To: Canadian Energy Regulator
opr-rpt@cer-rec.gc.ca

June 28, 2022

From: [redacted]
Process Safety Engineer (Retired)
Sarnia, Ontario
Email: [redacted]

Subject: Submission for Question 21 of CER Discussion Paper for OPR

Dear Sir/ Madam:

Please find below my response for the subject item.

I am a retired process safety engineer in Sarnia, Ontario.

Sincerely,

[redacted]

Question 21. How should the OPR include more explicit requirements for process safety?

Background:

Process Safety and Process Safety Management are distinct topics used in industry but are related. Clarifying this relationship may be useful to readers.

From the Center for Chemical Process Safety (CCPS)
Ref [1] [CCPS Process Safety Glossary | AIChE]

Process safety is "A disciplined framework for managing the integrity of operating systems and processes handling hazardous substances by applying **good design principles**, engineering, and operating practices.

Note: Process Safety focuses on efforts to reduce process safety risks associated with processes handling hazardous materials and energies. Process Safety efforts help reduce the frequency and consequences of potential incidents. These incidents include toxic or flammable material releases (loss events), resulting in toxic effects, fires, or explosions. The incident impact includes harm to people (injuries, fatalities), harm to the environment, property damage, production losses, and adverse business publicity. "

From CSA Z767 Process Safety Management
Ref [2] [CAN/CSA-Z767-17 | Product | CSA Group]

"**Process safety management (PSM)** is the application of management principles and systems for the identification, understanding, avoidance, and control of process hazards to prevent, mitigate, prepare for, respond to, and recover from process-related incidents. These principles and techniques may be applied across industry sectors."

There are four foundational pillars for PSM:

a) process safety leadership;
b) understanding hazards and risks;
c) risk management; and
d) review and improvement.

Each of the pillars contains a number of elements.

There are some traditional design principles that can be applied/ considered for the specific purpose of environmental protection, as demonstrated in this response.

Inherently safer design principles aim to avoid hazards instead of controlling.

Part A - Proposed Requirements (suitable for use in regulation)

1. A company shall implement and ensure an effective process safety management system consistent with recognized industry practices or standards.

2. A company shall utilize a process safety discipline framework to ensure the integrity of operating systems that applies industry recognized **design principles**, engineering, and operating practices.

Part B - Proposed Guidance (suitable for use in technical guidance)

1. CSA Z767 provides information useful for the implementation and for ensuring ongoing effectiveness of Process Safety Management systems.
Ref [2] CAN/CSA-Z767-17 | Product | CSA Group

2. CSA Z767 applies throughout the lifecycle that includes:

- Conceptual design
- Facility (or location) siting
- Preliminary and process design
- Detail engineering design
- Construction
- Commissioning and start-up
- Operations/ maintenance
- Revamps/ modifications
- Decommissioning
- Site or infrastructure closure (can apply to abandonment)

Part B Continued

3. A company should utilize prevailing or established emerging industry best practices for safety in design. Some examples include:

   - Leakproof pipeline design created by University of Calgary researchers https://www.cbc.ca/news/business/leakless-pipelines-university-of-calgary-1.4127888

   - Advanced leak detection using nano-coating sensing technology, Alberta Innovates. https://albertainnovates.ca/impact/newsroom/direct-c-advances-nano-coating-sensing-technology/

4. Conceptual design options should consider the inherently safer design (ISD) principles shown below for the purposes of environmental protection. The perspective of ISD is on relative level safety (i.e., more, less) and not on an absolute level of safety which requires a risk assessment to determine acceptability of risk using a society-recognized risk acceptance criteria.

Part B Continued

ISD Principles	Details	Clarifications	Links
Minimization	For storage equipment, avoid storing amounts of chemicals beyond what is needed for efficient operations.		
	With optimized routing, minimize the number or length of crossings through areas of concern, through geohazard areas, through areas having higher corrosion potential.	Areas of concern can include those with concentrated population centers, social or economic use areas (including drinking water sources), indigenous lands or lands of cultural/ traditional significance, protected areas, environmentally sensitive areas (reserves, wildlife habitats, areas with species-at-risk, seasonal nesting areas, migratory path resting areas, feeding/ foraging areas, wetlands, fens, marshes)	
		Geohazard areas can include those exposed to the following natural hazardous events: earthquakes, flooding, landslides, snow avalanches, tsunamis/ storm surges.	
		Higher corrosion potential areas can include areas with soil conditions that promote microbiologically influenced corrosion; e.g., environments soured by sulfate reducing bacteria, water-saturated clay-type soils of near-neutral pH with decaying organic matter and a source of sulfate reducing bacteria	Ref [3] Different Types of Corrosion: Microbiologically Influenced Corrosion (MIC), Microbial Corrosion or Biological Corrosion - Causes and Prevention, by WebCorr Corrosion Consulting Services, Corrosion Short Courses and Corrosion Expert Witness. corrosion types, corrosion forms, pipe corrosion, generalized corrosion, pitting corrosion, galvanic corrosion, MIC corrosion, erosion corrosion, corrosion under insulation, M.I.C., MIC, CUI corrosion (corrosionclinic.com)
		Higher corrosion potential areas can include pipelines collocated, sharing, paralleling, or crossing high voltage AC power line rights-of-way.	Ref [4] https://store.ampp.org/sp0177-2014-formerly-rp0177-mitigation-of-alternating-current-and-lightning-effects-on-metallic-structures-and-corrosion-control-systems Microsoft Word - INGAA Criteria for Pipelines Co-Existing with Electric Power Lines_PP105012_FINAL REPORT.docx Ref [8] https://s1.c-pdf.best/standards/NACE-SP21424-2018/

