

# PROCESS SAFETY MANAGEMENT: SUMMARY AND RESOURCES

Around the world, process safety management (PSM) is becoming central to worker safety and managing risk. PSM implementation protects personnel, equipment, and production uptime, and is associated with lower maintenance cost, insurance and capital.

The Wood Pellet Association of Canada (WPAC), BC Forest Safety Council (BSFSC), Dalhousie University, and DustEx Research Ltd., along with Obex Risk Ltd. as project technical lead, recently completed a research project to look at the implementation of PSM using the CSA Z767 Process Safety Management standard as the framework.

The recommendation from *Integrating Process Safety Management into Canadian Wood Pellet Facilities that Generate Combustible Wood Dust* is that the industry proceed with PSM implementation through a strategic long-term plan. It is anticipated this initiative will be a core

focus of the WPAC Safety Committee Workplan for the next 5-7 years.

This summary of current resources has been developed to help support wood pellet operations implement PSM.

## OVERVIEW OF PSM FRAMEWORK

CSA Z767 is a Canadian standard applicable to a Canada-based project and provides the opportunity to consider industry best practices based on the practices and standards developed by experts in a wide range of high-hazard industries.

PROCESS SAFETY MANAGEMENT ELEMENTS			
PROCESS SAFETY LEADERSHIP	UNDERSTANDING HAZARDS AND RISKS	RISK MANAGEMENT	REVIEW AND IMPROVEMENT
Accountability	Process knowledge and documentation	Training and competency	Investigation
Regulations, codes, and standards	Project review and design procedures	Management of change	Audits process
Process safety culture	Process risk assessment and risk reduction	Process and equipment integrity	Enhancement of process safety knowledge
Conduct of operations – senior management responsibility	Human factors	Emergency management planning	Key performance indicators



# PSM IMPLEMENTATION STRATEGY

PSM implementation is aligned with our sector’s approach to continuous improvement and commitment to our people, the communities we operate within, and the customers we serve. Safety experts will do most of the hands-on work and will be guided by a steering committee.



**Communicate and evaluate research outcomes;** provide recommendations and gain consensus from stakeholders on the next actions.



**Establish PSM Steering Committee,** who will provide input on workplans, timelines and material and process development.



**Develop process to provide ongoing support** across the industry.



**Develop implementation guide, workplan and milestones.**



**Develop self-assessment worksheets** for each of the PSM elements.



**Develop additional resources** with input from operations based on their needs.



**Complete qualitative gap analysis** against CSA Z767 standard using the self-assessment sheets.



**Develop action plans and other tools and resources** to address identified areas for improvement.



**Create library** of PSM policies and procedures for operations to refer to and adapt accordingly.



**Develop PSM implementation, site-specific and industry benchmarking process safety KPIs** to monitor and report out on progress.



**Develop additional guidance and resources** to support operations for determining the effectiveness of PSM element implementation, as part of the Plan-Do-Check-Act cycle.

## THREE PHASE PROCESS

The implementation of the PSM elements (found on page 1) has been broken down into three phases so it is achievable for smaller organizations.

### PHASE 1

- Accountability
- Process safety culture
- Process risk assessment and risk reduction
- Management of change (MOC)
- Investigation
- Key performance indicators (KPIs)

### PHASE 2

- Conduct of operations – senior management responsibility
- Process knowledge and documentation
- Human factors
- Training and competency
- Process and equipment integrity

### PHASE 3

- Emergency management planning
- Project review and design procedures
- Audit process
- Regulations
- Standards and codes
- Enhancement of process safety knowledge

# RESOURCES AND INDUSTRY BEST PRACTICES BY PSM ELEMENT

Use these industry best practices and resources to learn about PSM implementation in other industries.

