparatus

- MIKE-3
  - Minimum ignition energy

Apparatus

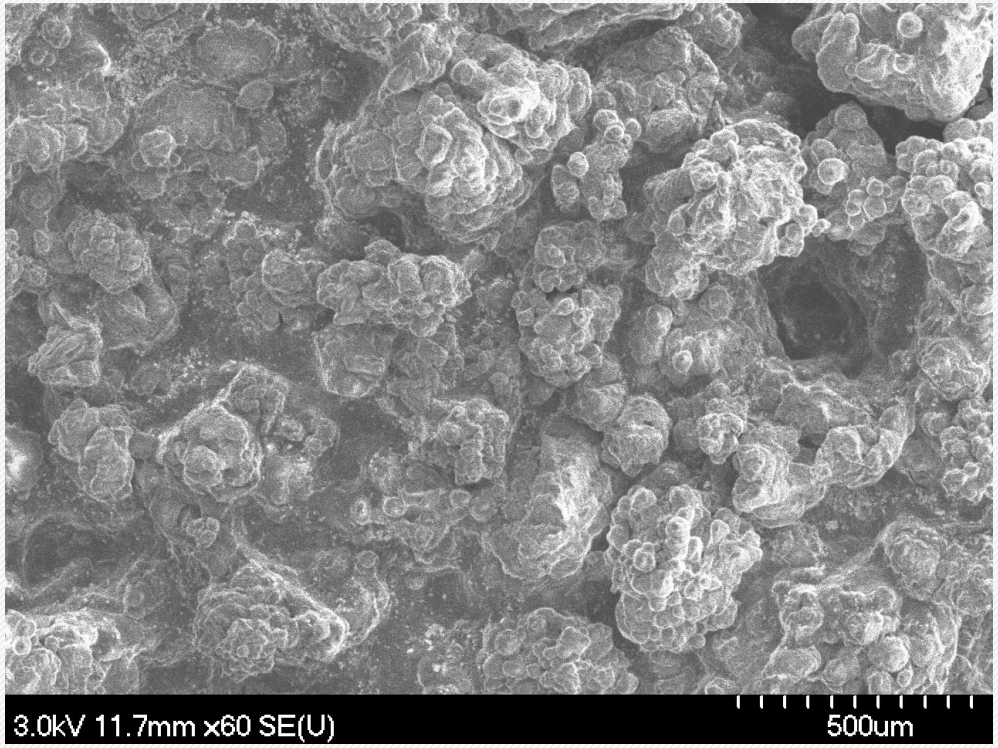
- BAM Oven
  - Minimum ignition temperature



Experimental Results

Dust Characterization

- Received sample had large particle size (D_{50} = 777 µm)
  - Sample was sieved using US35 mesh, resulting in two batches of sample, processed and unprocessed
  - Experiments performed on unprocessed and processed samples
- Moisture Content: 0.023%
- SEM Images taken of sample



