Advancing Process Safety Management in Wood Pellet Production

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Process Safety Management Division (PSMD) Symposium.

November 7, 2022

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Presentation Outline

- Overview of Canadian Wood Pellet Production
- Recent Process Safety Projects
  - Inherently Safer Bow Ties for Dust Hazard Analysis
  - Analysis of Deflagration Isolation in Wood Pellet Production for Safer Operation
- Ongoing Process Safety Project: Integrating PSM into Canadian Wood Pellet Facilities that Generate Combustible Wood Dust
  - PSM in Wood Pellet Operations Survey
  - Key Performance Indicators (KPIs)
  - Process Safety Culture
- Closing Remarks

Introduction

- Based in Halifax, Nova Scotia
- Process Safety Specialist with expertise in process hazard analysis, bow tie analysis, and inherently safer design (ISD)
- Previous experience in aerospace, oil and gas, and nuclear, providing technical guidance on a range of health and safety, environmental protection, and continuous improvement programs

- Provide range of industrial risk management services including bow tie analysis workshops, inherently safer design workshops, critical control management, process safety research and development, and combustible dust hazard consultation
- Deliver agile and personalized service. Provide practical, forward-thinking approaches to reduce risk and protect personnel, business, and the environment.

Canadian Wood Pellet Production

- Wood pellets manufactured from forest residues and by-products of other sectors in wood processing industry, like sawmilling
- Wood pellets are fuel used for heat and power generation
- 47 wood pellet plants located across Canada; plant capacities range approximately 20,000 – 400,000 tonnes per year
- Wood pellet production generates combustible wood dust, which presents risk of fire and explosion involving equipment such as dryers, conveyors and dust collectors.
- Strong emphasis on combustible dust mitigation in wood products industry following incidents at Lakeland Mill and Babine Forest Products sawmills in 2012.

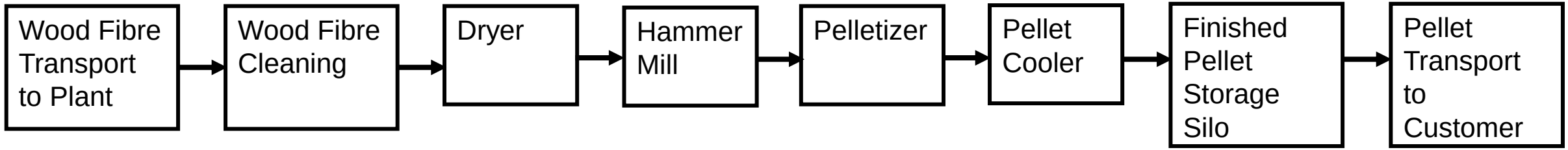


Figure 1. Block flow diagram of wood pellet production process

Canadian Biomass (2022)

Project: Inherently Safer Bow Ties for Dust Hazard Analysis

- Completed through collaboration of Dalhousie University, Wood Pellet Association of Canada (WPAC), BC Forest Safety Council (BCFSC) and Dust Safety Science.
- Completed in parallel with WPAC-BCSFC Critical Control Management (CCM) project
- Research objective: Incorporate principles of inherently safer design (ISD) into management of combustible dust hazards associated with wood pellet production
  - Effective risk reduction involves implementation of ISD, engineered equipment, and procedural measures
  - ISD focusses on elimination of hazards and treatment of hazards at the source, rather than relying on only add-on equipment and procedures.
  - ISD based on four principles – minimization, substitution, moderation, simplification

Kletz and Amyotte (2010); Amyotte and Khan (2020)

Hierarchy of Controls and Management of Combustible Dust Hazards

ISD (Minimization): Use of sloped surfaces to reduce combustible dust accumulation

