
Version 1
January 2013
American Chemistry Council

This guide necessarily addresses implementation activities of a general nature. Local, state and federal laws and regulations should be reviewed with respect to particular circumstances.

In publishing this work, the American Chemistry Council is not undertaking to meet the duties of employers, manufacturers or suppliers to warn, properly train and equip their employees and others exposed, concerning health and safety risks and precautions.

Information concerning process safety, employee safety, environmental protection and proper precautions with respect to particular operations, processes and conditions should be obtained from the employer, manufacturer or supplier of that material or equipment or the material safety data sheet.

This Guide provides sample strategies and resources to assist companies in implementation of the Responsible Care Process Safety Code of Management Practices. The sample strategies and implementation resources are intended solely to stimulate thinking and offer helpful ideas on code implementation. They are in no way intended to establish a standard, legal obligation or preferred option for any practice. Other approaches not described in this document may be just as effective or even more effective for a particular company. If a company so chooses, it may adopt any of these strategies or may modify them to fit the company’s unique situation.

The American Chemistry Council and its employees, subcontractors, consultants and others assigned make no warranty or representation, either express or implied, with respect to the accuracy, completeness or utility of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication.

Copyright © 2013 American Chemistry Council
# TABLE OF CONTENTS

**Background** 3


**Implementing the Code in Your Company** 8

**Management Practices Description and Guidance:**

1. Management Practice 1 9
2. Management Practice 2 11
3. Management Practice 3 14
4. Management Practice 4 18
5. Management Practice 5 25
6. Management Practice 6 29
7. Management Practice 7 31

**References**

2. Supplemental Information for Management Practice #4 37
4. Glossary 43
5. Frequently Asked Questions 45
6. Process Safety Reference Sources 48
I. Background

This guidance document was produced by the American Chemistry Council (ACC) to assist its member and Responsible Care Partner companies to implement the Responsible Care Process Safety Code of Management Practices. Implementation of the Process Safety Code is an obligation of membership in the American Chemistry Council. Effective implementation of the Code should assist ACC member and Partner companies to achieve the goals found in the Responsible Care Guiding Principles (March 2008), specifically:

- To make continual progress towards our goal of no accidents, injuries or harm to human health and the environment from our products and operations.
- To design and operate our facilities in a safe, secure and environmentally sound manner.
- To instill a culture throughout all levels of our organizations to continually identify, reduce and manage process safety risks.
- To support education and research on the health, safety, environmental effects and security of our products and processes.
- To communicate product, service and process risks to our stakeholders and listen to and consider their perspectives.

A commitment to process safety excellence and safe operations has long been part of ACC’s Responsible Care program. In 1990, ACC adopted the Responsible Care Process Safety Code of Management Practices, which identified activities that chemical companies committed to take as part of their Responsible Care obligations. Companies implemented these activities over a five-year time frame and conducted self-assessments against the Code elements through the year 2000. In 1994, ACC introduced a Process Safety Performance Metric which tracked member companies’ process safety incidents against ACC-defined criteria. In 2001, ACC integrated its Responsible Care Codes into a Responsible Care Management System covering all Code elements, including the process safety discipline. The result of this integration effort was the creation of Responsible Care Management System® (RCMS®) and RC14001® technical specifications to which ACC members and Responsible Care Partners are required to conform. Conformance is demonstrated through the completion of third-party certification audits.

ACC and its members’ longstanding commitment to process safety is evident in the legacy Process Safety Code, its fifteen-year history of collecting and reporting Process Safety Performance Metric data and the incorporation of these concepts into the RCMS and RC14001 specifications. However, when ACC undertook a Strategic Review of Responsible Care in 2010-2012, clear feedback received from internal and external stakeholders alike was that ACC and its members must renew and update its articulation of process safety management requirements in light of recent learnings in the process safety area. In identifying elements of the renewed focus on process safety, ACC and its members determined that a new Code would be the best vehicle to add specificity to Responsible Care requirements in this area as a “bolt-on” to the RCMS and RC14001 requirements. Appendix 1 is a matrix that shows the interconnectivity of the legacy
Process Safety Code; RCMS; RC14001; and other relevant documents. A fundamental change as a result of the launch of this Code is that the Responsible Care certification process will include a review of the new Code's implementation.

