



BC Forest Safety

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Mobile Equipment Pedestrian Interface



DALHOUSIE
UNIVERSITY

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BCFSC and WorkSafeBC Different Voices
Webinar Series

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This presentation includes information and findings from a WorkSafeBC Applied Innovation Research Grant project titled “Integrating Inherently Safer Design for Mobile Equipment Risk Reduction,” which is a collaboration of Obex Risk Ltd., BCFSC, Dalhousie University, and WorkSafeBC. The authors gratefully acknowledge this funding.

The views, findings, opinions, and conclusions expressed herein do not represent the views of WorkSafeBC.

Outline

- ▶ Overview of mobile equipment hazards
- ▶ Ongoing work: Integrating ISD for Mobile Equipment Risk Reduction (WorkSafeBC Applied Innovation research grant)
 - ▶ Bow-tie analysis
 - ▶ Inherently safer design
- ▶ Engaging Workers: ISD Review
 - ▶ Brainstorming Questions
- ▶ Engaging Leadership: ISD in Management Systems Review
 - ▶ Self-Assessment
- ▶ Closing remarks

Introduction

- Based in Halifax, Nova Scotia, Canada
- Recently joined Jensen Hughes as a Lead Engineer, Industrial Process Safety (formerly Obex Risk Ltd.); adjunct with FutureMetrics (pellet consultancy)
- Expertise in process safety, bow tie analysis, combustible dust and inherently safer design (ISD)
- Additional experience working in aerospace, oil and gas, and nuclear industries
- Registered Professional Engineer
- Education:
 - Bachelor of Science (Chemistry, Honours)
 - Bachelor of Engineering (Chemical)
 - Master of Applied Science (Chemical – Process Safety)



Mobile Equipment Hazards and Project Background

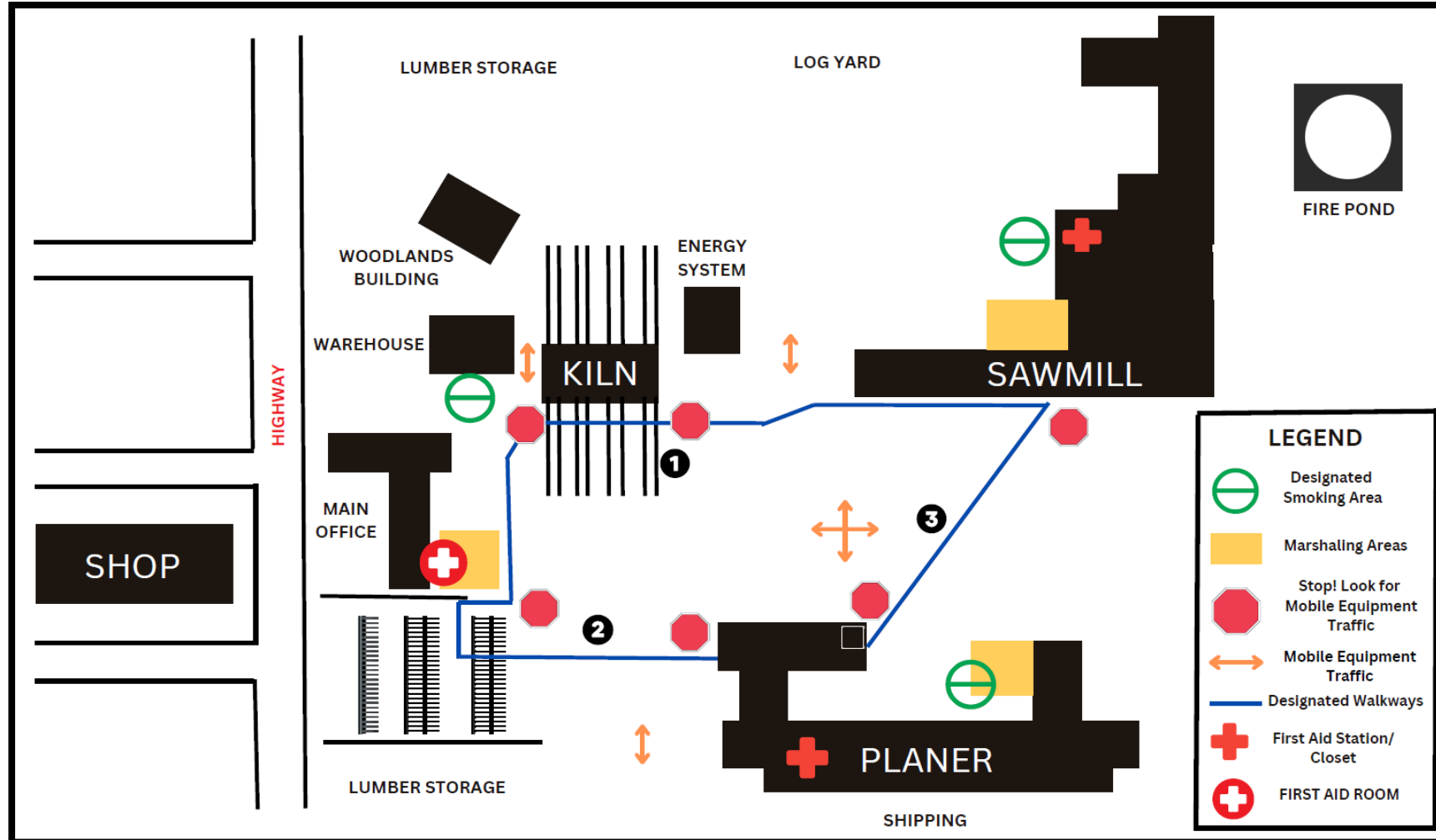
- Mobile equipment (ME) poses a significant workplace risk, including the mobile equipment-pedestrian interface (ME-PI) (struck-by incidents) as well as ergonomics and MSI (musculoskeletal injuries).
- ME and MSI hazards are included in WorkSafeBC's 2021-2023 Manufacturing High Risk Strategy (MHRS).