Passive Engineered: Installation of flap valve

Active Engineered: Installation of chemical isolation

Administrative: Wearing of personal protective equipment (PPE) by personnel

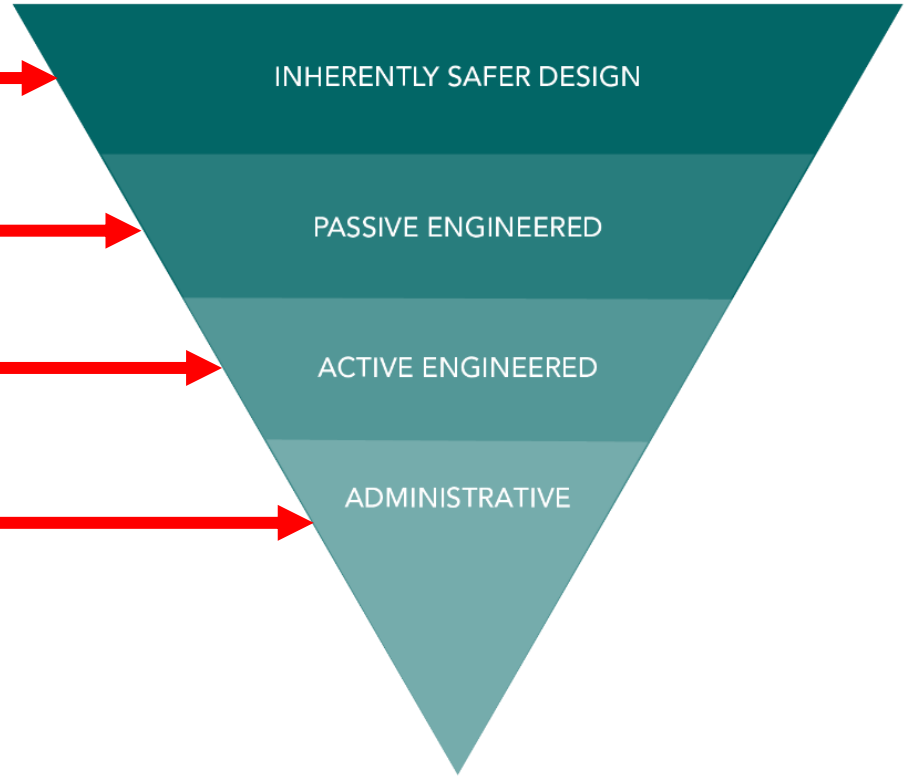


Figure 2. Hierarchy of controls for the management of combustible dust hazards

Project: Inherently Safer Bow Ties for Dust Hazard Analysis

- Key outcomes and learnings: ISD barriers were successfully identified
  - Use of paved surfaces on which to store feedstock to minimize rocks entering process and presenting risk of ignition sources,
  - Use of reduced sized silos to minimize inventory and increase turnover frequency,
  - Removal of unnecessary or hazardous equipment, like fans, following a redesign, and
  - Relocation of hazardous equipment, like cyclones, outside and away from personnel.
- Future Work: Developing and providing resources to operations to support adoption of ISD

Advancing PSM in wood pellet production: Explicitly considering ISD within PSM by incorporating into process hazard analysis (PHA) (bow tie analysis)

Rayner Brown et al. (2022)

Project: Analysis of Deflagration Isolation in Wood Pellet Production for Safer Operation

- Key outcomes and learnings:
  - Enhancing understanding of deflagration isolation,
  - Common isolation methods and locations for isolation in wood pellet production,
  - Managing and maintaining isolation technique effectiveness, and
  - Incorporating isolation methods.