Information in this guidance document was collected from ACC member and Partner company representatives and is intended to provide simple strategies and tools for use in implementing the Process Safety Code. Each section of the document identifies the relevant code management practice, a short guidance section, implementation examples and examples of relevant leading and lagging indicators. A number of supporting appendices including a Glossary and Frequently Asked Questions (FAQs) can be found following the Management Practices' implementation information.

ACC members and Responsible Care Partners using this document are encouraged to build upon existing programs such as: their current Responsible Care management system, practices based on ACC's previous Process Safety Code (1990), internally-developed practices; as well as any local, state or federal regulatory models they are subject to.

ACC is indebted to members of the Responsible Care Process Safety Code Task Force for its support and contribution of materials for this document.
II. Responsible Care® Process Safety Code of Management Practices

Purpose and Scope
The American Chemistry Council’s (ACC) Responsible Care companies are committed to the safe operation of their chemical processes. The Process Safety Code sets forth our collective commitment to a culture of process safety throughout our chemical processing operations, management systems and leadership organizations.

This Code aims to supplement existing process safety requirements contained within the Responsible Care Management System® (RCMS®) and RC14001® technical specifications, by specifically addressing process safety concepts such as leadership, accountability and culture in order to drive overall process safety performance improvement. It is also intended to complement regulatory requirements (e.g., OSHA’s process safety management (PSM) standard and EPA’s Risk Management Program (RMP) standard). Regulatory standards, by necessity, focus on process safety at an individual facility. In contrast, the Process Safety Code addresses issues at a more universal level, such as across a division or corporation, and includes a company commitment to set expectations regarding process safety, define accountability for process safety performance and allocate adequate resources to achieve performance expectations. These higher level considerations, contained within this Code, are critical elements of effective management of process safety.

This Code is a manifestation of the leadership that Responsible Care companies will undertake to seek systematic continuous improvement in process safety, drawing from the most current learning and advances. When implemented alongside the integrated Responsible Care management systems, this Code will help advance the chemical industry’s commitment to process safety by embedding state-of-the-art concepts within Responsible Care, strengthening process safety leadership, culture, management and ultimately, performance. Implementation of the Process Safety Code is mandatory for all ACC Responsible Care companies. The Code will be applied to chemical operations over which the ACC Responsible Care company has control, commensurate with risk.

Management Practices
Taken together with the RCMS® or RC14001®, implementation of the following management practices enables chemical manufacturers to systematically evaluate, demonstrate, and continuously improve their process safety performance. Each Responsible Care company’s management system must include the following process safety management practices:

1. Leadership and culture. Senior leadership commitment to creating and valuing a process safety culture. Each company’s leadership will demonstrate a visible and ongoing commitment to overseeing and improving process safety performance.

   Senior leaders demonstrate an understanding of the importance of process safety. Senior leaders establish and communicate process safety performance expectations, including
measurable goals, objectives and targets; allocate sufficient resources to meet performance expectations; and promote an observable culture of process safety across the organization. Senior leaders will promote and develop a process safety culture within their organizations, encouraging openness in raising concerns and identifying opportunities for improvement.

2. **Accountability.** Establishment of process safety accountability within the company. Process safety is integral to business processes and stakeholder expectations.

   Process safety roles and responsibilities across the organization are clearly-defined and include an expectation to raise, and authority to respond to process safety concerns. Senior leaders are held accountable for process safety performance. Employees understand the importance of process safety as it applies to their jobs and are responsible for following and contributing to the work processes to achieve improvement in company process safety performance.

3. **Knowledge, expertise and training.** Processes to provide that companies and their employees have the required knowledge, expertise, tools and training to manage process risks of their operations.

   Process safety competency requirements are established and executed for management, engineering and operational personnel, as well as contractors and third-party service providers, commensurate with the activities performed. Employees and contractors are trained on process safety, commensurate with their process safety responsibilities. Company process safety experts are provided continuing education related to emerging process safety tools and techniques.

4. **Understanding and prioritization of process safety risks.** Processes to systematically understand process safety risks throughout the organization, prioritize actions and allocate resources.

   Companies will identify and understand the hazards and risks of their processes. Companies will implement systems for documenting and accessing comprehensive and current information on process-related hazards and risks to enable informed decision making.

5. **Comprehensive process safety management system.** Development and implementation of a comprehensive process safety management system to manage process risk and drive continuous improvement.

   Companies will design systems to manage and mitigate identified risks with adequate safeguards. Management of process safety will take into account passive controls; engineering controls; operational controls; inherently safer approaches; inspection, maintenance and mechanical integrity programs; management of change procedures; and scenario planning.
6. **Information sharing.** Systems to actively share relevant process safety knowledge and lessons learned across the organization, including methods for making information available to relevant stakeholders.