Credit: https://unsplash.com/photos/F2C_mSrb6iM

WorkSafeBC (2022); Rayner Brown et al. (2022a)

Mobile Equipment Hazards and Project Background



Credit: BC Forest Safety Council

Obex Risk Ltd., BCFSC (2022). Bow Tie Analysis of Mobile Equipment-Pedestrian Interface in Sawmill Operations – Overview Report

Mobile Equipment Hazards and Project Background

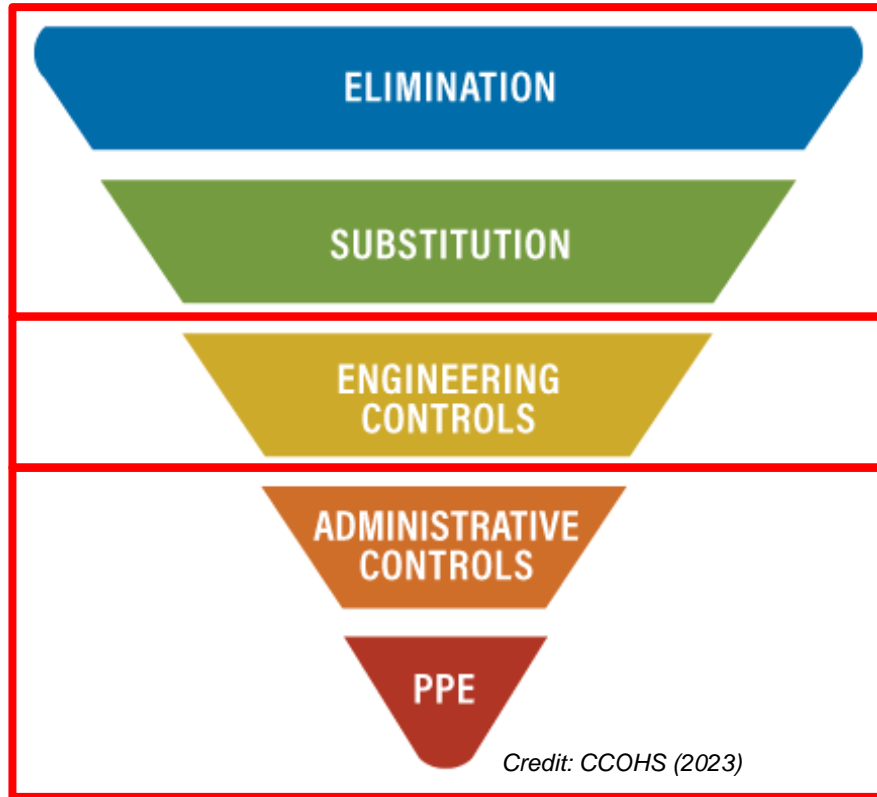
- Most barriers/safety measures currently being used to control ME hazards are administrative controls (least preferred and least effective)
- Need to explicitly consider how we can address ME hazards through design
- Research project: identify how to apply four principles of inherently safer design (ISD) (minimization, substitution, moderation, simplification)



