CSChE Chemical Spill
Environmental Risk Assessment
Guideline Development

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CSChE Process Safety & Loss Management Symposium
Calgary, AB
October 2016

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Background

- Early 2015
  - CSChE PSM Division meeting Feb 2015 to review candidate projects
  - Question on chemical spill (acute) environmental risk assessment guidance was raised
  - CSChE PSM Division acknowledged existing gap
    - No commonly recognized guidance in Canada for conducting environmental/ ecological risk assessments involving acute chemical spill accidents
  - Project accepted to research and develop guideline

- Spring 2015
  - Project co-chairs secured
Co-Chairs

- Eli Viloria, P. Eng.
  Process Safety Manager, Enbridge, Edmonton, Alberta
- Elizabeth Alderson, P. Eng.
  Senior Engineer, AMEC Foster Wheeler, Toronto, Ontario
- Manny Marta, P. Eng.
  Process Safety Specialist, Sarnia, Ontario

Special Support

- Marcello Oliverio,
  Process Safety Program Manager, Enbridge, Toronto, Ontario
- Gerard Chisholm, Environment Canada, Halifax, Nova Scotia
Safety risk assessment methodology for people impacts from acute chemical releases is well established

- In QRA's; Risk = Frequency * Consequence Severity [e.g. fatality(ies)]
- In PHA's; Risk = fn (Frequency Category, Consequence Severity Category) (e.g. as seen in a Risk Matrix)
- Time to recover in fatality or permanent injury risk assessments is not always an item for consideration

Environmental risk assessments for existing contaminated sites or continuous/chronic emissions has been done many times before; but:

- Concept of expected frequency is irrelevant as the condition exists/is already present
- Risk becomes then a function of expected consequence severity and associated probability;
  - i.e. Risk of a specific harm = Expected Harm * Probability of Harm;
    (given the contamination exposure condition is present)
- Expected Harm takes into account severity of harm, extent of harm, and expected duration for recovery; the greater each item is, the greater the expected harm
Starting Challenges (Cont’d)

- However, risk to environment due to exposure from acute chemical spills presents the following special challenges:
  - In general, we expect, for a particular location, these events to occur with a very low frequency (i.e., frequency $\ll 1/\text{yr}$);
    - e.g., theoretically, for a particular spill source location, one would not expect to see this type of environmental risk situation within one’s life time
    - In comparison, when considering a population of multiple similar situations (in different locations around the world), the frequency could range from once every 10 years to a few times in a year, depending on particular years.
  - Defining appropriate “scale” or “boundary” for risk assessment study
Starting Challenges (Cont’d)

Acute chemical spill environment risk challenges (cont’d):

- Consequences
  - There are many different receptors to take into account; not just, in comparison, a particular people impact (e.g., fatality)
    - Physical damage to the environment requiring clean up
    - Harm to wildlife (terrestrial, aquatic) with many species involved
    - Harm to aquatic and terrestrial eco-sensitive areas of various types uses of the environment
  - How to integrate these separate harms into an overall determination of consequence severity to apply in the risk relationship?
    - Can a QRA approach be undertaken?
    - Is Risk Matrix the only way?
Criteria for Risk Acceptance

➢ For safety (fatality) risk assessments, there is a widely defined risk level for acceptance of risk
  ▪ Based, in part, in comparison to “everyday activity risks” undertaken, or accepted as part of life, by society; e.g., driving, traveling in airplanes, undergoing life enhancing surgeries, dying from diseases/natural causes, being struck by lightning, etc.
  ▪ Risk level accepted, for particular activities/exposures, reflects society’s value towards preserving (quality) life

➢ For environmental/ecological risk assessments
  ▪ There is no globally defined, or widely used, level of risk acceptance for exposures to human initiated activities; e.g., set by UN or others
  ▪ A very major challenge!
Guideline Scope

➢ Chemicals
  ▪ Ecotoxic
  ▪ Alters ecosystem conditions
  ▪ Liquids
  ▪ Solids*
  ▪ Exclude vapors*
    – more of a concern for humans; i.e., human impact bounding
      already covered in current CSChE Risk Assessment Guideline

➢ Spill Sources
  ▪ Fixed chemical facilities
    – Manufacturing/ processing, production, storage
      (inland, onshore), distribution, loading/ unloading
    – Includes oil production (e.g., oil wells – drilling & operational)
  ▪ Transportation facilities/ equipment
    – Rail, marine, trucking, pipeline