*Companies establish processes fostering two-way flow of information between management, employees, contractors and other stakeholders to share process safety information. These processes will provide that experiences from process safety reviews, inspections, audits, and incident and near-miss investigations are shared, as relevant, across the company in a timely manner. The processes should also promote sharing of process safety concerns.*

7. **Monitoring and improving performance.** A system to monitor, report, review and improve process safety performance.

*Senior leaders, including the company’s senior operating committee, where applicable, monitor process safety performance. Routine evaluation of process safety management systems, independent of regulatory audits, is performed to confirm that desired results are achieved, using appropriate leading and lagging indicators. Results are reviewed at planned intervals to determine progress against process safety performance expectations and to take action to improve performance when needed.*

*Approved by ACC Board of Directors – November 2012*
III. Implementing the Code in Your Company

Each ACC member and Responsible Care Partner must implement the Process Safety Code within its ACC-dues based operations. The Process Safety Code should be integrated within the organization’s overall Responsible Care management system, taking into account the company’s existing programs and commensurate with the risks associated with its operations.

The implementation resources are taken from ACC policies and advocacy documents, chemical company policies, procedures, plans, and from other sources, such as government documents. Users of this implementation guide may wish to adopt the resources into their own process safety programs, changing the language to fit the particular characteristics of their companies and products. Note: it is advisable to examine all the resources and examples given in this implementation guide. Because of the interconnectedness of the seven management practices, a resource offered for one management practice may be useful in implementing other management practices as well.

Implementation Schedule
ACC members and Responsible Care Partners are expected to implement the Process Safety Code and be prepared for it to be reviewed beginning with the 2014-2016 Responsible Care Certification cycle. During the 2014-2016 and subsequent certification cycles, third-party auditors will have the ability to verify conformance to the Process Safety Code during audits. Unlike the new Product Safety Code, ACC will not require submission of a formal attestation of Code implementation.
1. Leadership and Culture

Management Practice 1

**Leadership and culture.** Senior leadership commitment to creating and valuing a process safety culture. Each company’s leadership will demonstrate a visible and ongoing commitment to overseeing and improving process safety performance.

*Senior leaders demonstrate an understanding of the importance of process safety. Senior leaders establish and communicate process safety performance expectations, including measurable goals, objectives and targets; allocate sufficient resources to meet performance expectations; and promote an observable culture of process safety across the organization. Senior leaders will promote and develop a process safety culture within their organizations, encouraging openness in raising concerns and identifying opportunities for improvement.*

Senior leadership commitment has been a touchstone of Responsible Care since its inception. Without such a commitment to process safety, success will be impossible. This management practice sets forth the leadership and resource requirements necessary for successful, ongoing process safety outcomes—namely, no incidents, no injuries. Demonstrating a commitment to process safety includes recognition that regulatory requirements are only a starting point for process safety excellence, and that efforts such as Responsible Care are necessary to complement, enhance and extend the requirements to promote true performance excellence. Successful implementation of this management practice requires visible, continued active involvement, and transparency on the part of senior leaders, in order to recognize that process safety is both a critical element in a successful enterprise, and an effective business management tool. As such, clear and concise measures of performance, both leading and lagging, must be reviewed by senior leaders and communicated to key stakeholders on a regular basis, with goals set as appropriate.

Development of a process safety culture, while more subjective than measures of process safety incidents, must be a priority and continually fostered through the reinforcement of both performance and behaviors, and measured regularly to detect changes (both positive and negative) which can then be acted upon. Creation of a process safety culture may require that senior leaders look for examples outside their own organizations through formal benchmarking with recognized leaders in the field.

Oversight is one of the key functions of senior leadership. Regular review of process safety performance, including changes in leading indicators in order to better understand shifts in a company’s attitude towards process safety, should be a standing agenda item for senior leadership meetings with appropriate action items identified for corrective action or continuous improvement.
**MANAGEMENT PRACTICE 1: IMPLEMENTATION RESOURCES**

The following are various strategies that companies can consider adopting to fulfill this management practice:

- Establish written company policies and systems, which include, but are not limited to, regulatory requirements around process safety performance. Such policies should include expectations for process safety including performance expectations and reporting of key process safety elements (see Management Practice 5 for a list of these elements).