## WPAC RESOURCES

- Factsheet: PSM Overview
- Presentation: PSM Implementation: Research Outcomes and Next Steps

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PROCESS SAFETY MANAGEMENT (PSM) IN WOOD PRODUCTS MANUFACTURING  
PSM OVERVIEW

**INTRODUCTION TO PSM**  
PSM is the use of management principles and systems to identify, understand, avoid, and control process hazards to prevent, mitigate, prepare for, respond to, and recover from process-related incidents.  
PSM provides wood products manufacturing facilities a framework to address risk associated with combustible dust to prevent loss-producing incidents, including fires and explosions.

**PSM ELEMENTS**  
The CSA Z767 Process Safety Management Standard is a 16-element system.

Process Safety Management Elements			
Process safety leadership	Understanding hazards and risks	Risk management	Review and improvement
Accountability	Process knowledge and documentation	Training and competency	Investigation
Regulations, codes, and standards	Project review and design procedures	Management of change	Audits process
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**WOOD PELLET**  
ASSOCIATION OF CANADA

**BC Forest Safety**  
Safety is good business

**OBEXRISK**

**PSM Implementation: Research Outcomes and Next Steps**  
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Prepared For: Wood Pellet Association of Canada (WPAC) and BC Forest Safety Council (BCFSC)

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## INDUSTRY BEST PRACTICES

- Adoption of CSA Z767 in BC Regulation. 2022 Canadian Society for Chemical Engineering PSM Symposium [BC Energy Regulator, 2022]
- Chemical Accident Prevention Program (CAPP) Guidance [Nevada Division of Environmental Protection (NDEP), 2023]
- Path 2 Risk and Safety Management Plan (RSMP) Implementation Guide [Technical Standards and Safety Authority (TSSA), 2020]
- Process Safety Code: Process Risk Management [Gulf Petrochemicals & Chemicals Association (GPCA), 2011]
- Process Safety Management Plan [HNI Risk Advisors, n.d.]
- Process Safety Management Requirements/ Guidelines [Penn State, 2023]
- PSM Implementation Guidelines [PSM Egypt, 2022]
- PSM Steering Committee [PSM Egypt, 2023]
- PSM Steering Committee Charter [Penn State, 2016]
- Rio Tinto Process Safety Standard [Rio Tinto, 2021]
- Risk Management Plan (RMP) & Process Safety Management (PSM) Manual [Newington Energy LLC, 2007]

# PHASE 1

Phase 1 focuses on high-priority elements that have the greatest potential for systemic changes in organizations and manage risk. As part of the research project, factsheets and self-assessment/gap analysis worksheets have been developed for selected elements, and are referenced below in the corresponding PSM element.

## ACCOUNTABILITY

Accountability addresses senior management’s responsibility for the PSM system, including establishing process safety goals and considering process safety risks throughout the facility lifecycle. Senior management is responsible for ensuring the PSM system is implemented, effective, reviewed and improved regularly.

### WPAC RESOURCES

Factsheet: Accountability

Self-Assessment Worksheet: Accountability

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## ACCOUNTABILITY

**INTRODUCTION TO ACCOUNTABILITY**

Accountability refers to senior management responsibility for the PSM system including establishing process safety goals and considering process safety risks throughout the facility lifecycle.

Accountability is an element of process safety management (PSM). The CSA Z767 *Process Safety Management* framework is shown below; accountability is highlighted.



Process Safety Management Elements			
Process safety leadership	Understanding hazards and risks	Risk management	Review and improvement
Accountability	Process knowledge and documentation	Training and competency	Investigation
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## INDUSTRY BEST PRACTICES

Corporate Governance for Process Safety: Self-Assessment Questionnaire for Senior Leaders [OECD, 2012]

Identifying Measurable Safety Goals [California Occupational Safety and Health, 2011]

Major Hazard Leadership Intervention Tool [Control of Major Hazards (COMAH), n.d.]