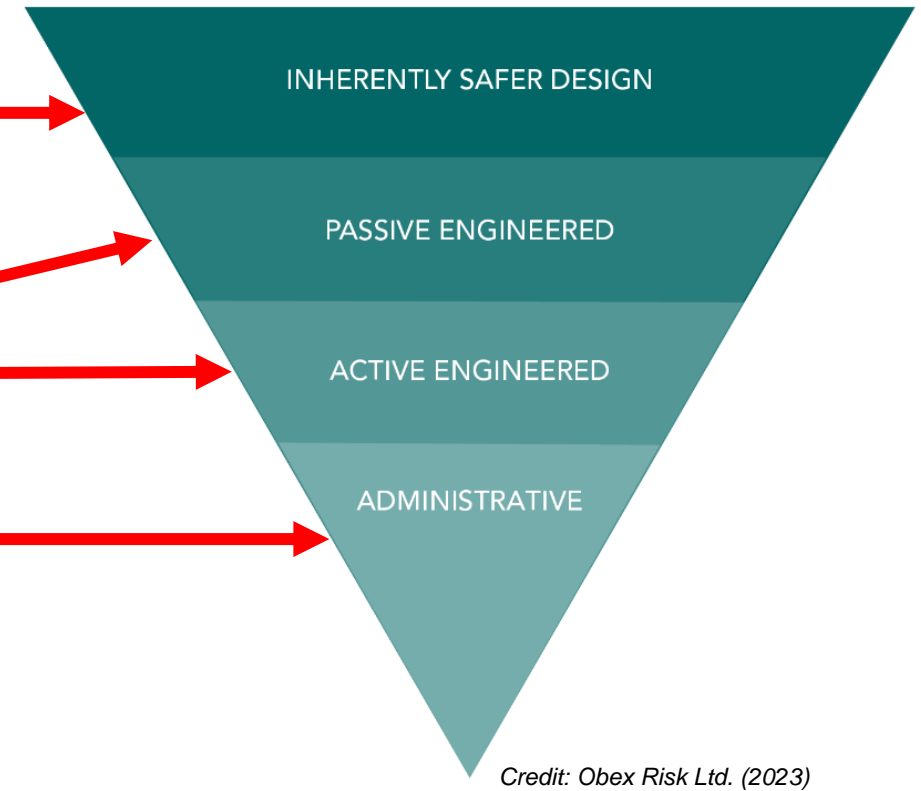
Credit: https://unsplash.com/photos/F2C_mSrb6iM

Reducing Hazards: Hierarchy of Controls

Occupational health and safety hierarchy of controls:



Inherently safer design (ISD) hierarchy of controls:



ISD Introduction

- ISD focusses on elimination of hazards and treatment of hazards at the source, rather than relying on only add-on equipment and procedures.
- How do we think about ISD? Four keywords/principles:

Minimization



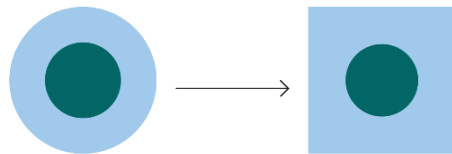
Redesign areas to minimize or eliminate the presence of pedestrians in the proximity of mobile equipment

Substitution



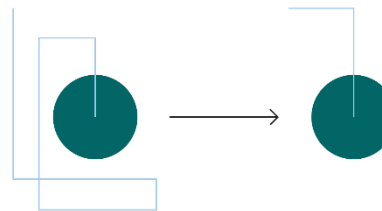
Use alternate process methods that eliminate or minimize the use or presence of mobile equipment near pedestrians

