HIDDEN HAZARDS AND BLIND SPOTS

Equipping your organization to better see the unforeseen

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Based on research with Ian Gellatly and Matt McLarnon and course materials developed by Kathleen Baker, John Cocchio, Chris Coles, Vivian Giang, Renato Macciotta, Gord Winkel, and Lisa White
UNCOVERING HIDDEN HAZARDS

- The Lynch School of Engineering Safety and Risk Management has been working with Energy Safety Canada (ESC) to create a Tailings Hazard Inventory of over 100 hazards, clustered into ‘bow-ties’ of release events, causes, and consequences
- Interviews with 158 frontline workers, supervisors, leadership, safety personnel and regional contractors
- Company incident databases specifically for tailings > 1500 incidents over the past three years
- U of A Tailings Ground Hazard Database, pictures taken of all sites in all seasons (summer, fall, winter, and spring)
- Presentation of findings in Tailings Safety Symposium (November 2018) to examine why hazards are not recognized, reported, or managed and brainstormed solutions
## OUTLINE OF WORKSHOP

1. **Quick review: What is a hazard?**
   - Types of hazards
   - Hazard identification
   - Hazards, impacts, and risks

2. **Uncovering hidden hazards**
   - How can hazards be better recognized?
   - Better understood?
   - Appropriately tolerated?
   - More effectively managed?

3. **Organizational ‘Blind Spots’**
   - Safety cultures and climates
   - Safety management systems

4. **Creating Resilience**
   - Equipping folks to see hidden hazards
   - Eliminating blind spots and turning a blind eye
   - Creating resilience
HAZARD IDENTIFICATION
WHAT IS A HAZARD?

Hazard – some form of energy that is a potential source of harm

Hazard - what could go wrong?

What is the difference between occupation and process safety hazards?

What hazards did you manage in your work experiences? Were these only occupational, or did you manage some process hazards?
**TYPES OF HAZARDS?**

- Most hazards are seen as exclusively occupational safety issues.
- Do not overlook these as process safety issues.

<table>
<thead>
<tr>
<th>Fire</th>
<th>Explosion</th>
<th>Detonation</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosion</td>
<td>Toxicity</td>
<td>Asphyxia **</td>
<td>Oxygen Deficiency</td>
</tr>
<tr>
<td>Radiation</td>
<td>Corrosive Liquids</td>
<td>Noise</td>
<td>Excess Pressure</td>
</tr>
<tr>
<td>Vibration</td>
<td>Noxious Materials</td>
<td>Electrocution</td>
<td>Slippery Surfaces</td>
</tr>
<tr>
<td>Flammability</td>
<td>Mechanical Failure</td>
<td>Security Breach</td>
<td>Elevations</td>
</tr>
</tbody>
</table>

- Workers successfully manage their exposures on a daily basis.
POTENTIAL CONSEQUENCES FROM HAZARDS

Identify specific undesirable or adverse consequences (impact on PEAP) of your operation / facility / activity

Identify Process Hazards, Substances, and Agents that Cause Those Consequences

Adverse Consequences

(Impacts on PEAP)

People
- Worker injuries
- Consumer injuries
- Community injuries
- On-site personnel
- Loss of employment
- Psychological effects

Environment
- Off-site contamination air / water / soil
- On-site contamination air / water / soil

Assets
- Property damage
- Equipment damage
- Stock value
- Insurance premiums
- Reputation
- Legal liability

Production Business Damage
- Production outage
- Inventory loss
- Product quality
- Lost markets
OCCUPATIONAL SAFETY VS. PROCESS SAFETY

**Occupational Health & Safety**
- Individual-oriented and controlled
- Focused on direct interaction between individual and equipment or structures
- Specific impact
- Work place rules and safety equipment
- Worker training and supervision

**Examples of Possible Incidents**
- Fall
- Spill
- Electrocution
- Asphyxiation
- Hearing Impairment and other chronic injuries
- Minor injuries (pinch, banged knee, etc.)

**Examples of Safeguards**
- Hazardous Work Permits
- Personal Protective Equipment
- Ventilation systems, confined space entry
- Guardrails, equipment guards

**Process Safety**
- Cooperative
- Broad impact
- Systems
- Little individual control

**Examples of Possible Incidents**
- Explosion
- Release of hazardous chemical
- Fire
- Release of hazardous energy

**Examples of Safeguards**
- Design
  - Pressure Safety Valves
  - Inherently Safer Design
  - Equipment Interlocks
  - Process Alarms
- Operations
  - Maintenance
  - Inspections
  - Training
  - Procedures
GROUP DISCUSSION

- Were you surprised by any of these hazards mentioned so far?
- Does your workforce understand the difference between hazards versus consequence?
- How mature are your systems and individuals’ training in identifying and understanding all these hazards?
UNCOVERING HIDDEN HAZARDS
DEFINITIONS

“Seen” Hazards: hazards that are identified and controlled using engineered, administrative controls or personal protective equipment to bring the risk to a level that is as low as reasonably practicable.