Managing Risk: The Hazards That Can Destroy Your Business. A Guide to Leadership in Process Safety [COMAH, 2018]

Practical Leadership for Process Safety Management [Travers, I., 2019]

Process Safety Leadership from the Boardroom to the Frontline [Center for Chemical Process Safety (CCPS), 2019]

Process Safety Leadership Guiding Principles [Health and Safety Executive (HSE), 2023]

Resources (Leadership Principles, Safety Leadership Charter, Lessons Learned) [Process Safety Forum, 2023]

The Role of Leadership in Process Safety Management System “No Process Safety Management System is an Island” [Levovnik et al., 2019]

## PROCESS SAFETY CULTURE

Process Safety Culture involves the collective mindset of the organization with respect to safety and risk, including attitudes and behaviours.

### WPAC RESOURCES

- Factsheet: Process Safety Culture
- Self-Assessment Worksheet: Process Safety Culture

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PROCESS SAFETY MANAGEMENT (PSM) IN WOOD PRODUCTS MANUFACTURING

### PROCESS SAFETY CULTURE

**INTRODUCTION TO PROCESS SAFETY CULTURE**

Process safety culture is the collective mindset of the organization with respect to safety and risk, including attitudes and behaviours.

Process safety culture is an element of process safety management (PSM). The CSA Z767 *Process Safety Management* framework is shown below; process safety culture is highlighted.



Process Safety Management Elements			
Process safety leadership	Understanding hazards and risks	Risk management	Review and improvement
Accountability	Process knowledge and documentation	Training and competency	Investigation
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### INDUSTRY BEST PRACTICES

- Building Process Safety Culture Tool Kit: Tools to Enhance Process Safety Performance [CCPS, 2021]
- Enhancing Health & Safety Culture & Performance [WorkSafeBC, 2023]
- Example Safety Culture Policy Statement [Transport Canada, 2021]
- Extract from Inspectors’ Human Factors Toolkit: Safety Culture Questions [HSE, n.d]
- Chronic Unease: Learning from Incidents - Examples of Weak Signals and Mind Traps [Shell, 2023]
- Hearts and Minds Safety Culture Toolkit [Energy Institute, 2023]
- How to Ensure Sustainable Process Safety Performance – Strategies for Managing, Maintaining, and Improving PSM Systems [Arendt, S. and Manton, M., 2015]
- Organisational Culture: Guidance [HSE, 2023]
- Safety Climate and Safety Culture Videos, Assessment Guidance, Factsheet (Safety culture, climate and leadership), Factsheet (Getting the most out of your safety climate survey) [WorkSafe Queensland, 2023]
- Safety Culture: A Guide to Effective Measurement and Improvement [Manufacturing Safety Alliance of British Columbia, n.d.]
- Safety Culture Assessments Guidance and Example [Contra Costa County Health Services, 2011]
- Safety Culture Assessment Overview [Contra Costa County Health Services, 2011]
- Safety Culture Survey Example: Baker Panel Report [Contra Costa County Health Services, 2011]
- Safety Culture Survey Example: DuPont Safety Perception Survey [DuPont, 2010]

## PROCESS RISK ASSESSMENT AND RISK REDUCTION

Process risk assessment and risk reduction involves the identification and analysis of process-related hazards, documentation of hazard analyses, and implementation of risk reduction measures.

### WPAC RESOURCES

Critical Control Management Resources [2023]

### INDUSTRY BEST PRACTICES

Barrier-Focused Approaches to Risk Analysis -Introduction to Bow Tie Analysis [WorkSafeBC, 2019]

Critical Control Management Resources [WPAC, 2023]

Path 2 RSMP Guidelines for Operating Engineers Safety Program - Appendix B: Detailed Guidance & References on Process Safety Risk Assessment [Technical Standards and Safety Authority (TSSA), 2020]

Process Safety Code: Process Risk Management [GPCA, 2011]

## MANAGEMENT OF CHANGE (MOC)

Management of change (MOC) refers to the formalized process to manage risks associated with changes to design, equipment, procedures, personnel, and the organization; and includes temporary and permanent changes.

### WPAC RESOURCES

Factsheet: Management of Change

Self-Assessment Worksheet: Management of Change

### INDUSTRY BEST PRACTICES

Combustible Dust Management Assessment Handout [SAFER, n.d.]

