Canadian Society for Chemical Engineering | *For Our Future*

CSChE ERA Guideline Development Status

for PSM Division

“Bridging Process Safety and Environmental Science”

Manny Marta

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Presentation Contents

- Backgrounder
  - Informative Perspective on Proposed Guideline
- Progress/ Status Since Spring 2017

Backgrounder – A Useful Perspective

- Extensive research revealed unique concepts/ practices in environmental field
  - applicable for prospective risk assessments
- Proposed guideline – a hybrid guideline incorporating recognized risk assessment practices, concepts, terminology from
  - Process Safety
  - Environmental
- As a result, will be an exclusive/ unique reference in the world

Backgrounder – A Useful Perspective (Cont'd)

- **Some environmental aspects**
  - **Scientific approach to assessing exposure & effects to ecological & socio-economic receptors from acute chemical spills/ releases**
  - **Risk communication/ involvement with external stakeholders**
- **Some process safety aspects**
  - **Determination & assessment of release scenarios**
  - **Risk analysis – integrating expected frequency & consequence severity**
  - **Risk control/ management – considerations for reducing event likelihood/ minimizing consequence severities**
  - **Risk assessment – transparent & explicit risk acceptance/ decision criteria**
    - ***Guideline looking at adapting UK Dept. of Environment* Risk Decision Criteria info (unique in the world focused on environmental impacts)***

** Management of Harm to the Environment: Criteria for the Management of Unplanned Releases; 1998; UK Department of the Environment, Transport and Regions; Stationary Office: London; ISBN 0 11 753456 0*

Progress Since Spring 2017

1) Developed Key Terms & Acronyms Document
   - No. of Acronyms = 57
   - No. of Key Terms = 229
- Some terms copied from recognized process safety or environmental references
- Some terms developed/ customized for the purposes of the guideline to reflect its unique hybrid nature (*remember backgrounder*)
- Based on separate original references, some terms will have dual meanings (PS & Env contexts) and will show up separately with identified context
- All terms will be reviewed by cross-rep team of experts (PS, Env) and interested parties
- Link to online shared location for document

https://drive.google.com/open?id=0B4hKgrr_Gus5fmF0TlliNkNMNGY2b3hlYU1wTGYxeHRRQlN2U3NNUDhjT3YwbC1xNUh6aE0

Progress Since Spring 2017 (Cont'd)

2) Team Review of Draft Guideline Contents (Orientation Package)

- Review Team
  - Process Safety Experts/ Consultants
  - Environmental Experts/ Consultants
  - Interested Parties
    - Regulators (Ontario TSSA, Alberta Energy Regulator, BC Oil & Gas Commission)
    - Industry Knowledge (Pipelines, Marine, Fixed Facilities)
- Online review meetings started June 12th
- Every 3 weeks for 2 hours
- Have held 5 meetings to date
- Meetings currently on hold until I move to and settle in new address
- Planning 1 maybe 2 more online meetings for remainder of this year

Progress Since Spring 2017 (Cont'd)

2) Sections of Orientation Package Reviewed To Date

1. Team Making Decision Process
2. Acknowledgements
3. Key Terms & Acronyms
   - Separate document updated on ongoing basis
   - Is involving reasonable amount of discussion
4. Guideline Introduction
5. General Purpose of Guideline
6. Guideline Objectives or Goals (partial review)

Progress Since Spring 2017 (Cont'd)

2) Sections of Orientation Package Left for Review

7. Key Regulatory Requirements
8. Scope for Guideline
   - Types of Chemicals
   - Fixed Facilities
   - Transportation Systems
   - Ecosystems
   - Areas of Concern
   - Spill Location Criteria (Non-Fixed) Sources
   - Receptors
9. Possible Typical Applications for Use of Guideline
10. Typical Triggers
11. Overall Process Explained
12. General Problem Understanding
13. General Planning
14. Design/ Operations Hazard Analysis and Spill Scenarios Development

Progress Since Spring 2017 (Cont'd)

2) Sections of Orientation Package Left for Review (Cont'd)