Moderation



Relocate activities involving pedestrians away from mobile equipment

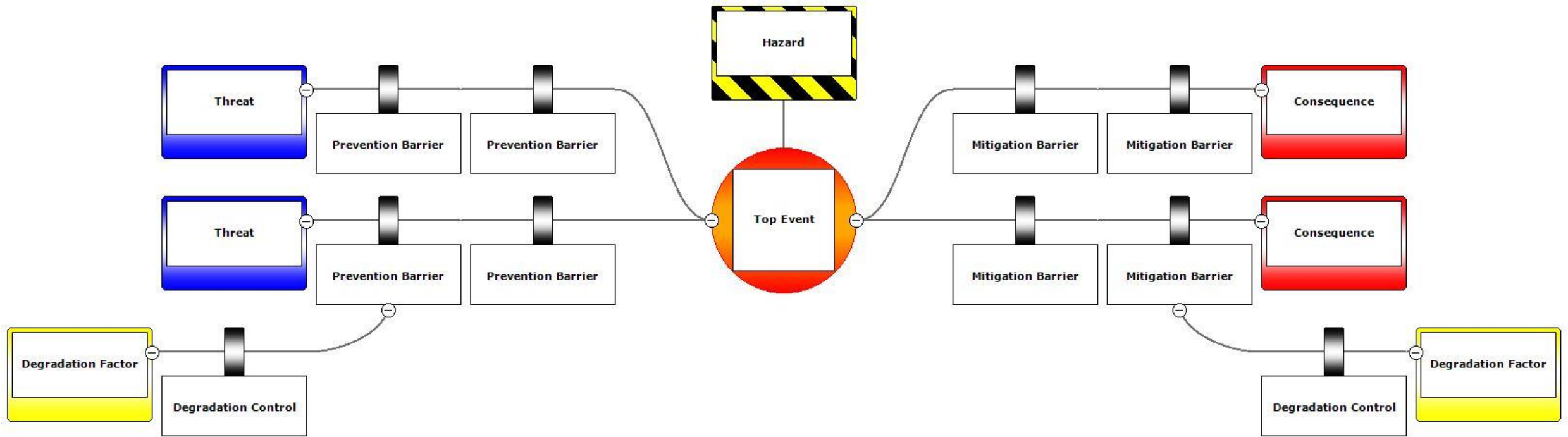
Simplification



Redesign processes and areas to make it difficult or impossible to produce a hazardous scenario due to error

Hazard Analysis: Bow Tie Method

- Analyzes how different scenarios and conditions can lead to the loss of control of a hazard and lead to consequences
- Bow tie elements are hazard, top event, threat, prevention barrier, consequence, mitigation barrier, degradation factor and degradation control.



Generic bow tie analysis (drawn using BowTieXP)

Credit: Obex Risk Ltd. (2023)

Integrating ISD: ISD Workshops

INHERENTLY SAFER DESIGN WORKSHOP

ISD workshops involve:

1. Identifying a hazard in your plant
2. Brainstorming potential ISD options and opportunities, and
3. Discussing feasibility of ISD options.

Bow tie analysis

Evaluate the hazards.

Identify ISD options using ISD checklist questions and examples.

Discuss feasibility and impact of ISD option.

Develop ISD action plans (priority, action, owner).

Review and assess ISD implementation results.