“Normalized” Hazards: common hazards in one's work environment that are tolerated by workers independent of the risk associated with them.

“Unseen or Overlooked” Hazards: hazards that are unidentified by workers, are not detected by monitoring systems, engineered or administrative controls.
WHY HAZARDS BECOME NORMALIZED

- Cognition
- Emotional
- Organizational
Workers depend on sensory cues to identify hazards \(^2\)
Mental shortcuts can either help or hinder the workers ability to identify hazards \(^3, 4\)
• Technical risk level of a hazard can be very different from the perceived risk\(^5\)
• Risk = Hazard + Outrage\(^5\)
• Angry drivers experience lapses in concentration, minor losses of vehicle control, close calls, aggressive driving and risky behaviour\(^6\)
• Frustration causes neural transmitters to go into survival mode instead of allowing us to reason\(^7\)

(EMOTIONAL)

(![](States of mind Inattention Increase risk to hazards Harm)

(after Sylvestre)
FACTORS AFFECTING RISK TOLERANCE (CREATING BLIND SPOTS)

• Voluntariness (right to refuse)
• Controllability (your job)
• Familiarity (normalization of risks)
• Benefits (livelihood)
• Understanding (over confident)
• Trust (company will take care of you)
• Incident history (memory of past event)
• Anger (distracted from tasks)
“Safety Culture” - How things are done around here
• Reward or penalty motivational factors
• Over worked or under worked
• Supervisors and co-workers
• Internal communication
• Time constraints
• Peer pressure
WHY ARE HAZARDS UNSEEN?

- Within the Worker’s Control
- Within the Organization’s Control
CAUSES OF UNSEEN HAZARDS

Within the Worker’s Control:\(^9\)

- Unfamiliarity with tools and equipment
- Hazard that are unassociated with the primary task
- Perceived low levels of risk
- Stopping hazard recognition prematurely
- Selective attention or inattention
- Task unfamiliarity
Within the Organization’s Control:

- Latent or stored energy hazards
- Visually unperceivable/obscure hazards
- Infrequent or unexpected hazards
- Unknown potential hazards
- Hazard source detection failure
- Multiple hazards associated with a single source or task
- Hazards without immediate outcome
GROUP ACTIVITY

- What are the unseen or overlooked hazards on your work site?
- What are the higher consequence hazards?
ORGANIZATIONAL BLIND SPOTS
WHY ARE HAZARDS NOT IDENTIFIED OR REPORTED?

- Lack of Training
- Fear
- Risk Tolerance
- External Pressures
- Cultural Inaction
- Complacency
- No Accountability
- Dynamic Work

- "People are uncertain if some things are hazards"
- "Lost contract due to performance"
- "Inadequate training as to what 'hazards' are"
- "Fear of retribution (job loss, bullying by coworkers)"
- "If you can’t do it right do it at night"
- "Production driven 'blindness'"
- "The hazard was discuss several times with different personnel. No corrections made to date"
- "I am comfortable doing the job - won't happen to me"
- "Someone else has already identified it"
- "Work space is constantly changing (cell advances, pull backs)"
WORKERS’ HAZID/MANAGEMENT DEPENDS ON SYSTEMS

VERBATIM EXAMPLES

“Tailings is the clean up crew, the armpit of the operations.”
“The tailings are called the “ass-end” of the operations. All the good stuff has been taken out and we’re dealing with what is left.”

“Documents can be 5+ years out of date, hard to understand and difficult to access.”
“Analysis paralysis.”
“So much paper work, makes operations less safe.”

“Inconsistencies with supervisors, one wants production, one wants safety, no one in between.”
“Direction changes shift by shift, even on the same task. Why is it okay to do one shift and not the other?”

“People don’t look for hazards on their own, they are not empowered, or held accountable. They are too focussed on their job descriptions.”
“Use safety as an excuse to not do work.”