ISD Principles	Details	Clarifications	Links
	Minimize the potential amount or rate of hazardous material that could be spilled from a leak or rupture by considering the design concepts shown under the column Clarifications	Adequate secondary containment for storage facilities (see NFPA 30 Flammable and Combustible Liquids Code) (Also ISD Principle Simplification)	Ref [5] NFPA 30 (cimico.net)
		Consider applying principle of "limitation of effects" by considering smaller bore piping (upon rupture, this will result in a comparatively slower flowrate).	Ref [6] Process Plants: A Handbook for Inherently Safer Design, Second Edition - Trevor A. Kletz, Paul Amyotte - Google Books
		For areas of concern consider enhanced protection measures that can include the following: • Local sensitive/ immediate leak detection and alarm system. This can include a sensitive in-point/ out-point mass balance differential processor. • Double piping with annular leak detection and alarm system (Also ISD Principle Simplification) 5. For rivers, pipeline running inside a reinforced tunnel below a riverbed with leak detection and alarm system. (Also ISD Principle Simplification)	
Moderation	Use of less aggressive operating pressures or temperatures		
	Restrict use of chemicals in equipment where vapor pressure can challenge the design pressure rating		
Substitution	For a given material of construction or susceptible environment, use materials that will not chemically attack the intended material of construction, or restrict use of chemicals in the product mix that could present highly toxic effects to an exposed environment.		

ISD Principles	Details	Clarifications	Links
Simplification	Eliminate unnecessary complexities to reduce the chance of human error or random equipment failures		
	Design to allow for required inspection and maintenance		
	Use a mechanical design or material of construction more resistant to potential forces (internal, external), and corrosion mechanisms (chemical, biological, moisture), and third party external impacts.		
	Designs to consider facilitation of emergency response measures, where suitable, e.g., utilize in-place containment booms to facilitate vacuuming.		

Part B Continued

5. Design in Development should consider the following:

- Passive protective measures. Examples include:
  - superior mechanical designs for strength and corrosion effects
  - process equipment secondary containment (e.g., double wall)
  - spill secondary/ passive containment (e.g., spill containment dyke)

- Additional active protective measures required based on required risk reduction. Examples include priority process alarms, pressure relief devices, and safety instrumented systems.

- Design of Safety Instrumented Functions/ Systems per **IEC 61511 "Functional Safety – Safety Instrumented Systems for the Process Industry Sector"**. This includes Safety Integrity Level Determination (i.e., amount of risk reduction required) and Safety Integrity Level Verification (i.e., verifies SIS design will in fact deliver required risk reduction by calculating the Probability of Failure on Demand for the system).
  Ref [7] https://www.61508.org/knowledge/what-is-iec-61511.php

- Design safeguards that account for the following failure causes:
  - Equipment random failures
  - Instrumentation or control random failures
  - Human/operator error (omission, commission)
  - External events that can include weather related, geological, environmental, anthropogenic, sabotage.

References

Ref [1] CCPS Process Safety Glossary | AIChE
Ref [2] CAN/CSA-Z767-17 | Product | CSA Group
Ref [3] Different Types of Corrosion: Microbiologically Influenced Corrosion (MIC), Microbial Corrosion or Biological Corrosion - Causes and Prevention, by WebCorr Corrosion Consulting Services, Corrosion Short Courses and Corrosion Expert Witness. corrosion types, corrosion forms, pipe corrosion, generalized corrosion, pitting corrosion, galvanic corrosion, MIC corrosion, erosion corrosion, corrosion under insulation, M.I.C., MIC, CUI corrosion (corrosionclinic.com)
Ref [4] Microsoft Word - INGAA Criteria for Pipelines Co-Existing with Electric Power Lines_PP105012_FINAL REPORT.docx
Ref [5] NFPA 30 (cimico.net)

Ref [6] Process Plants: A Handbook for Inherently Safer Design, Second Edition - Trevor A. Kletz, Paul Amyotte - Google Books

Ref [7] https://www.61508.org/knowledge/what-is-iec-61511.php

Ref [8] https://s1.c-pdf.best/standards/NACE-SP21424-2018/