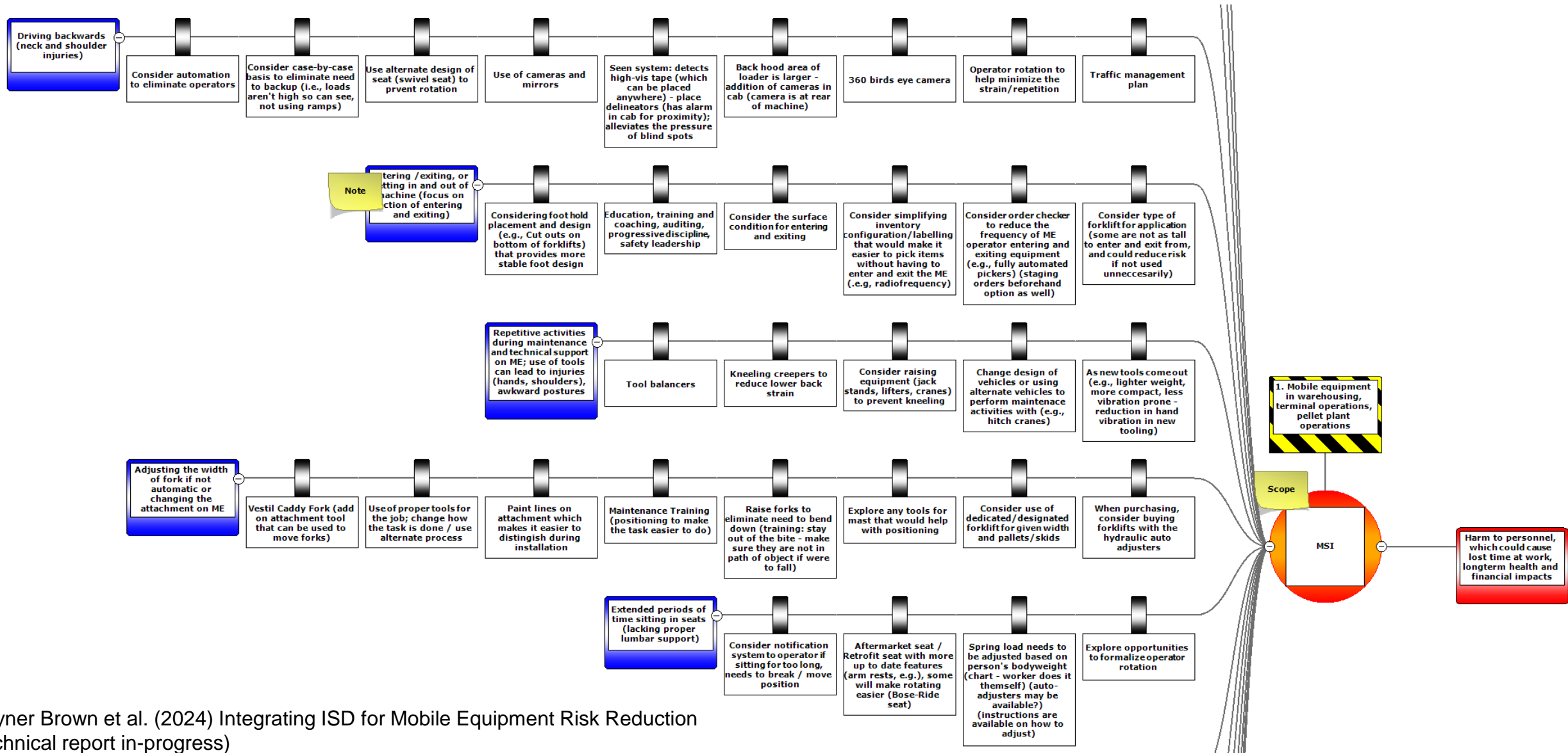
Edwards et al., (2015), Rayner Brown et al. (2020), Rayner Brown et al. (2022b)
Developed in collaboration with BC Forest Safety Council.

Credit: Obex Risk Ltd. (2023)