- Define and communicate ownership of, and implementation responsibility for, all key process safety elements (see MP 5 for these elements). Also, this overlaps with MP 2.

- Establish a mechanism for regular, visible, documented reviews of process safety performance.

- Communicate and publish, as appropriate, process safety performance measures.

- Communicate expectations to all stakeholders, beginning with employees and contractors, and reaffirm these expectations on a regular basis.

- Develop and implement a means to assess process safety culture, and reassess regularly to foster continual improvement.


**Examples of Leading and Lagging Indicators**

**Lagging**
- Number and rate of Tier 1 Process Safety Events (PSEs).
- Number and rate of Tier 2 PSEs.

**Leading**
- Process Safety Culture survey developed and conducted per schedule.
- Results of Process Safety Code assessments.
- Compliance with field walkthrough schedules.
- Reviews of Process Safety performance conducted with employees per schedule.
- Process safety program improvement goals are evident in overall site/organization business goals and key performance indicators used for business planning and budgeting purposes.
2. Accountability

Management Practice 2

**Accountability.** Establishment of process safety accountability within the company. Process safety is integral to business processes and stakeholder expectations.

*Process safety roles and responsibilities across the organization are clearly-defined and include an expectation to raise, and authority to respond to process safety concerns. Senior leaders are held accountable for process safety performance. Employees understand the importance of process safety as it applies to their jobs and are responsible for following and contributing to the work processes to achieve improvement in company process safety performance.*

Everyone in the organization or working on its behalf who has process safety responsibilities, from senior leadership to process operators to maintenance contractors, must exercise appropriate authority, judgment, understand and accountability for their process safety performance. Creating an accountable work force relies on clear communication of responsibilities and authorities; continued education; and awareness-raising by senior leadership at the site and corporate level.

To assist in raising process safety awareness and reinforcing process safety accountability, the organization may consider making process safety a distinct focal point of its environmental, health, safety and security (EHS&S) programs and not include it as part of a generic, broad ‘safety’ terminology. This distinction is recommended regardless of the regulatory status, i.e. OSHA PSM, etc.

“Process safety” excellence should be held in high esteem and not be viewed as secondary compared to “occupational safety” from a leadership perspective. To that end, employees at all levels of the organization should understand what aspects of their work could impact process safety performance, either positively or negatively as well as their responsibilities to manage process safety. As appropriate, inclusion of process safety performance in annual goals, objectives and appraisals should be documented.

In addition, this Management Practice recognizes the role employees have in contributing to organizational process safety excellence and their ability to raise concerns about issues/activities and if necessary, respond to situations where unacceptable process safety risks are uncovered.

**Management Practice 2: Implementation Resources**
The following are various strategies that companies can consider adopting to fulfill this management practice:
• As part of the management review process, the organization may require process safety reviews (HAZOPs, etc.) and audits to establish organizational process safety goals/objectives which are translated into individual performance goals and objectives. These can be included as part of annual personnel performance appraisals.

• For leadership and management, establish process safety knowledge as part of position requirements commensurate with other skills, including financial acumen.

• Clearly articulate skills and proficiencies required to perform process safety tasks and activities. For example, engineers who perform HAZOPs or safety reviews are be required to have methodology training. Management positions that budget resources should have training to understand the value derived from such safety studies and any regulatory drivers for the program. Job description should include authority to respond to process safety concerns.

• Divide ‘safety’ responsibilities into discrete requirements highlighting process safety along with occupational safety duties. This should include authority to respond to process safety concerns.

• As part of their EHSS training programs, organizations clearly identify positions which affect process safety performance and provide appropriate training. This can be done via a matrix system, with tiered approaches based upon job function, etc.

• Include defined ‘process safety projects’ as part of the annual capital planning process to elevate awareness and organizational understanding.

• Adapt near-hit/-miss reporting programs and tracking systems to look beyond housekeeping or occupational safety scenarios and investigate to a level of the potential (not actual) impact. This would also include the definition of a ‘process safety near hit/miss’ in relevant training programs and identify individuals who should report such events (if a subset of the general employee population).

• List ‘process safety’ as part of the organization’s Environment, Health, Safety and Security or Responsible Care policy statement.

• Include process safety action plans and items in the organization's follow-up, tracking, and closure systems with clearly identified responsibilities and due dates.

• Report process safety goals and performance as part of community meetings or other stakeholder outreach processes.

• Recognize process safety teams for identification of risks and timely closure of action plans.
• Highlight process safety skill sets in systems to manage organizational changes.