FIRST-ORDER THEMES

Apathy
Bureaucracy
Lack of standards and consistency
Diffuse Responsibility

AGGREGATE DIMENSIONS

Complexity → Ambiguity in interpretation
WORKERS’ HAZID/MANAGEMENT DEPENDS ON SYSTEMS
WORKERS’ HAZID/MANAGEMENT DEPENDS ON SYSTEMS

VERBATIM EXAMPLES

“If there’s a procedure, stick to it. If the job must be done, you can break the rule.”
“Make more connections per shift get an “atta boy”. No feedback for safety, slows things down.”
“Higher incidents when there are family issues and strain. Affects mental health”

“Employees, contractors, everyone, are busy looking over their shoulders. You’re gonna get fired. We all have a family to feed.”

“90% of job is a high potential to get stuck. If you don’t have a high-risk tolerance, you don’t belong in tailings.”
“People have a tough time admitting that they need help and don’t know.”

FIRST-ORDER THEMES

Competing Demands
Fear of punishment or judgement
Risk Tolerance

AGGREGATE DIMENSIONS

External and internal influences on judgment
WORKERS’ HAZID/MANAGEMENT DEPENDS ON SYSTEMS

VERBATIM EXAMPLES

“Don’t take anything for granted. The road travelled yesterday literally might not be there tomorrow.”
“In the winter steam you feel like you are going in blindfolded with your hands behind your back. Claustrophobic. No reference to tell if you are getting stuck.”

“Rescued people from landmines when I worked in the military and I am more scared here.”

“It’s the unpredictable ones. Unforeseen. How do you see what you can’t? How do you make hazards foreseeable?”

FIRST-ORDER THEMES
- Dynamic, everchanging operations
- Highly challenging operations
- Unseen/normalized hazards

AGGREGATE DIMENSIONS
- Uncertainty about operations
Safety culture refers to shared understandings of how to identify, tolerate, and manage hazards

Our research focused on the following key perceptions:

| Perception of management commitment to safety | Perception of communication and use of safety procedures | Perception of tolerance to risk | Overall, safety perceptions |

The question is how do these four perceptions combine to produce unique experiences of safety culture?
TYPES of SAFETY CULTURE

To determine different types, we looked for subgroups within the population who shared similar experiences on the key perceptions.
TYPES of SAFETY CULTURE

Four Patterns Emerged:
These combinations reflect types of safety culture observed in the sample

- Management Commitment to Safety
- Communication and use of Procedures
- Tolerance to Risk
- General

Suboptimal
- Suboptimal Negligent
- Suboptimal Disconnected
- Suboptimal Lip Service
- Optimal

4% 6% 25% 65%
What Are These Data Telling Us?

- 65% of respondents experienced an Optimal safety culture
  - i.e., stronger than average safety perceptions

- 35% experienced various forms of suboptimal cultures
  → *We can improve the safety cultures these workers are in!*

- What makes the three suboptimal cultures *suboptimal*?
  
  - Negligent culture = very low on everything, especially management commitment
  
  -Disconnected culture = better than average on most things, but extremely low on overall safety practices
  
  - Lip Service culture = optimal levels of management commitment but below-average implementation
Some Interesting Observations

Labour/Operators more likely in **Negligent** or **Disconnected** groups

Older workers more likely in **Optimal** group

Larger organizations more likely to have workers in the **Negligent** rather than the **Disconnected** group

**What are the behavioural safety implications?**

Weakest safety performance in the **Disconnected** group

**Optimal** group had **strongest** safety performance

**Negligent** and **Lip Service** slightly better than **Disconnected**, but still worse than **Optimal**

Follow-up analyses may use LTIR as well
GROUP DISCUSSION

- How would these different groups of workers (feedback listed on slides 25-28, suboptimal subcultures listed on slides 29-32) need different tailored strategies to improve their specific set of safety perceptions?

- What would you expect as ‘push back,’ preventing effective implementation of these strategies?
CREATING RESILIENCE
BUILDING RESILIENCE

- Resilience engineering looks at how the organisation or system functions as an interdependent whole:¹⁰
  - **Respond.** Knowing what to do, or being able to respond to regular and irregular changes, disturbances, and opportunities by activating prepared actions or by adjusting current mode of functioning.
  - **Monitor.** Knowing what to look for, or being able to monitor that which is or could seriously affect the system’s performance in the near term – positively or negatively. The monitoring must cover the system’s own performance as well as what happens in the environment.
  - **Learn.** Knowing what has happened, or being able to learn from experience, in particular to learn the right lessons from the right experience.
  - **Anticipate.** Knowing what to expect, or being able to anticipate developments further into the future, such as possible disruptions, novel demands or constraints, new opportunities, or changing operating conditions.
TAILOR INTERVENTIONS TO DRIVE ENGAGEMENT AND IMPROVEMENT

