

Type and timing of risk assessment appropriate to Canadian Oil Sands Facilities

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I Want a QRA!

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Overview of types of risk assessment available, including

- Qualitative
- Quantitative

When should they be conducted?

For which facilities (and which type of risk assessment)?

What are the benefits of doing “risk based” design?

What criteria is available to compare the results against?

$$\text{Risk} = \text{Severity} \times \text{Likelihood}$$

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Background on how risk is defined and assessed in these studies:

Severity

Broken up into:

- Personnel
- Asset / financial
- Environment
- Reputation

Qualitative vs Quantitative (e.g. Consequence modeling)

Likelihood

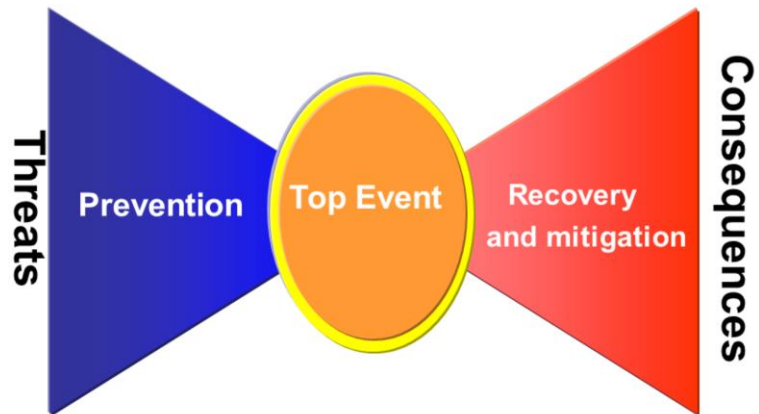
Qualitative vs Quantitative

Could include frequency analysis; ETA; FTA; Historical evidence.

Types of Risk Assessments

Qualitative

- HAZIDs
- Bow-Tie Analysis
- HAZOPs



SNIKLV

Consequences

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Hazard Identification Workshop (HAZID):

Often combined with a hazard identification workshop. Hazards can be assessed using a number of different techniques including:

- Checklists;
- What-If
- Brainstorming
- Failure Modes & Effects Analysis

Combines with a qualitative risk assessment typically using the company risk matrix to assess the risk. Typically done at a higher level than a HAZOP workshop (e.g. Unit or facility wide)

Output is often a Hazards & Effects Register which should be managed throughout the lifecycle of the project / facility & list of actions for additional mitigations to reduce risk. Also identifies Major Accident Hazards which can be assessed in more detail in a Bow-Tie Analysis workshop.

Bow-Tie Analysis

A Bowtie is a simple graphical tool used to illustrate the relationships between Major Incident Hazards (MIH), causes, potential consequences and controls/barriers.

Bowtie analysis facilitates an assessment of whether hazards are managed to an acceptable level or not, by qualitatively assessing the effectiveness of the barriers in place. Used to identify gaps to determine if additional or stronger existing controls are

required and to aid in demonstrating ALARP.

A higher level of detail gives a simple and clear overview of the barriers in place to manage the MAH.

A more detailed level can show the equipment and processes required to maintain control and ensure that barriers remain in place over time (i.e. Safety Critical Elements and Safety Critical Tasks).

HAZOP

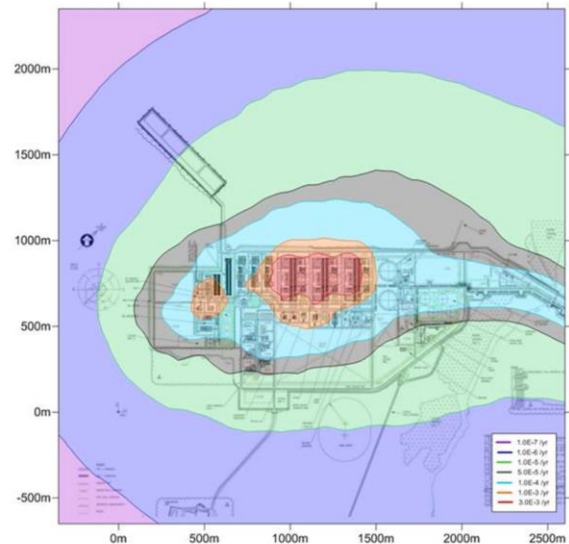
Familiar to industry, Similar to the HAZID workshop whereby a set of guidewords are used to identify hazards which are then risk ranked. Uses P&ID level of detail.