Advancing PSM in wood pellet production:

- Enhancing risk assessment and risk reduction related to deflagration propagation
- Improving reliability and integrity of process safety equipment, supported by training and process safety culture elements

Ongoing Project: Integrating Process Safety Management into Canadian Wood Pellet Facilities that Generate Combustible Wood Dust

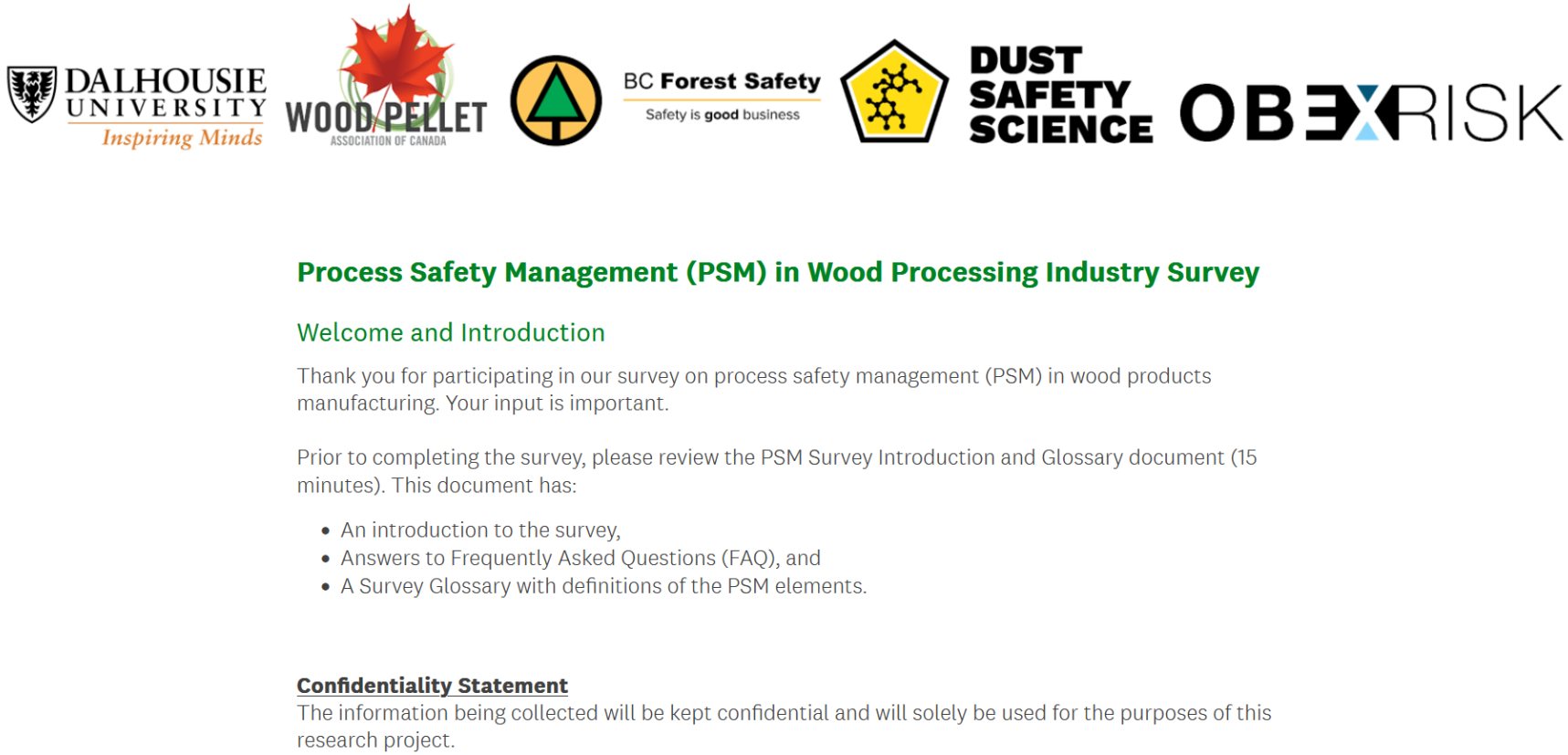
- Project being completed in collaboration with WPAC, BCFSC, Dalhousie University, Dust Safety Science and Obex Risk Ltd.