Explosion Parameter Testing

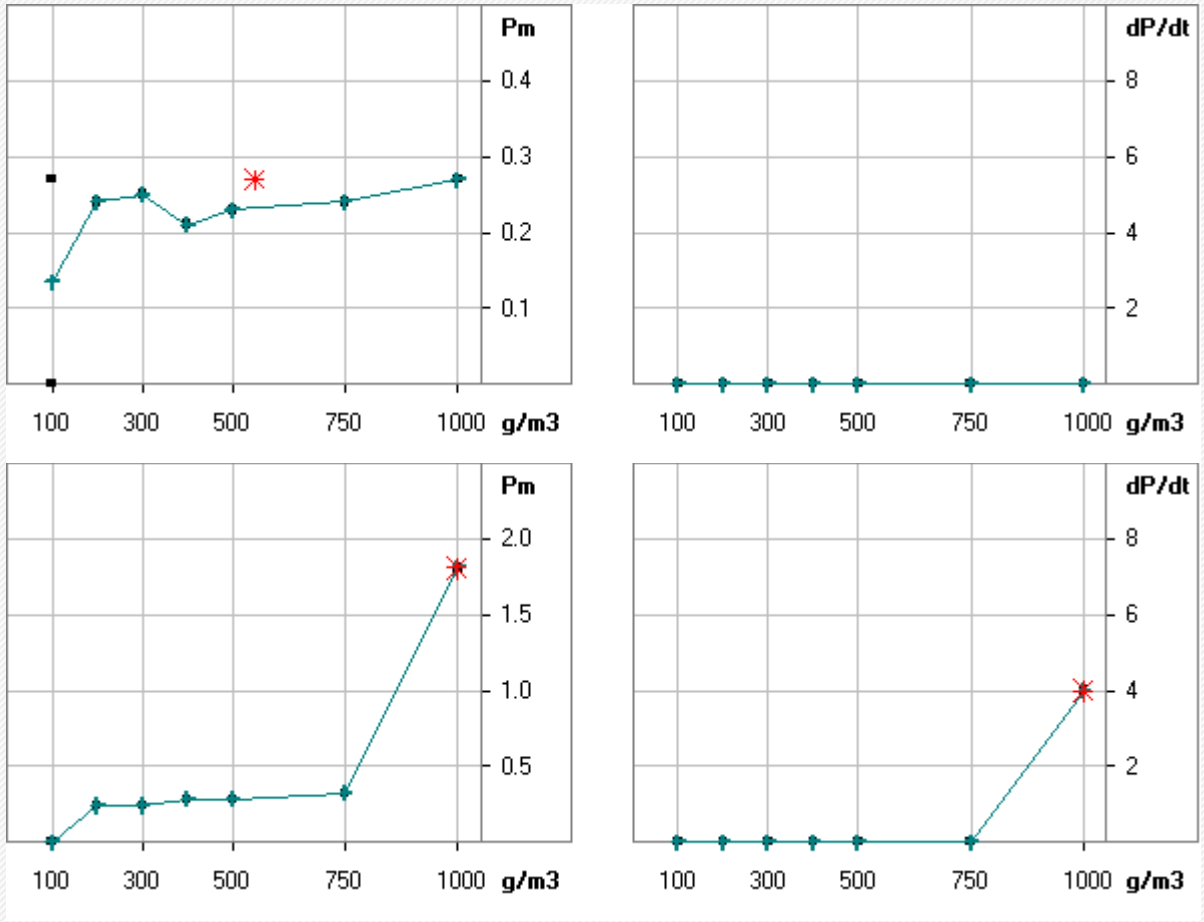
- Explosion parameter testing performed on dust
  - Minimum ignition energy (MIE)
  - Minimum ignition temperature (MIT)
  - Minimum explosible concentration (MEC)
  - Maximum explosion pressure (P_{max})
  - Size-normalized rate of pressure change (K_{St})

Minimum Ignition Energy & Minimum Ignition Temperature

- MIE found to be >1J for both samples
  - Trials performed with and without inductance and at varying delay times
- Both samples tested found to have an MIT of 450°C
- Results consistent with MIE and MIT for this dust in previous work at Dalhousie

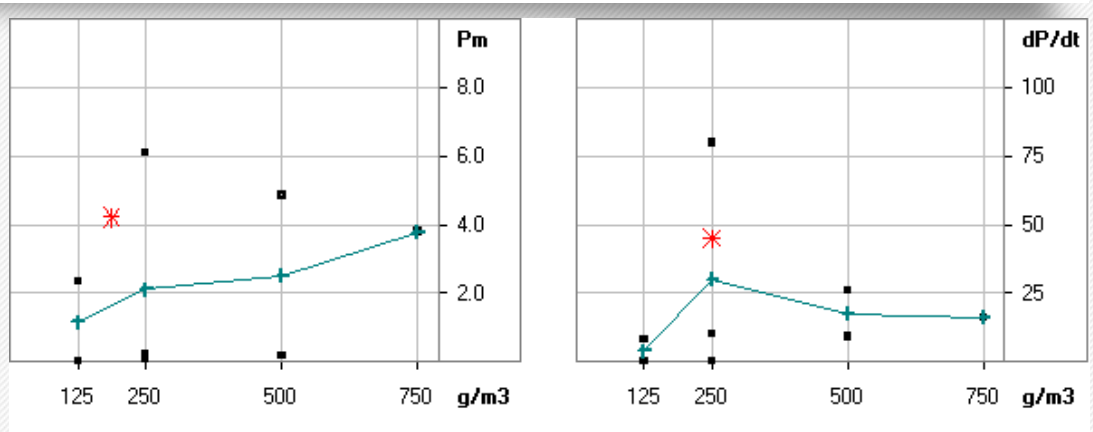
Minimum Explosible Concentration

- Unprocessed sample did not explode at concentrations tested
  - 0 – 1000 g/m^3
- MEC of processed sample lies between 750 – 1000 g/m^3
- Results consistent with prior work at Dalhousie