Golden Rules for Combustible Dust [CCPS, 2021]

Management of Change Guideline [PSM Egypt, 2022]

Managing the Health and Safety Impacts of Organizational Change [Canadian Society for Chemical Engineering (CSChE), 2004]

MOC Guidelines [Occupational Health and Safety Administration (OHSA), 2019]

Process Safety Management: Management of Change Form [Penn State, 2016]

Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities [National Fire Protection Association (NFPA) 664, 2020]

Standard on the Fundamentals of Combustible Dust [NFPA 652, 2019]

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## MANAGEMENT OF CHANGE

**INTRODUCTION TO MANAGEMENT OF CHANGE**

Management of change (MOC) is the management of risks associated with changes to design, equipment, procedures, personnel, and the organization, and includes temporary and permanent changes.

MOC is an element of process safety management (PSM). The CSA Z767 *Process Safety Management* framework is shown below; MOC is highlighted.



Process Safety Management Elements			
Process safety leadership	Understanding hazards and risks	Risk management	Review and improvement
Accountability	Process knowledge and documentation	Training and competency	Investigation
Regulations, codes, and standards	Project review and design procedures	Management of change	Audits process
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## INVESTIGATION

Investigation is the program established to identify, report, investigate, and record process safety incidents. Process safety incidents include near misses as well as significant events.

## KEY PERFORMANCE INDICATORS (KPIs)

Key performance indicators (KPIs) for process safety involves the use of leading and lagging indicators that are selected and monitored to target for improvement.

Leading indicators are process-focused metrics that signify the function of operating discipline, processes, or safety barriers/controls. Leading indicators are selected to provide an early signal of potential issues or degradation of safety controls so proactive corrective actions can be conducted.

Lagging indicators are outcome-focused metrics that can signify recurring issues and include events that have taken place.

## INDUSTRY BEST PRACTICES

[Developing Process Safety Indicators A Step-By-Step Guide for Chemical and Major Hazard Industries \[HSE, 2006\]](#)

[Process Safety Metrics Guide for Leading and Lagging Indicators \(Version 4.1\) \[CCPS, 2022\]](#)

[Process Safety Performance Indicators for a Fuel Storage Site: A Worked Example \[Fanelli, P., 2014\]](#)

[Safety Performance Leading Indicators \[Chemical Business Association, 2018\]](#)

## INDUSTRY BEST PRACTICES

[Compliance Guidelines for Incident Investigation \[Penn State, 2014\]](#)

[High Potential Incident Reporting \(HiPo or HPI\) Standard Procedure Instruction \[Vale, 2017\]](#)

[Incident Investigation Standard Procedure Instruction \[Vale, 2016\]](#)

[Introduction to Incident Investigation \[CCPS, 2023\]](#)

[Investigating Accidents and Incidents: A Workbook for Employers, Unions, Safety Representatives and Safety Professionals \[HSE, 2014\]](#)

[Process Safety Incident Report Form \[Penn State, 2016\]](#)

## WPAC RESOURCES

[Factsheet: Key Performance Indicators](#)

[Self-Assessment Worksheet: Key Performance Indicators](#)


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PROCESS SAFETY MANAGEMENT (PSM) IN WOOD PRODUCTS MANUFACTURING

### KEY PERFORMANCE INDICATORS

**INTRODUCTION TO PROCESS SAFETY KEY PERFORMANCE INDICATORS**

Process safety key performance indicators (KPIs) involves the use of leading and lagging indicators that are selected and monitored to target for improvement. Leading indicators are process-focussed metrics that signify the function of operating discipline, processes, or safety barriers/controls. Leading indicators are selected to provide an early signal of potential issues or degradation of safety controls so proactive corrective actions can be conducted. Lagging indicators are outcome-focussed metrics that can signify recurring issues and include events that have taken place.



KPIs is an element of process safety management (PSM). The CSA 2767 *Process Safety Management* framework is shown below; KPIs is highlighted.