Advancing PSM in wood pellet production:

- Project objective: Development of PSM integration tool to explicitly and effectively consider PSM elements in wood pellet production
- Identifying PSM system implementation appropriate for size, scale, and complexity of wood pellet operations
- Key focus: PSM systems, key performance indicators (KPIs), process safety culture

Process Safety Management (PSM) Survey

- Identify PSM elements currently found in wood pellet industry using CSA Z767 as the framework
- Understand areas to prioritise and help to improve for implementation of PSM within a given organization



Process Safety Management (PSM) in Wood Processing Industry Survey

Welcome and Introduction

Thank you for participating in our survey on process safety management (PSM) in wood products manufacturing. Your input is important.

Prior to completing the survey, please review the PSM Survey Introduction and Glossary document (15 minutes). This document has:

- An introduction to the survey,
- Answers to Frequently Asked Questions (FAQ), and
- A Survey Glossary with definitions of the PSM elements.

Confidentiality Statement

The information being collected will be kept confidential and will solely be used for the purposes of this research project.

Preliminary Survey Feedback – KPIs

- Preliminary feedback indicates that enhancing Key Performance Indicators (KPIs) is an area of interest for improvement
  - KPIs or Process Safety Performance Indicators (PSPIs): Key performance metrics that indicate when a process safety accident is most likely to occur
  - Involves the use of leading indicators and lagging indicators that are selected and monitored to target for improvement.
- Research focus:
  - Leveraging data and outcomes from previous projects to support development of KPI recommendations
  - Collecting current industry practices to deliver resources and guidance on current KPI practices

Azizi (2016)

Process Safety Culture

- Safety Culture
  - Features: Just, Reporting, Learning and Flexible (Decision-Making) cultures (Hopkins, 2005)
- Collective Mindfulness
  - Preoccupation with failure and sensitivity to operations
  - Avoiding complacency and maintaining a sense of vulnerability
- Risk Awareness
  - Avoiding normalizing evidence (“normalization of deviance or deviation”)
- Research focus:
  - Safety culture effectiveness can be tracked as part of KPIs; creating a safety culture survey tailored to wood pellet operations as an internal mechanism for measuring and monitoring safety culture.
  - Providing resources and guidance on current safety culture practices

CCPS (2022); Hopkins (2005)

Conclusion

- The explicit and effective integration of PSM within wood pellet operations presents the opportunity to enhance the prevention and mitigation of loss of control incidents
- Recent process safety projects have focussed on PSM elements subset and industry high-priority hazards (deflagration propagation)
    - Process risk assessment and risk reduction
    - Process and equipment integrity
    - Training
    - Process safety culture
- Ongoing PSM project supports integration of PSM through delivery of systems, tools and guidance appropriate for scale of wood pellet operations leveraging key elements of KPIs and process safety culture

Acknowledgements

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

- Project team gratefully acknowledge funding from WorkSafeBC.
- Project team also extend thanks to all personnel at the forest products manufacturing facilities involved in the research for their commitment and collaboration.
- Deflagration Isolation Project:
  - Project funding provided by Dalhousie University and arranged by Dr. Paul Amyotte (Professor, Chemical Engineering, Department of Process Engineering and Applied Science)
  - All subject matter experts for providing input and expertise (in alphabetical order by first name)
    - Jay Juvenal (CV Technology),
    - Jeff Mycroft (Fike),
    - Jeramy Slaunwhite (Rembe),
    - Luc Cormier (Jensen Hughes),
    - Dr. Paul Amyotte (Dalhousie University),
    - Tim Heneks (Dustcon Solutions Inc.),
    - All others who wished to provide input without attribution

Acknowledgements

- Deflagration Isolation Project Continued:
  - WPAC, BC Forest Safety Council and Dr. Chris Cloney (DustEx Research Ltd.) for providing guidance on project scope and definition
  - BC Forest Safety Council for extensive project support, including project scoping, research methodology development, stakeholder outreach, and report review
  - Dr. Paul Amyotte, for extensive project support and report review

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