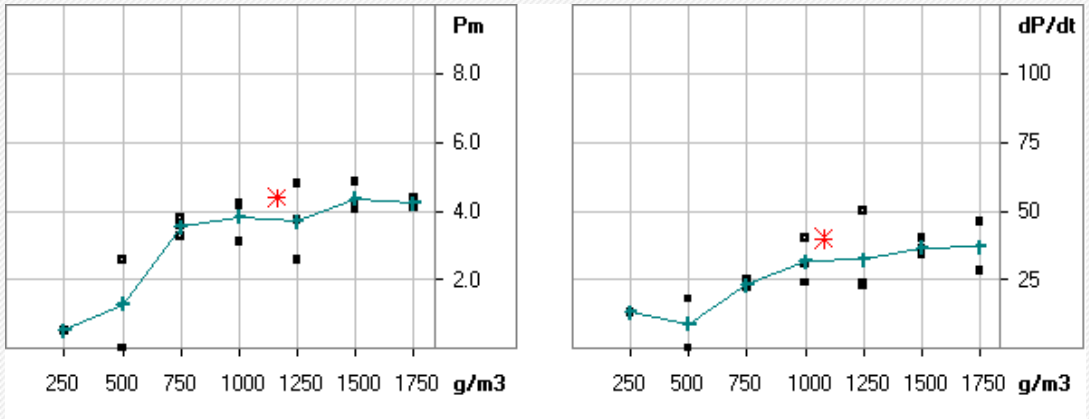


P_{max} & K_{St}

- Unprocessed sample had inconsistent results
  - Large particle size
- Processing the sample improved consistency
  - P_{max}: 4 bar
  - K_{St}: 11 bar m/s



Pmax (L) and KSt (R) results for unprocessed sample



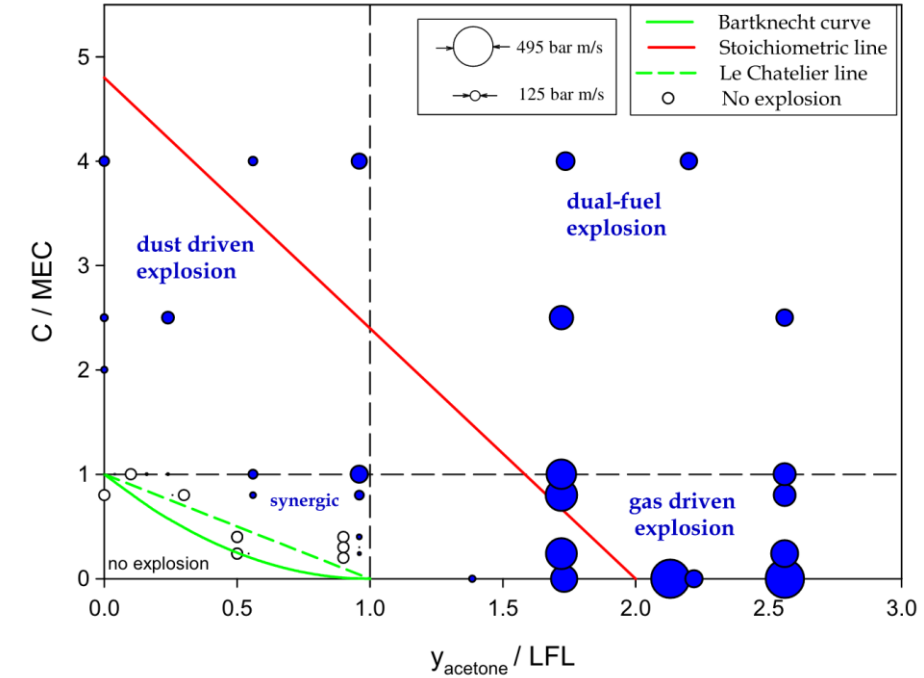
Pmax (L) and KSt (R) results for processed sample