Process Safety Management Elements			
Process safety leadership	Understanding hazards and risks	Risk management	Review and improvement
Accountability	Process knowledge and documentation	Training and competency	Investigation
Regulations, codes, and standards	Project review and design procedures	Management of change	Audits process
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## PHASE 2

Phase 2 consists of mid-priority elements that work in conjunction with the other PSM elements to manage process risk.

### CONDUCT OF OPERATIONS - SENIOR MANAGEMENT RESPONSIBILITY

Conduct of operations refers to carrying out operational and management tasks methodically to achieve operational excellence. Conduct of operations is closely tied to an organization's culture. This element refers to the role of senior management responsibility for conduct of operations.

#### INDUSTRY BEST PRACTICES

Audit Process Safety for Compliance and Performance, CEP (Chemical Engineering Progress) (subscription required) [Klein and Thompson, 2022]

Introduction to Conduct of Operations [CCPS, 2022]

Key Principles of Process Safety for Operational Readiness [CCPS, 2022]

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### PROCESS KNOWLEDGE AND DOCUMENTATION

Process knowledge and documentation includes process safety information, which consists of data relating to the characteristics of a process involving hazards, including hazardous materials properties, technologies and methods, equipment, and operation. This includes technical documentation, piping and instrumentation diagrams (P&IDs), process flow diagrams, and process risk assessments.

#### INDUSTRY BEST PRACTICES

Presentation: Prevention Program Safety Requirements for Program Level 3 Processes [Environmental Protection Agency (EPA), 2013]

Process Safety Information Procedure [Inland Star Distribution, 2016]

Process Safety Information Program [Nevada Division of Environmental Protection Chemical Accident Prevention Program (NDEP), 2011]



## HUMAN FACTORS

The human factors element considers how the interaction of humans, technology, and organizations can affect process safety. Human factors evaluates human interactions with respect to other components of a workplace system with the goal to optimize safety, human well-being and overall system performance.

### INDUSTRY BEST PRACTICES

Guidelines for Preventing Human Error in Process Safety [CCPS, 1994]

Human Factors Overview and Resources [WorkSafeBC, 2023]

Human Factors Self-Assessment Guide and Tool for Safety Management Systems at Petroleum and Major Hazard Facility Operations [State of Western Australia, Department of Mines, Industry Regulation and Safety, 2021]

Process Hazard Analysis Human Factors Checklist [Contra Costa County Health Services, 2011]

Reducing Error and Influencing Behaviour [HSE, 1999]

The Human Factor in Process Safety Management [Gambetti, F., Casalli, A., Chisari, V., 2012]

Video: Human and Organizational Performance - The 5 Principles in Action [Energy Safety Canada, 2022]

## TRAINING AND COMPETENCY

Training and competency refers to the system in place to ensure that personnel have the required qualifications and competencies to fulfill their roles and responsibilities and conduct their tasks safely and effectively. This includes experience, education, and training.

### INDUSTRY BEST PRACTICES

A Guide to Enhancing Process Safety and Plant Efficiency Through the Competence of Control Room Operators (CROs) [Leach and Wright, 2014]

HSE Requirements for Contractors [Hitachi, 2022]

HSE Training Matrix [Hitachi, 2022]

## PROCESS AND EQUIPMENT INTEGRITY

Process and equipment integrity includes systems to ensure the integrity of the process and process equipment, including inspection, testing, and maintenance (ITM) of equipment, establishing safe work practices, and conducting a pre-startup safety review (PSSR) before running a new or modified process or equipment.

### INDUSTRY BEST PRACTICES

Alarm Handling Checklist [HSE, n.d.]

Alarm Management: A Pillar of Process Safety Management [Hydrocarbon Processing, 2021]

Alarm Management - A Practical Guide [ABB, 2021]

Alarm Management Primer [Honeywell, 2012]

Better Alarm Handling Information Sheet [HSE, 2000]

Risk Engineering Position Paper: Pre-Start-Up Safety Review [Marsh, 2016]

## PHASE 3

Phase 3 consists of longer-term elements that complete the full PSM framework to manage process risk.