**Examples of Leading and Lagging Indicators**

**Lagging**
- Number of Process Safety Events (PSE) with a cause related to uncertain ownership of process safety responsibility.
- Senior leaders’ variable pay reflects process safety performance measures.
- Number of PSEs with a cause related to failure to follow procedures (could also be used for MP 1).

**Leading**
- Number of positions with identified process safety responsibilities not filled.
- Percentage (%) of personnel with adequate discussion of process safety responsibility performance in their performance appraisal.
- Number of shutdowns triggered by operators as a result of an unsafe condition.
- Consistent failure to complete process safety action plan commitments on time is reflected in the performance rating of personnel assigned those actions and their direct supervision.
3. Knowledge, Expertise and Training

**Management Practice 3**

**Knowledge, expertise and training.** Processes to provide that companies and their employees have the required knowledge, expertise, tools and training to manage process risks of their operations.

*Process safety competency requirements are established and executed for management, engineering and operational personnel, as well as contractors and third-party service providers, commensurate with the activities performed. Employees and contractors are trained on process safety, commensurate with their process safety responsibilities. Company process safety experts are provided continuing education related to emerging process safety tools and techniques.*

The objective of this management practice is the development and implementation of formal (which may include documented) programs so those individuals responsible for operating and maintaining hazardous processes and equipment understand the associated hazards and the requirements for safe operation. The programs should include both employees and contractors. The program should include a verification of required process safety related competencies *commensurate with activities performed.* The program should address new employees, changing job assignments, new learning, as well as periodic refresher training and verification. Written records should be maintained and the program should be periodically audited.

An organization’s Human Resources department plays a critical role in ensuring effective training programs are developed, implemented and delivered as well as monitoring employee participation and progress. The organization should develop methods for monitoring emerging issues in process safety which may impact its operations and have a process for communicating this information to relevant employees and others working on its behalf (contractors, etc.).

**Management Practice 3: Implementation Resources**

The following are various strategies that companies can consider adopting to fulfill this management practice:

- Recognizing the diversity of staffing structures among various organizations, the following is an outline of suggested skills/competencies for generic job titles/descriptions. Each organization should consider its own staffing model, process safety circumstances and identify its own relevant skills/competency requirements.

- **Site Manager**
  - Ability to create an environment for the safe operation of all plants/units on site.
  - Basic knowledge of process safety topics at the site.
Overview of relevant processes in on-site manufacturing plants - depth and detail depending on hazard potential and complexity of processes.
 Emergency management skills, including knowledge of plant and site related emergency procedures.
 Establishes and participates in site process safety “rituals” or significant formalities.

**Environment, Health and Safety Manager**
- Support and coordination regarding occupational, process and plant safety and environmental affairs on site/plant.
- Primary contact to corporate EHS organization.
- Basic knowledge of process safety methods (e.g., Process Hazard Analysis (PHA), etc.) and of process safety topics on site - depth and detail depending on hazard potential and complexity of processes on site. Detailed knowledge in all relevant regulatory issues, laws and company directives.

**Operations Manager/Unit Manager**
- Responsible for the safe operation of production facilities.
- Generate and update safety instructions, and plant operating procedures.
- Responsible for process safety training (content, scheduling).
- Detailed knowledge of the production processes under her/his responsibility (covering e.g. materials, reactions, stability, compatibility, technical installation).
- Understanding the consequences of changes to the process.
- Understanding of safeguards / safety concepts, including ability to define response to a malfunction, deviation and/or incident.
- Advanced knowledge of the PHA procedure and approval responsibility for PHAs.

**Operations Engineers**
- Detailed knowledge of the production processes in her/his area of responsibility (covering e.g. materials, reactions, stability, compatibility, technical installation).
- Understanding of changes to the process.
- Understanding of the safeguards / safety concepts. Ability to define response to a malfunction, deviation and/or incident. Advanced knowledge of the PHA procedure.

**Operator/Technician**
- Personal responsibility to act according to process safety regulations and company directives and actively participate in the continuous improvement process.
- Knowledge of key safety critical areas of relevant processes, respective hazardous materials (hazard categories and related hazard potentials) and safety installations.
- Understanding of primary hazards in their operating area and of the safeguards in place to manage them.

**Process Specialist** (*Employees directly involved in manufacturing operations in supervisory role. Has a limited management role.*)
- Advanced process safety knowledge.
- Leadership and competence to handle the PTW (permit to work) process.
Basic knowledge of the PHA procedure and knowledge of specific PHA results in area of responsibility.