Current Research

16

Explosion Regime Diagrams

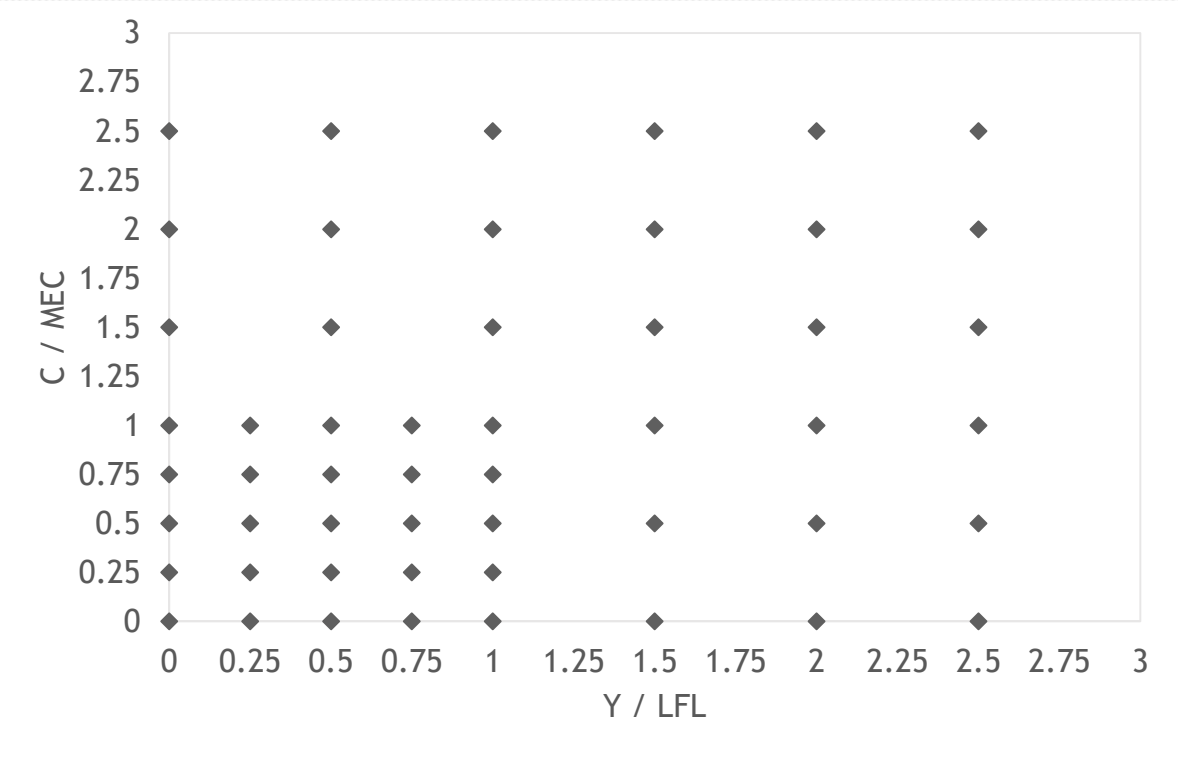
- Reproduce explosion regime diagrams found in work by Roberto Sanchirico et al. at the Institute of Combustion Research in Italy.
- Specific emphasis on the synergic explosion region
  - Below LFL and MEC of the gas and dust, respectively



R. Sanchirico, A. Di Benedetto, A. Garcia-Agreda, and P. Russo, "Study of the severity of hybrid mixture explosions and comparison to pure dust–air and vapour–air explosions," *Journal of Loss Prevention in the Process Industries*, vol. 24, no. 5, pp. 648–655, Sep. 2011, doi: 10.1016/j.jlp.2011.05.005.