Tailoring intervention tools to your organizations’ maturity level would best drive engagement and improvement.11–12

Knowing what has happened

- *Awareness* – simple knowledge of a ‘better’ alternative to current state
- *Creation of need* – active personal desire to achieve the new state
- *Making the outcome believable* – believing that the new state is sensible for those involved
- *Making the outcome achievable* – making the process of achieving the new state credible for those involved
- *Personal vision* – definition by those involved of what they expect the new situation to be
- *Information about successes* – provision of information about others who have succeeded
TAILOR INTERVENTIONS TO DRIVE ENGAGEMENT AND IMPROVEMENT

Knowing what to do
- *Plan construction/operation* – creation by those involved of their own action plan
- *Measurement points* – definition of indicators of success in process
- *Commitment* – signing-up to the plan of all involved

Knowing what to look for
- *Do* – start implementing action plan
- *Review* – review progress with concentration upon successful outcomes
- *Correct* – reworking of plan where necessary

Knowing what to expect
- *Review* – management review of process at regular (and defined in advance) intervals
- *Outcome* – checks on internalisation of values and beliefs in outcome state
What controls would you put in place to reduce the consequences and/or likelihood of associated with these hazards?

Not all controls are equal in their effectiveness in reducing risks. How would you risk rank these controls?

What measures would you use to ensure that these critical controls are in place and working?
IN SUM:

We are capable of becoming resilient

• Operators and heavy construction companies work in harsh environments, and innovating solutions, while keeping your eye on maintained improvements.

• There are risks associated with inherently hazardous work. We put risk mitigations in place to control the associated probability and consequences to an acceptable level.

• We need to learn from those incidents to continually improve our risk management program.

• Because of this, most systems are able to absorb these risks. We need to understand successes. We need to understand how a system works, when subjected to differing risks, how it responds, learns, anticipates and monitors – to better absorb risk.
WHAT’S NEXT

• We have engaged in an external evaluation / audit at a scale that I have never seen before!

• We have created awareness and made plans, developed enhancements, and we are monitoring these.

• We will continue to work with the Construction Owners Association of Alberta and Energy Safety Canada to analyze these findings, develop new enhancements, and provide assistance in implementation.
THANK YOU

QUESTIONS? COMMENTS?
APPENDIX

ADDITIONAL MATERIALS
REFERENCES

# HAZARD, IMPACT, AND RISK

## HAZARD

<table>
<thead>
<tr>
<th>Type of Incident</th>
<th>Odour or Irritation</th>
<th>Irreversible Effects</th>
<th>Life Threatening Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxic Gas Release (1 hour exposure)</td>
<td>ERPG - 1</td>
<td>ERPG - 2</td>
<td>ERPG - 3</td>
</tr>
<tr>
<td>Fireball - Immediate Ignition (60 second exposure)</td>
<td>1st degree burns 2 kw/m²</td>
<td>2nd degree burns 5 kw/m²</td>
<td>3rd degree burns 8 kw/m²</td>
</tr>
<tr>
<td>Flash Fire - Delayed</td>
<td>no low level Ignition consequence</td>
<td>1/2 of lower flammable limit</td>
<td>at lower flammable limit</td>
</tr>
<tr>
<td>Unconfined Vapour Cloud Explosion</td>
<td>Window Breakage 0.02 bar</td>
<td>Partial demolition of a structure 0.07 bar</td>
<td>Ear drum rupture Major structural damage 0.16 bar</td>
</tr>
</tbody>
</table>
LINKING CAUSES AND EFFECTS WITH SIMPLE MODEL

The simple cause and effect model has five components:

Loss
- People
- Environment
- Assets
- Production

Incident Description
- Contact with energy
- Contact with substance
- Contact with agent

Immediate Causes
- Substandard practices
- Substandard conditions

Basic Causes
- Personal factors
- Job factors
- Design factors

Latent Causes
- Weaknesses in MS elements characterized as:
  - Inadequate program
  - Inadequate program standards
  - Inadequate compliance to standards

This model is based on a model developed by Bird Jr., F.E. and Germain, G.L. (1992). Practical loss control leadership. Loss control management. Det Norske Veritas Inc.
OCCUPATIONAL AND PROCESS SAFETY INCIDENTS

- Catastrophic Event
  - Fatality
  - Sustained Release
    - Loss of Containment / Applied Load > Design Case
    - Single Barrier Failure
  - Near Miss
  - Lost Time Incident
  - Total Recordable Case
  - First Aid Case
    - Unsafe Acts & Conditions / Process Safety Incident
    - Systems, Culture & Competencies