Ability to identify and assess risks in everyday operation.

Understanding of the protection measures and emergency responses for the particular unit process and the interaction of process safety procedures (Management of Change (MOC), PHA, etc.).

- **Shift Supervisor/First Line Supervisor** (Employees directly involved in manufacturing operations in supervisory role; first line supervisors. No management role but with responsibility as hands-on trainers and "role-models").
  - Basic process safety knowledge.
  - Leadership and competence to handle the PTW (permit to work) process.
  - Knowledge of specific PHA results in their area of responsibility.
  - Ability to identify and assess risks in everyday operation.
  - Understanding of the protection measures and emergency responses for the particular unit process and the interaction of PS procedures (MOC, PHA, etc.).

- **Maintenance Craftsmen** (Works based on detailed written procedures and instructions from supervisors).
  - Basic knowledge of relevant process safety topics – depth and detail of knowledge depending on type of service provided, hazard potential and complexity of processes.

- **Maintenance Supervision** (Employees directly involved in maintenance and/or support functions in a supervisory role).
  - Basic process safety knowledge consistent with operators.
  - Leadership and competence to handle the PTW (permit to work) process; basic knowledge of specific PHA results in area of responsibility; ability to identify and assess risks in everyday operation; understanding of the protection measures and emergency responses for the particular unit process and the interaction of PS procedures (MOC, PHA, etc.).

- **Process Safety Practitioner/Engineer**
  - Leads PHA process.
  - Develops/supports site process safety training (can be trainer).
  - Detailed knowledge of the safety review process and its application. Detailed knowledge and identification of Process Safety Hazards.
  - Competence in hazard identification techniques, risk assessment techniques and safeguard level determination. Competence in the understanding of safety characteristics of materials and substances and reactions.

- **Administration and other non-production related functions**
  - Responsible to act according to basic process safety rules and regulations on site.
  - Understanding of safety requirements and their importance (prevention, preparedness, emergency planning, reaction to alarms, etc.).
• **Additional Examples of Training Approaches**
  
  o Key individuals with process safety program responsibilities receive training in formal auditing techniques and participate in auditing other facilities or units within their organization on some level of frequency.
  
  o Key process hazards assessment experts attend external technical conference(s) on a reasonable frequency – such as those offered by CCPS ([http://www.aiche.org/ccps/resources/conferences](http://www.aiche.org/ccps/resources/conferences)).
  
  o Key process safety program owners receive both basic and advanced training on statistical process control concepts and techniques.
  
  o Key process safety program owners receive basic and advanced training on root-cause failure analysis or similar failure mode investigation techniques.

**Examples of Leading and Lagging Indicators**

Lagging:
- Number of Process Safety Events (PSEs) with a cause related to a lack of training or understanding.
- Critiques of emergency response effectiveness from incidents.
- Number of PSEs with a cause related to less than adequate procedures or documentation.

Leading:
- Percentage (%) of personnel with Process Safety responsibilities having training plans that adequately cover their duties.
- Percentage (%) compliance with training plan requirements.
- Percentage (%) completion of emergency drills (operations teams and specialized response teams).
4. Understanding and Prioritization of Process Safety Risks

Management Practice 4

**Understanding and prioritization of process safety risks.** Processes to systematically understand process safety risks throughout the organization, prioritize actions and allocate resources.

*Companies will identify and understand the hazards and risks of their processes. Companies will implement systems for documenting and accessing comprehensive and current information on process-related hazards and risks to enable informed decision making.*

The objective of this management practice is to develop and implement a documented system for the risk assessment, design, operation and oversight of a company's process safety risks. This includes risk assessments for initial design, as well as for changes in facility design/operation or for changes in criteria impacting risk such as an encroaching population.

This practice is intended to apply to all chemical processes and facilities, regardless of whether they are currently PSM regulated or not. It is recognized that roles and responsibilities are distributed differently within each company and facility based upon size and structure of the specific location and commensurate with the risk of each process.

**Management Practice 4: Implementation Resources**

The following are various strategies that companies can consider adopting to fulfill this management practice:

A suggested set of steps for process risk assessment includes:

1. **Define tolerable risk**
   Determine acceptable risk tolerance level for company/facility/process.

2. **Analyze**
   Analyze processes to identify and document risks.

3. **Quantify**
   When required, perform quantitative process risk assessments to help assign risk rating/value.