Upcoming Experiments

- New fine sample received
  - D_{50}: 188 µm
- Proposed experimental protocol places greater emphasis on synergic zone
  - Comparison to theoretical models
- Gas mixture consisting of gases of most concern for first diagram
- Single gas trials for further explosion regime diagrams



Test matrix with emphasis on synergic zone

Conclusion

- Industrial samples received, size reduction performed to improve consistency of results
- Dust explosion parameter consistent with previous work done at Dalhousie
- Current research on explosion regime diagrams, with emphasis on the synergic region

Acknowledgements

- Katherine Axani, Sr. Process Engineer, Imperial Oil Limited
- Dr. Paul Amyotte, P.Eng., Dalhousie University
- Dr. Mohammad Alauddin, Dalhousie University
- Albert Addo, Dalhousie University

Questions

Thank you all for your attention

QRA of HRS in Canada

- Anirudha Joshi – University of Alberta
- (slides have yet to be published)

CSA Z662 – Construction of Pipelines
CSA Z663 – Land Use Planning for Pipelines

- Jyoti Patel – Principal Consultant, RRMS
- Adrian Pierorazio – Operations Leader (Senior Director), East Canada, Jensen Hughes

CSA Z662:23 Oil and Gas Pipeline Systems – Updates

JYOTI PATEL

RRMS, PRINCIPAL CONSULTANT

SEPTEMBER 2023

RRMS
Resolute Risk Management Services

Overview

- Released June 2023
- Free Availability of selected standards via the Western Regulators Forum for 1 year
  - Full list available at the end of presentation
  - The Western Regulators Forum is made up of the Canada Energy Regulator (CER), BC Energy Regulator (BCER), Alberta Energy Regulator (AER), the Saskatchewan Ministry of Energy and Resources (MER Saskatchewan) and the Office of the Regulator of Oil and Gas (OROGO) in the Northwest Territories.
- High Level/Introductory Revisions and Modifications:
  - Document Structure
  - Definitions
  - Guidelines for Risk Assessment of Pipelines (Annex)
  - Limit states design of onshore Pipelines (Annex)
  - Management Systems

Notable Differences

Document Structure	Linear vs. Storyboard Subtitles
Definitions	PSM CSA z767
Guidelines for Risk Assessment of Pipelines	Framework
Limit States Design of Onshore Pipelines	Safey Classes, Hydrogen blend, sour pipelines
Management Systems	PSM CSA z767, Audit

RRMS
Resolute Risk Management Services

Suite of free CSA Oil and Gas Standards

Z662 – Petroleum and Natural Gas Industry Pipeline Systems and Materials (CSA Z662, CSA Z245.1, CSA Z245.6, CSA Z245.11, CSA Z245.12, CSA Z245.15, CSA Z245.16, CSA Z245.17)

Z245.20 Series Plant-applied external coatings for steel pipe (CSA Z245.20, CSA Z245.21, CSA Z245.22)

Z246 – Security Management for Petroleum and Natural Gas Industry Systems (CSA Z246.1, CSA Z246.2)

Z247 – Damage Prevention for the Protection of Underground Energy and Utility Networks

Z260 – Pipeline System Safety Metrics

Z276 – Liquefied Natural Gas

Z341 – Storage of Hydrocarbons in Underground Formations (CSA Z341.1, CSA Z341.2, CSA Z341.4)

Z620 – Flaring, Venting and Fugitive Emissions (CSA Z620.2, CSA Z620.3)

Z624 – Well Integrity Management

Z625 – Well Design

Z663 – Land Use Planning

https://www.cer-rec.gc.ca/en/about/news-room/whats-new/2023/csa-focused-safe-reliable-petroleum-natural-gas-industry.pdf

CSA Z663

Land use planning in the vicinity of pipeline systems

Status and Update

Quick Notes

- 2018 Standard Re-affirmed
- TC starting to meet to revise
- Free downloads

Recognize support of Western Regulators Forum (WRF)

Canada Energy Regulator (CER)

Alberta Energy Regulator (AER)

British Columbia Energy Regulator (BCER)

Saskatchewan Ministry of Energy and Resources (MER)

Northwest Territories Office of the Regulator of Oil and Gas Operations (OROGO)

Break

- Starting again at 10:45
- Thanks