15. Spill/ Release Consequence Analysis
    - General
    - Determining Release Rates and Amounts
    - High Consequence Area Sensitivity Ranking
    - Consequence Scoring
    - Transport and Fate Modeling
    - Exposure Assessment
    - Effects Assessment
    - Key Challenges
16. Risk Analysis
17. Risk Assessment
    - Includes review of separate document "Environmental Risk Decision Methods" and separate developed "Excel Tool"

Progress Since Spring 2017 (Cont'd)

2) Sections of Orientation Package Left for Review (Cont'd)

18. Risk Control/ Management
19. Uncertainty and Confidence
20. Risk Communication
21. Longer Term Monitoring
22. Addenda
23. Process to complete final (clean up) writing of the guideline after team discussions on content sections listed above

- **Link to online shared location for Orientation Package, Env. Risk Decision Methods documents**
  https://drive.google.com/open?id=0B4hKgrr_Gus5NGIxRTIlQlM3eEU

Progress Since Spring 2017 (Cont'd)

2) Benefits Seen from Online Review Meetings

- **Good clarifications/ improvements on various definitions of environmental terms in the context for the hybrid Guideline**
  - transport and fate
  - model domain (for transport and fate modeling)
  - valued ecosystem component
  - stakeholders that are indigenous peoples – i.e., first nations, metis, inuit (not just "first nations")
  - ecological risk assessment
  - environmental risk assessment
  - endpoint (biological)
  - endpoint (chemical)
  - chemicals of potential concern
  - hazard analysis (design, operations, maintenance context)
  - hazard analysis (exposure and effects context) (environmental context in env. references)
  - recovery
  - etc.
- **Active "cross-fertilization" of process safety and environmental knowledge/ learning**

Progress Since Spring 2017 (Cont'd)

3) Developed Compact Excel Tool for Risk Acceptance/ Decision Criteria (Significant Development)

- Foundation = UK Dept. of Environment Reference
- Risk = Frequency x Environmental Harm Index (EHI)
- $EHI_{Total} = \sum_k \left[\sum_j (EHI_{Biotic} + EHI_{socio-economic})_j \right]_k$
- Where
  - j – represents different toxic chemicals with different effects on different receptors
  - k – represents different ecosystems; e.g., aquatic, wetland, terrestrial affected by the same spill
- $EHI_x = \frac{Extent}{Extent_{ref}} + \frac{Severity}{Severity_{ref}} + \frac{Recovery}{Recovery_{ref}}$

Progress Since Spring 2017 (Cont'd)

3) Compact Excel Tool for Risk Acceptance/ Decision Criteria (Cont'd)

- **Excel Sheet 1 – Extent Consideration**
  - **Direct copy from UK Reference**
  - **$Extent_{ref}$ Factor for:**
    - **Medium (land/ water/ air)**
    - **Various Receptors**
  - **$Extent_{ref}$ only and <u>not</u> Extent/ $Extent_{ref}$ ratio**

Progress Since Spring 2017 (Cont'd)

3) Compact Excel Tool for Risk Acceptance/ Decision Criteria (Cont'd)

- **Excel Sheet 2 – Severity Consideration**
  - **Severity/ $Severity_{ref}$ Ratio Factors**
  - **For ecological systems & socio-economic situations (separately)**
  - **However, UK reference is specific for a particular system -> medium -> receptor -> exposure pathway relationship**
    - **i.e., ecological –> water –> fauna* –> ingestion pathway**

*** Relevant fauna = water based animals/ fish/ organisms, land based and air based animals interacting with water**

Progress Since Spring 2017 (Cont'd)

3) Compact Excel Tool for Risk Acceptance/ Decision Criteria (Cont'd)

- Excel Sheet 2 – Severity Consideration (Cont'd)
  - Specific severity ratio factor from UK reference
    - Severity/ Severity(ref) = PEC(max)/ LC50,min
    - PEC(max) = Maximum predicted aquatic environmental concentration determined from transport and fate modeling
    - LC50, min = Lethal concentration to 50% of exposed most sensitive representative individual species

Progress Since Spring 2017 (Cont'd)

3) Compact Excel Tool for Risk Acceptance/ Decision Criteria (Cont'd)