Workshops

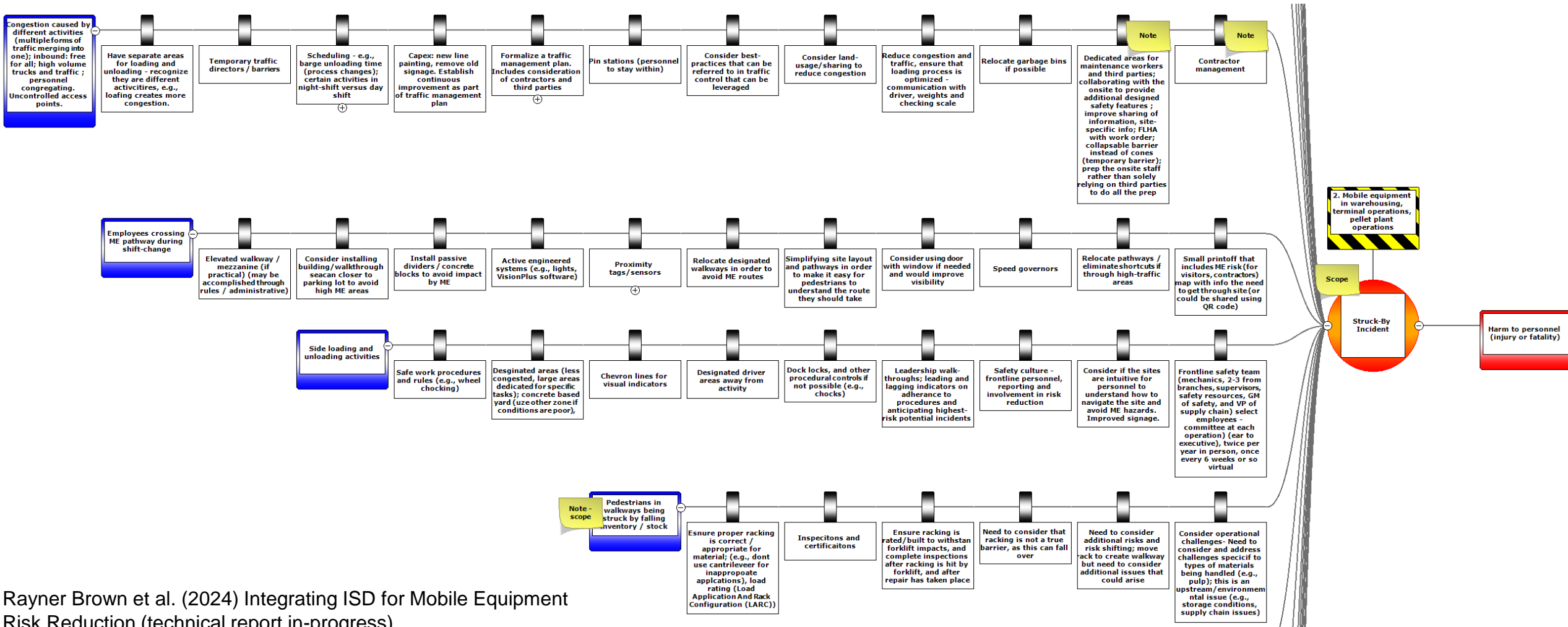
- Virtual and in-person workshops were held Q4 2023
- Attended by mix of frontline personnel, safety resources, facility managers, equipment suppliers; approximately 15 individuals participated
- The workshops provided attendees opportunities to collaborate with other colleagues to learn other perspectives, challenges, and opportunities for improvement.

MSIs Bow-Tie Analysis Results (Excerpt)



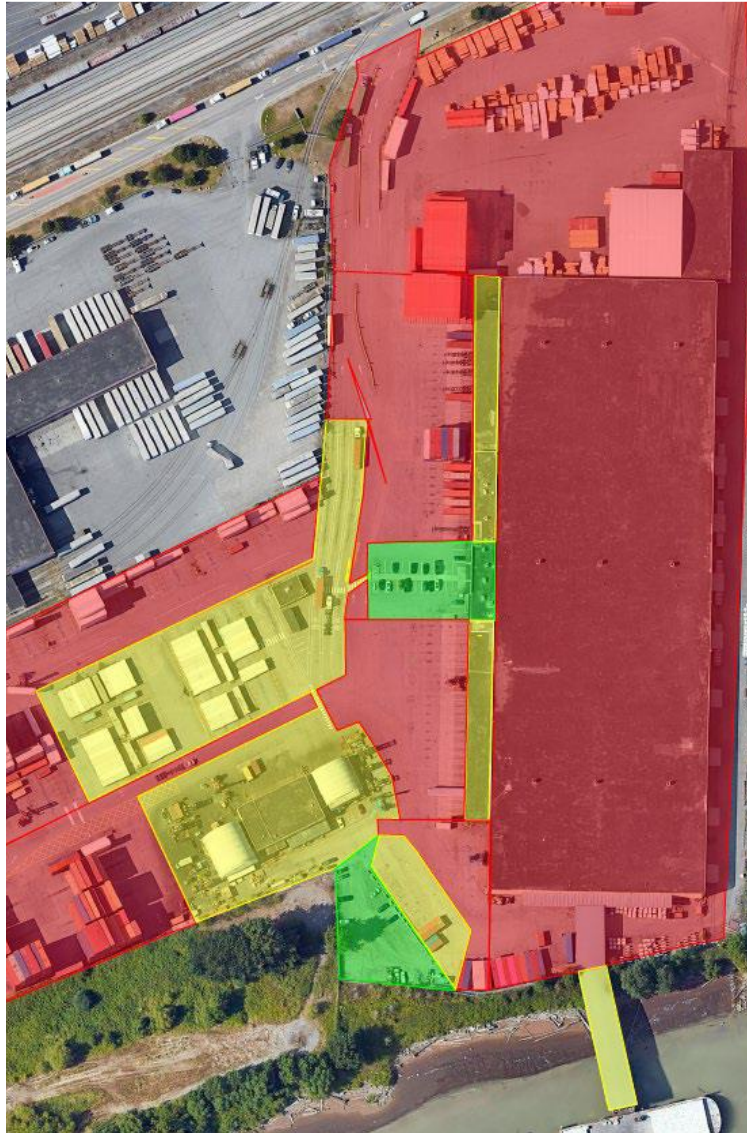
Rayner Brown et al. (2024) Integrating ISD for Mobile Equipment Risk Reduction (technical report in-progress)