*initial suggestion only, subject to validation by team experts
Guideline Scope (Cont’d)

➢ Ecosystems
  ▪ Aquatic, terrestrial
  ▪ Eco-sensitive areas, nature/ wildlife conservation areas, wildlife habitats and migratory paths, bird seasonal nesting areas

➢ Receptors
  ▪ Physical (non-biotic)
  ▪ Biotic (fauna, flora). Includes contaminated animal drinking water and food supply.
  ▪ Socio-economic (human drinking water supply – surface/ underground, commercial use, farm use, recreational use)
Guideline Objectives

Goal on Level of Guidance

- Too general, vague, obscure
  Hard to understand and apply in practice
- Too detailed, very specific for different situations
  Voluminous detailed information

Balanced - generic, yet practical
- General but useful guidance
- Specific technical guidance for process
- Adaptable for specific environmental risk situations (chemical – source – pathways – receptors)
- Reference other information sources for more details, where more appropriate
Guideline Objectives (Cont’d)

- Risk assessment process guidance document
  - Overall framework
  - Technical analyses
  - Assessment, risk management, risk communication
- Support risk assessment elements in proposed CSA PSM Standard
- For predicted acute chemical spill scenarios/accidents.
  - Generally, these should occur with a relatively low expected frequency
- For short-term and long-term environmental impacts from acute spills
- **Not** for chronic/continuous releases to environment
- **Not** for existing or known contaminated sites
Guideline Objectives (Cont’d)

➢ Provide guidance for risk-based decision-making
  ▪ Not based on consequence severity only
  ▪ For consideration by guideline development team experts
    – Absolute risk, using
      • Environmental Harm Indices/ Scores
      • Severity, extent, recovery period
      • Consideration of background risks
    – Relative/ prioritized risks using risk scores or indices
    – Cost-benefit
    – Precautionary principle
Example Applications

- Risk is generated from activities
- In general, address societal risk questions/ issues/ concerns on proposed or current activities; some examples below:
  - Is the risk to the environment acceptable with the proposed activity of oil super tankers travelling through the narrow inlet sounds and along coast of BC?
  - Is the risk to the environment acceptable with the proposed activity of a LNG terminal operation on ocean shores of BC?
Example Applications (Cont’d)

Risk question examples cont’d:

- Is the risk to the environment acceptable with the proposed activity of drilling for oil or having operational oil wells in the Arctic Ocean?
- Is the risk to the environment acceptable with the proposed activity of installing fracturing wells for oil and gas or having these wells operational in a particular jurisdiction?
- Is the risk to the environment acceptable with the proposed/current activity of transferring oil via a pipeline passing through certain (eco-sensitive; socio-economic sensitive) areas?
Example Applications (Cont’d)

➢ Possible use for Environmental Risk Assessment of proposed transportation activities/operations (e.g., per Responsible Care): Examples below;
  ▪ New proposal to transport by ship, truck, rail or pipeline a potentially ecotoxic chemical through specific transportation corridors that travel through or nearby water bodies or ecologically sensitive areas

➢ Possible use in Regulatory Environmental Assessments for proposed activities/operations, desiring risk-based approach
Example (General) Triggers

- Infrastructure development submission to regulator
  - Fixed or transportation operations
  - Having potential, upon failures, to harm ecosystem
  - Regulator’s public review raises significant concerns
- New infrastructure development or operations publicly announced by organization
  - Having potential, upon failures, to harm ecosystem
  - Public raises significant concerns
Example (General) Triggers (Cont’d)

- Significant historical spills involving existing/ similar infrastructures or operations
  - Public/ regulator raises significant concerns
- Project hazard review or cyclical existing facility PHA
  - Through risk screening, reveals potentially significant environmental risk scenario(s). Examples below:
    - Oil well suffers failure and causes massive contamination of ocean
    - Pipeline ruptures and causes major contamination of nearby river
    - Wastewater dyke fails causing major impact to nearby river
    - Major in-plant spill occurs during major rainfall in a facility with inadequate containment of “process-contaminated” water, or is accidentally bypassed, releasing significantly contaminated effluent to nearby river causing major impact.
  - Potential for significant public/ regulatory concerns
  - Benefit from more rigorous and greater resolution risk assessment process
## Possible Contents
### Acute Risk Assessment Guide