4. **Prioritize**
   Quantified/rated risks are compared to risk thresholds. Exceedances of acceptable risk thresholds are identified for mitigation (rated risk >threshold).
Identified unacceptable risks are prioritized (risk ranking process).

5. **Mitigate**
   Unacceptable risks are mitigated according to prioritization to levels below the risk threshold via controls and other means with sufficient confidence levels.

6. **Verify**
   Mitigation controls are periodically verified that they remain effective

*Note: this management practice mainly focuses on #3 and #4 of the above highlighted steps although all six steps will be addressed below.*

The following section *(italics)* provides some example activities from CCPS, “Guidelines for Risk Based Process Safety,” AIChE, New York, 2007, chapters 8 and 9. The actual CCPS book should be consulted for the full detail. Readers are encouraged to visit the CCPS website: [www.ccpsonline.org](http://www.ccpsonline.org), and obtain this book online at: [www.aiche.org/ccps/resources/publications](http://www.aiche.org/ccps/resources/publications) to understand CCPS’s complete guidance related to hazard identification and risk analysis.

*Excerpts from Guidelines for Risk Based Process Safety – Chapter 8 & 9 Introduction*

To understand hazards and risks a company’s facility faces, there should be a focus on:

- Collecting, documenting and maintaining process safety knowledge in the areas of:
  - Reactive Chemical and Process Chemical data, e.g., Reactivity Data, Toxicity Information/Exposure Limits, Flammability Data, Corrosivity Data.
  - Process Technology Information, e.g., Maximum inventories, Material and Energy Balances, Safe Operating Limits.
  - Process Equipment Information, e.g., Material of Construction, P&IDs, Relief System Design basis.

**Define tolerable risk**

To make informed decisions on risk a company needs to establish risk tolerance criteria so that risk assessment teams can make risk judgments and recommendations for an informed decision by management.

Management should communicate its risk tolerance to the risk assessment teams so they can make risk judgments. This guidance may be in a simple, qualitative form, such as an instruction that the facility must conform to recognized and generally accepted good engineering practices, or that risks must be reduced as low as reasonably practicable (ALARP). Management may fund the development of corporate process safety standards and require adherence to them as well. However, neither of these approaches provides guidance for all situations. Thus, some organizations develop a risk matrix to communicate their tolerance for any scenario falling within a specific range of severity and likelihood. These categories may be defined either qualitatively or quantitatively. Beyond that, some companies choose (or regulators impose) some absolute risk criterion that events of this
magnitude shall not exceed a specified likelihood, for example, the likelihood of a worker fatality at the facility shall not exceed $10^{-4}$ events/yr. In addition to specific risk tolerance criteria, the company may also specify a preference or priority for the types of risk control measures employed. For example, a company may prefer inherently safer design alternatives to be considered first, then those requiring risk controls, and it may prefer passive controls to be considered before active controls, or it may prefer engineered controls to be considered before administrative controls.

**Analyze**

Conducting hazard identification and risk analysis studies (HIRA) – These studies typically address four main questions to a level of detail commensurate with an analysis objectives, life cycle stage and available information and resources. The four main questions are:

- **Hazards** – What can go wrong with a process that will cause Undesired Consequences?
- **Undesired Consequence Severities** – How bad can the Undesired Consequences be?
- **Existing Layers of Protection or Safeguards** – What are the engineering and administrative controls that are part of the process which prevent causes from propagating to Undesired Consequences or mitigate the Undesired Consequences if they occur?
- **Consequence Likelihoods** – How often might the Undesired Consequences happen?

The objective is to perform only the level of analysis necessary to reach an informed decision because insufficient analysis may lead to poor decisions (potentially introducing unacceptable risk) and alternatively, excessive analysis may waste critical resources. A suite of tools are available to accommodate varying risk analysis needs and depend on a company establishing risk tolerance criteria.

To manage risk, hazards must first be identified, and then the risks should be evaluated and determined to be tolerable or not. HIRA reviews may be performed at any stage in a project's life cycle – conceptual design, preliminary design, detailed design, construction, ongoing operation, decommissioning, or demolition. In general, the earlier that a hazard is identified (e.g., during conceptual design), the more cost-effectively it can be eliminated or managed. Studies performed during the early design stages are typically done at corporate or engineering offices. Studies performed once a process is near startup, during operation, or before decommissioning are typically done in a plant environment.