- Excel Sheet 2 – Severity Consideration (Cont'd)
  - UK reference is directly applicable to aquatic fauna ingestion situations involving spills to rivers, estuaries; can possibly be used for oceans (was just a jurisdictional issue)
  - UK reference not directly applicable to other situations
  - However, for other situations: developed severity ratio factor by using modified Environment Canada reference information
    - Detailed information found in Excel Sheet 4
    - As a result, this will require calibration work

Progress Since Spring 2017 (Cont'd)

3) Compact Excel Tool for Risk Acceptance/ Decision Criteria (Cont'd)

- Excel Sheet 3 – Recovery Consideration
  - Recovery factors to use for different recovery time categories
  - Recovery(ref) is set to 5 years
- Excel Sheet 4 – Additional Severity Considerations (Other Situations)
  - Severity/ Severity(ref) factors for modified Environment Canada information
  - To augment limited Excel Sheet 2 severity situation applicability
  - Ecological Severity Categories and "Relative Severity Score"
  - Socio-Economic Severity Categories and "Relative Severity Score"

Progress Since Spring 2017 (Cont'd)

3) Compact Excel Tool for Risk Acceptance/ Decision Criteria (Cont'd)

- **Excel Sheet 5 – Risk Criteria**

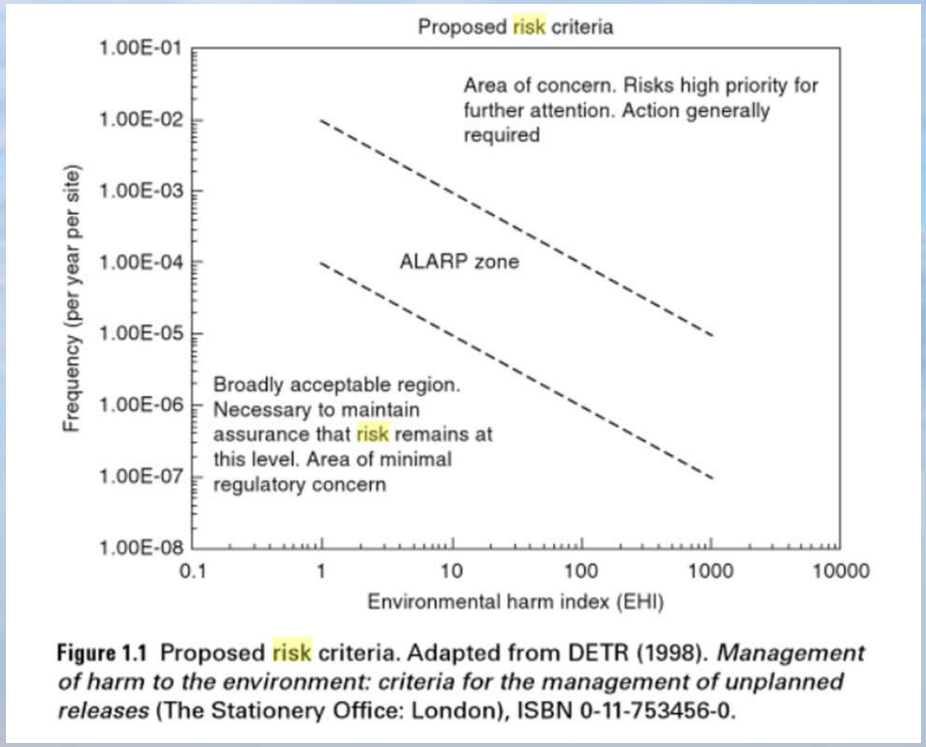

Figure 1.1 Proposed risk criteria. Adapted from DETR (1998). *Management of harm to the environment: criteria for the management of unplanned releases* (The Stationery Office: London), ISBN 0-11-753456-0.

- **Link to online shared location for Excel Tool ("EHI Integrated Tables")** https://drive.google.com/open?id=0B4hKgrr_Gus5NGlxRTllQlM3eEU

Acknowledgement: Free Powerpoint Template from https://www.presentationmagazine.com/free_powerpoint_template.htm