### REGULATIONS, STANDARDS, AND CODES

The regulations, codes, and standards element refers to the management system for the control of pertinent regulations, standards, and codes to ensure relevant documentation is up to date, communicated with relevant stakeholders, and consistently used throughout the organization.

#### INDUSTRY BEST PRACTICES

Introduction to Compliance With Standards [CCPS, 2023]

### PROJECT REVIEW AND DESIGN PROCEDURES

Project review and design procedures includes the consideration of risk assessments throughout project status, including request for approval, siting decisions, and the design process.

#### INDUSTRY BEST PRACTICES

Controlling Risk During Major Capital Projects [Bridges, W. and Tew, R., 2008]

Facility Siting Checklist [EPA Ohio n.d.]

Process Hazard Analysis Facility Siting Checklist [Contra Costa County Health Services, 2011]

### EMERGENCY MANAGEMENT PLANNING

Emergency management planning is the program used to manage the consequences of hazardous scenarios that could arise from a loss of containment incident considering regulatory requirements, standards, and industry best practices, in the preparation for and response to an emergency.

#### INDUSTRY BEST PRACTICES

Corporate Emergency Response Plan [Fortis BC, 2022]

Emergency Management Program [Arc Resources Ltd., 2021]

Emergency Management Manual [BC Energy Regulator, 2021]

Firefighting Precautions at Facilities with Combustible Dust [OSHA, 2013]

Northeast BC Emergency Response Program [Arc Resources Ltd, 2022]

Pipeline Operations Emergency Response Plan [Nova Chemical, 2020]

Silo Fires: Fire Extinguishing and Preventive and Preparatory Measures [Persson, H., 2013]

## AUDIT PROCESS

The audit process is the system for assessing the organization's current PSM program with respect to a given PSM standard to determine if the program conforms to the standard and if the PSM program is implemented and maintained.

## INDUSTRY BEST PRACTICES

Process Safety Element Audit Checklist [NDEP, 2016]

Process Safety Management Audit Protocol Workbook [CSCHE, 2013]

Process Safety Management Standard Audit Protocol [CSCHE, 2013]

PSM Auditing Checklist [OSHA, 2019]

PSM Program Review Checklist [Georgia Tech OSH Program, 2011]

Site Self-Assessment Tool [CSCHE/Major Industrial Accidents Council of Canada, 2001]

## ENHANCEMENT OF PROCESS SAFETY KNOWLEDGE

Enhancement of process safety knowledge includes the continuous improvement of process safety knowledge through industry learnings and participation in various associations (e.g., professional, trade, labour, technical), and incorporation of advances and improvements where feasible.

## INDUSTRY BEST PRACTICES

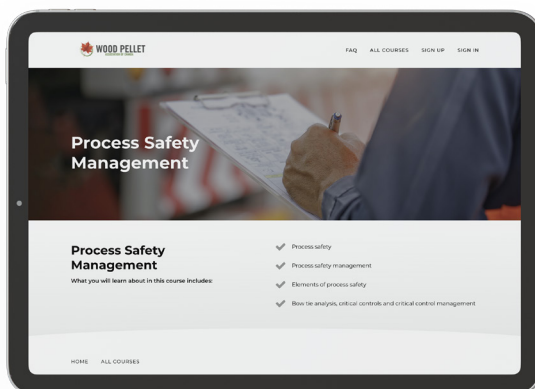
Combustible Dust Incident Database and Reports [DustEx Research Ltd., 2023]

Process Safety Code: Process Risk Management – Enhancing Process Safety Knowledge [GPCA, 2011]

Process Safety Fundamentals [International Association of Oil and Gas Producers, 2020]

Process Safety - Process Safety Summit [Conoco Philips, 2023]

Toolbox Webinar Series (including Learning from Incidents, The Role of Leadership in Accident Investigations, Learning from What Goes Right and others listed) [Energy Institute, 2023]



Visit [www.wpaclearning.com](http://www.wpaclearning.com) for the free PSM training module.