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*Unique to ERA or has an approach that is unique to ERA*
## Possible Contents
### Acute Risk Assessment Guide

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| 11   | Consequence Analysis | Unique for environmental risk assessments  
|      |         | a) Identify typical experts needed for this part  
|      |         | b) Consequence analysis, sensitivities, and probabilities  
|      |         | c) Identifying relevant representative receptors (e.g., species) and attributes for assessment (e.g. mortality)  
|      |         | d) Identifying harmful concentration levels/dosage rates for receptors; quotients  
|      |         | e) Predicted Biotic Stress – Exposure – Response; predicted physical damage  
|      |         | f) Contamination modelling in ecosystem; transport and fate; exposure & effects  
|      |         | g) Predicted Severity, Extent, Time to Recover  
|      |         | h) Identify possible sources of data  
|      |         | i) Integration of consequence per receptor of concern |
| 12   | Risk Analysis | Unique for environmental risk assessments  
|      |         | Summation of risk =  
|      |         | [Expected frequency of harmful ecosystem contamination] *  
|      |         | [Summed, probability- factored, consequences per receptor of concern] |
Development Strategy

For credibility purposes, involve two groups of people

1. Experts with “how to” knowledge in their own fields (includes information on scientific/historical data sources)
   - PSM/ risk assessment
   - Identification of chemical spill sources/ failure modes (and expected frequencies)
   - Environmental Impact Assessors
     - Eco-toxicologists
     - Biologists/ ecologists (fauna, flora, marine, terrestrial)
     - Environmental modeling (aquatic, terrestrial)
     - Financial impact estimators (clean up, wildlife treatment, restoration cost, economic loss, cost-benefit analysis, etc.)
     - Environmental engineering (contamination prevention, mitigation, abatement)
   - Experts from process safety, environmental consultants, academia
2. Naturally interested groups
   - Chemical/ oil production or processing, storage, distribution
     - company environmental specialists
   - Chemical/ oil transportation system representatives (rail, marine, trucking, pipeline)
     - can include company environmental specialists
   - Government/ regulators
     - Environment Canada, BC Oil & Gas Commission, Ontario TSSA, Alberta Energy Regulator, Canada Dept. of Fisheries and Oceans
   - Environmental interest groups – NGO’s & Non-Industry
Development Strategy (Cont’d)

- Promote research of available published information on methods/ approaches
- Obtain knowledge readily available from experts and interest groups
- Collate information (different perspectives/ approaches) from varied sources into “topic buckets”
- For each topic, team of experts review/discuss and modify/ select specific technical method
- Experts and interest group provide guiding feedback on all aspects
- Involve experts and interest groups as needed during development process
Development Strategy (Cont’d)

- Mid 2015 – organize project leads
- Project leads define
  - Propose scope, objectives, development strategy, table of contents
  - Identify team requirements; secure team
- Latter part of 2015
  - Organize team; provide orientation
  - Validate with team:
    - Proposed scope, objectives, contents, development strategy, including:
      - Development and Calibration of assessment straw model
      - Use of data from major/minor historical environmental incident for Calibration
      - Communications with others (e.g., CSChE PSM Division, others to be identified)
    - Roles (contributory; commentary; administrative)
    - Validate proposed decision-making process for team
    - Validate administrative measures (e.g. how meetings will occur, when to hold meetings, etc.)
Development Strategy (Cont’d)

- 2016 (to 2017?)
  - Review information on previously identified references (and reviewed by project leads)
  - Identify & conduct research of additional references
  - Assemble contents per strategy defined (using efficient administrative process)
  - Decide on topic-related options; finalize assessment straw model
  - Calibrate assessment straw model using data from historical major/minor environmental incident
    - Identify test incidents deemed unacceptable and acceptable risk
      - Examples - Deepwater Horizon oil well spill; Exxon Valdez; Pipeline Spill at Marshall, Michigan; Others?
  - Update assessment model
  - Review with extra stakeholders (e.g., CSChE PSMD, others identified)
  - Publish document
Next

Workshop with audience to solicit input on
  – Scope
  – Objectives
  – Possible Contents
  – Development Strategy

THANK YOU