MEPI Bow-Tie Analysis Results (Excerpt)



Rayner Brown et al. (2024) Integrating ISD for Mobile Equipment Risk Reduction (technical report in-progress)

MEPI ISD Workshop Results



- Consider swapping mechanic and office personnel/ME operators parking; but mechanics arrive early when there is less traffic

Rayner Brown et al. (2024) Integrating ISD for Mobile Equipment Risk Reduction (technical report in-progress)

MEPI ISD Workshop Results



- Consider creating an express lane
- Improve separation of traffic entering and exiting
- Improve access control (formalize stop and release point)
- Install stop light and pedestrian activated crossing light and/or gate

Rayner Brown et al. (2024) Integrating ISD for Mobile Equipment
Risk Reduction (technical report in-progress)

MEPI ISD Workshop Results



- Improve signage to make it more obvious to personnel
- Remove unnecessary equipment (containers) to reduce congestion

MEPI ISD Workshop Results



- Review and improve the signage. Is signage clear to audience? Can they be seen by drivers? Is it understandable?
- Consider removing the stairs - confirm if they actually have a work purpose or if they are no longer needed. Are they encouraging shortcuts and posing hazards?

Rayner Brown et al. (2024) Integrating ISD for Mobile Equipment Risk Reduction (technical report in-progress)

Workshop Findings

- Need to increase awareness of new safety features available on ME
- Procurement of facilities and ME are key opportunities to consider ISD; key stakeholders (end-users, operators, staff) need to be consulted
- Leadership buy-in is key; need to challenge the perception that ISD is always more expensive than administrative controls
- Poor management of change effects safety culture – if changes are made and all impacts of such not appropriately assessed, this will result in poor implementation and buy-in

ISD Review Questions

Guideword	Review Question
Minimize	Can the hazardous equipment or activity be eliminated or minimized?
	Can the number of mobile equipment or pedestrians involved in a given activity or task be minimized?
	Can pedestrians and bystanders be eliminated from loading/unloading processes?
	Are all materials or mobile equipment onsite removed when they are no longer needed to reduce congestion?
	Can the distance that mobile equipment needs to travel be minimized?
	Can the distance that pedestrians need to travel be minimized?
	Can the number of pedestrian-ME intersections/crossings be reduced?
	Can blind corners for pedestrians and ME operators be minimized?
	Can elevated walkways be designed and constructed that separate pedestrians from mobile equipment and eliminate potential interactions?
	Can pinch points be minimized by removing obstructions from aisles, roadways and intersections?
Can the site be reconfigured to reduce backing-up/reversing of heavy duty vehicles?	

ISD Review Questions

Guideword	Review Question
Substitute	Can alternate processes or workflows that are less hazardous be substituted?
	Is alternate equipment that eliminates or substantially reduces the hazard available?
	Can electric hand pallet movers or conveyor belts be used instead of forklifts?
	Can alternate equipment be used that has better line of site for operators?
	Can alternate lighting configurations or types be used at entrances/exits of buildings to avoid drastic changes in light levels that are difficult for personnel's vision to quickly adjust to?
	Can alternate locations be designated for lunch and worker breaks that minimizes potential exposure to ME risk?