- Significant
- High Potential
- Barrier Failure
- Other Incidents
- Latent Factors
### Detailed Cause and Effect Model:

<table>
<thead>
<tr>
<th>Losses Type</th>
<th>Incident Type</th>
<th>Immediate Causes Type</th>
<th>Basic Causes Type</th>
<th>Latent Causes Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Aid</td>
<td>Struck against</td>
<td>Use of Protective Defenses (assumes in place)</td>
<td>inadequate technical design</td>
<td></td>
</tr>
<tr>
<td>Medical Treatment</td>
<td>Struck by</td>
<td>Use of Tools or Equipment (good equipment available)</td>
<td>inadequate ergonomic design</td>
<td></td>
</tr>
<tr>
<td>Lost Time</td>
<td>Fall to lower level</td>
<td>Following Procedures General: (assumes sound &amp; exist)</td>
<td>inadequate assessment of loss exposures</td>
<td></td>
</tr>
<tr>
<td>Fatality</td>
<td>Fall on same level</td>
<td>Following Procedures Specific: (assumes sound &amp; exist)</td>
<td>inadequate standards, specifications and/or design criteria</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>Caught in</td>
<td>Inattention / Lack of Awareness (not focused)</td>
<td>inadequate monitoring of construction</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>Caught on</td>
<td></td>
<td>inadequate assessment of operational readiness</td>
<td></td>
</tr>
<tr>
<td>Environmental Heat</td>
<td>Caught between</td>
<td>Substandard Conditions</td>
<td>inadequate monitoring of initial operation</td>
<td></td>
</tr>
<tr>
<td>Assets</td>
<td>Contact with:</td>
<td>Workspace Hazards</td>
<td>inadequate job procedures</td>
<td></td>
</tr>
<tr>
<td>Minor &lt;$5,000</td>
<td>Environmental Cold</td>
<td>Organizational factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serious $5,000-$50,000</td>
<td>Cold surface</td>
<td>Incompatible goals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major $50,000-$500,000</td>
<td>Fire</td>
<td>Inadequate training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catastrophic &gt;$500,000</td>
<td>Electricity</td>
<td>Inadequate communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business Interruption</td>
<td>Chemical - corrosive</td>
<td>Personal Factors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor &lt;$5,000</td>
<td>Chemical - toxic</td>
<td>inadequate physical / physiological state / capability to do the work.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serious $5,000-$50,000</td>
<td>Noise</td>
<td>Perceived inadequate mental / psychological state / capability to do the work.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major $50,000-$500,000</td>
<td>Pressure</td>
<td>Physical or physiological stress.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catastrophic &gt;$500,000</td>
<td>Radiation</td>
<td>Perceived mental or psychological stress.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*This model is based on a model developed by Bird Jr., F.E. and Germain, G.L. (1992). Practical Loss Control Leadership. Loss Control Management. Det Norske Veritas Inc. Adapted by ESRM Program at The U of Alberta, including the APEGA Model for Management System Elements.*
UNCOVERING HIDDEN HAZARDS

1. IDENTIFY THE HAZARD
   - SEE IT?
     - Identifying Hazards
   - UNDERSTAND IT?
     - Perceiving the Risk
   - TOLERATE IT?
     - Combat Sense of Lack of Vulnerability

2. FACTORS THAT INFLUENCE RISK TOLERANCE
   - Overestimating capacity / experience
   - Familiarity with task
   - Seriousness of outcome
   - Voluntary actions and being in control
   - Personal experience with an outcome
   - Cost of non-compliance
   - Confidence in the equipment
   - Confidence in protection and rescue
   - Potential profit and gain from actions
   - Role models accepting risk
   - Anger
   - Inattention
   - Time constraint
   - Budget constraint

3. HIERARCHY OF CONTROLS
   - Elimination
     - Physically remove the hazard
   - Substitution
     - Replace the hazard
   - Engineering controls
     - Isolate people from the hazard
   - Administrative controls
     - Change the way people work
   - PPE
     - Protect the worker with Personal Protective Equipment

4. EMERGENCY RESPONSE
   - MECHANICAL PROBLEMS
     - SAFETY INSTRUMENTED SYSTEM
     - ALARMS & OPERATOR INTERVENTION
   - BASIC PROCESS CONTROL SYSTEMS
   - PROCESS DESIGN

5. HOW DO I MITIGATE IT?
   - Effectively Control the Risk with Multiple Layers

6. SAFE BEHAVIOR

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Centers of Disease Control and Prevention, 2018

Safe Risk, 2019