Quantitative information can also be used as an input into a HAZOP.

Types of Risk Assessments

Quantitative

- Scenario Based
- Integrated
 - Risk Based Facility Siting
 - QRAs (Facility & Pipelines)
 - Transport



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More of a “numeric” type of assessment. Typically uses consequence modeling and frequency analysis to determine the severity and likelihood respectively.

Scenario Based

Assess the risk with particular scenarios e.g. Fire Risk Assessments - Tank Fires. Often used to assess risk to assets (financial) or the environment. Can also be used to investigate particular scenarios (e.g. MAH) which have been identified (from the HAZID) as requiring further analysis.

Integrated

Examines the risk (typically to personnel) from a number of scenarios and integrates to determine the Individual Risk (IRPA and/or LSIR) and Societal Risk (PLL and / or F/N Curves).

- Facility Siting – Determines the risk to personnel in occupied buildings
- QRAs – Similar to Facility Siting but also considers personnel time outside of occupied buildings e.g. outdoors or in process buildings. Can determine the risk to Public.
- Transport – Examines the risk of getting to and from the facility. Often used to compare a number of different options, and effects of mitigation measures e.g. travel by bus instead of car.

Combined

Can often combine different types of risk assessment together, depending on information available and objectives of the study.

Risk Assessment in the Project Lifecycle

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- Concept
- Basic Engineering
- Detailed Engineering
- Operations

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Concept

Typically a HAZID with qualitative Risk Assessment – Identifies any show stoppers, any scenarios with unacceptable level of risk and identifies areas / studies where further analysis is required in later phases. Can also compare between various options.

Basic Engineering

Re-validate HAZID
Bow-Tie analysis for MAHs
Facility Siting
HAZOP
Scenario Based

In-between

QRA

Detailed

Transport
Updated RA from previous phases

Operations

SIMOPs - Workshop to discuss the operations and identify hazards that can be developed with 2 operations being conducted simultaneously.

Management of Change e.g. Facility Siting Study - Additional of new occupied buildings or process equipment
Re-Validate HAZOP
Job based RA Workshops e.g. Critical Lifts; Novel Operations or new / modified procedures and processes.

Applicability

Oil sands & Gas Facilities

- Gas Facilities
- SAGD (& CSS)
- Mineable Oil Sands

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All

HAZID with qualitative Risk assessment – identifies further studies
HAZOP

Gas

Bow-Tie
Scenario Based (e.g. NGL Bullets)
Facility Siting – Occupied Buildings

SAGD – Well Pads

Normally minimal further studies required.
Scenario Based if H₂S present

SAGD - CPF

Bow-Tie
Scenario Based (optimized Fire Protection in high risk areas e.g. Tank Farm, inlet separation)
Facility Siting – Occupied Buildings

Mineable

Bow-Tie
Scenario Based (optimized Fire Protection)

Facility Siting
QRA

Risk Based Design

“Informing decisions”

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- Facility Siting (/layout)
- Identifying mitigation measures
 - Type of Fire Protection
 - Blast Resistant Buildings
 - PPE Requirements
- Identifying additional studies
- Demonstrating ALARP

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Facility Siting

Risk to people inside buildings

Determine most appropriate mitigation measures based upon scenarios where risk is coming from e.g. Toxic; thermal radiation and / or VCE

Also identify areas of lower risk in which to (re-)locate the buildings.

Mitigation Measures

Justification for Fire Protection e.g. Tank protection – let it burn vs protecting surrounding assets. Can be used as an input into a Cost Benefit Analysis.

PFP Requirements e.g. API 2218 for pool fires & risk based decision (CBA) for Jet fire rated PFP.

Similar for other types of mitigations.

Additional Studies

More detailed RA – HAZID may identify to conduct a QRA on high / medium risk scenarios.

Computational Fluid Dynamics (CFD) – Complex scenarios or confined / enclosed unit explosions – Dispersion and VCE modeling

Building Blast Assessment – Structural analysis of building’s response to blast design loads; Recommendations to modify the building design.

Demonstrating ALARP

Determine Risk Reduction from implementing mitigation measures e.g. in the QRA you can determine the reduction in the Potential Loss of Life (PLL) value and make a comparison against the cost of implmenting.

Risk Criteria

- Corporate Risk Matrix
- Regulatory Requirements
- Industry Guidance

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Regulatory Requirements

BCOGC – LNG Facility Regulation

Industry Guidance

MIACC Guidance (LSIR)

UK HSE

Thank You

Any Questions?

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