ISD Review Questions

Guideword	Review Question
Moderate	Can potential hazards be reduced by less severe operating conditions of equipment? For example, speeds and maneuvers.
	Are all hazardous processes and equipment stored as far away as possible to eliminate disruption or possible harm to people and property in the event of an incident?
	Can the worksite be re-arranged to have more separation and distance between pedestrians and mobile equipment?
	Can high-traffic areas for mobile equipment and pedestrians be re-configured to reduce congestion?
	Can separate entrances, exits and paths be designed or reconfigured to be dedicated for each pedestrians and mobile equipment?
	Can heavy-duty mobile equipment (e.g., loaders, forklifts, tractors) be separated from light-duty vehicles (e.g., cars, pickup trucks, carts)?
	Can the conditions of the roads and paths be modified or improved (e.g., fixing potholes, uneven surfaces, slippery surfaces) to ensure the stability of ME and loads to reduce the likelihood of upset conditions (e.g., spilled loads, slips, trips and falls, sudden and unexpected maneuvers or deviation from designated safe areas)?

Rayner Brown et al. (2024) Integrating ISD for Mobile Equipment Risk Reduction
(technical report in-progress)

ISD Review Questions

Guideword	Review Question
Simplify	Is the workplace designed for consideration of human factors (i.e., is the workplace ergonomically designed for different physical conditions of personnel, including eyesight, age, mobility and walking speed)?
	Can the worksite be configured to make it less desirable for pedestrians to walk in undesignated paths (shortcuts)?
	Can equipment or work processes be designed such that it is difficult or impossible to create a potential hazardous situation due to an operating error or maintenance issue?
	Can the site be reconfigured to use one-way roads to simplify traffic flow and direction?
	Can signage be updated (including style, font, colouring) to be consistent and aligned with standards that personnel would expect and be familiar with?
	Can there be designated parking areas for all vehicles onsite, with appropriate spots dedicated for large vehicles (e.g., heavy-duty vehicles parked away from high pedestrian-traffic areas)?
	Can the efficiency of pedestrian, ME and load movements be reviewed and made more optimal through planning and automation?

ISD Self-Assessment

Senior Leadership

- Are they aware and knowledgeable about the hierarchy of controls? Or when it is the best time to consider ISD?
- Does senior leadership direct decision-makers to consider ISD?
- Does senior leadership ensure that relevant stakeholders (such as mobile equipment staff, onsite safety resources) are included in key activities, such as project design, procurement, risk assessments and incident investigations? Are these stakeholders knowledgeable about ISD as well?
- Are there arrangements in place for communicating mobile equipment safety information to staff?
- What resources and initiatives are need to help leadership be aware of ISD?

ISD Self-Assessment

Risk Assessment

- Are engineered controls generally regarded as preferred over administrative/procedural controls?
- Is the hierarchy of controls and ISD considered when identifying and selecting control measures from a risk assessment?
- Have you identified critical controls? How are you ensuring reliability? Have you identified responsibilities and accountabilities at all levels of your organization?

ISD Self-Assessment

Management of Change (MOC)

- Are engineered controls generally regarded as preferred over administrative/procedural controls?
- Is the hierarchy of controls and ISD options considered during management of change?
- Are operators involved or consulted when work processes are developed? When new mobile equipment is being introduced? When new materials are being handled? When facility changes (layout, additional changes, temporary building) are being proposed?
- How are changes being handled with respect to seasonality, inventory, shipping?

ISD Self-Assessment

Equipment Procurement

- Are key stakeholders involved when procuring (leasing or buying) mobile equipment?
- When procuring mobile equipment, are all available safety features discussed with the supplier? Do you discuss new technology that is available on equipment that may help with MSIs and MEPI?
- Are different safety features on mobile equipment considered with respect to the hierarchy of controls? Do operations select equipment that is more inherently safe for given applications?
- Do you collaborate or discuss challenges or benefits of equipment and safety features with others in your industry?

ISD Self-Assessment

Facilities Design and Procurement/Leasing


- Facilities are a main driver of ISD – during selection and leasing of facilities, is inventory flow and traffic management considered in order to reduce MEPI?
- Are key stakeholders involved when selecting and leasing facilities?

Closing Remarks

- Mobile equipment hazards are a significant risk to personnel onsite.
- Bow-tie analysis allows for clear visualization of hazards and provides valuable opportunities to involve frontline personnel.
- Inherently safer design (ISD) is the most-effective and most-preferred approach to risk reduction.
- ISD review questions can be used to help identify ways to implement ISD.
- Self-assessment of management system elements and related topics can support a gap analysis and action plan.
- Frontline personnel should be meaningfully engaged when undertaking changes onsite that influence mobile equipment.

Questions and Answers

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