The risk understanding developed from these studies forms the basis for establishing most of the other process safety management activities undertaken by the facility. Again, an incorrect perception of risk at any point could lead to either inefficient use of limited resources or unknowing acceptance of risks exceeding the true tolerance of the company or the community.

A HIRA study is typically performed by a team of qualified experts on the process, the materials, and the work activities. Personnel who have formal training on risk analysis
methods usually lead these teams, applying the selected analysis technique(s) with subject matter experts from engineering, operations, maintenance, and other disciplines as needed. A simple early-in-life hazard identification study may be performed by a single expert; however, a multi-disciplined team typically conducts more hazardous or complex process risk studies, especially during later life cycle stages. Involving operating and maintenance personnel early in the review process will help identify hazards when they can be eliminated or controlled most cost effectively. When the study is complete, management must then decide whether to implement any recommended risk reduction measures to achieve its risk goals based on its risk tolerance criteria.

- Tools for hazard identification (and qualitative risk analysis) include
  - Hazard and operability analysis (HAZOP),
  - What-if checklist analysis, and;
  - Failure modes and effects analysis (FMEA).

**Quantify**

Once the Hazards and Risks have been identified, the next step is to conduct Risk Assessments. These assessments typically address the following questions:

- Risks of Undesired Consequences – What are the risks of the Undesired Consequences, based on their Severities and Likelihoods?
- Risk Tolerance Assessment – Are the Risks of Undesired Consequences tolerable?
- Recommendations – If the Risks of Undesired Consequences are not tolerable, what are the recommendations that, when implemented, will eliminate, reduce or mitigate the risk to acceptable levels.
- Tools for hazard identification and simple or semi-quantitative risk assessments include:
  - Failure modes, effects and criticality analysis (FMECA) and

Tools for detailed quantitative assessments of risks identified by methods mentioned above include fault trees and event trees (see the CCPS text “Guidelines for Chemical Process Quantitative Risk Analysis” for details)

Appendix 4 presents an example of a detailed risk assessment developed by ACC members that uses the quantitative Fault Tree Analysis method to determine the Likelihood of an Undesired Consequence relative to company-specific acceptable risk tolerances.
Example (for demonstration purposes only)
An additional semi-quantitative way for risk assessment based on severity, frequency and other risk aspects to arrive at a cumulative risk total is presented below. Cumulative values above company-specific risk threshold(s) would initiate mitigation actions to lower predicted risk values on a prioritized basis (based on score).

Severity x Frequency x Additional Weighting Factors (e.g., Timing Factor) = Cumulative Risk Total

<table>
<thead>
<tr>
<th>Safety Severity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5--Immediate Safety Risk</td>
</tr>
<tr>
<td>4--High Safety Risk</td>
</tr>
<tr>
<td>3--Moderate Risk</td>
</tr>
<tr>
<td>2--Low Risk</td>
</tr>
<tr>
<td>1--Not Applicable or Minimal Risk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental Severity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5--Severe Environmental Impact</td>
</tr>
<tr>
<td>4--Moderate Environmental Impact</td>
</tr>
<tr>
<td>3--Localized Impact</td>
</tr>
<tr>
<td>2--Minimal Environmental Impact</td>
</tr>
<tr>
<td>1--Not Applicable or No Environmental Impact</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency (event opportunity):</th>
</tr>
</thead>
<tbody>
<tr>
<td>5--Continuous basis</td>
</tr>
<tr>
<td>4--Batch basis</td>
</tr>
<tr>
<td>3--Inconsistent basis</td>
</tr>
<tr>
<td>2--Rare basis</td>
</tr>
<tr>
<td>1--Special cause basis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Timing Weighting Factor:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3—Internally or externally required action within 12 months</td>
</tr>
<tr>
<td>2—Internal requirement or externally required action beyond 12 months</td>
</tr>
<tr>
<td>1—No timing constraints</td>
</tr>
</tbody>
</table>

For an example condition with a Safety Severity rating of 5 (Immediate Safety Risk), a Localized Environmental Impact factor of 3, a Frequency factor of 4 (batch processing) and a Timing Weighting factor of 2, the resulting cumulative risk result is 120 (5 x 3 x 4 x 2). If the company acceptable risk tolerance threshold is 100 or less, this hypothetical condition would require mitigation actions to reduce the cumulative risk to less than the risk tolerance threshold.
**Prioritize and Implement**
The next step is to prioritize, schedule and implement recommendations for bringing risks to within tolerance criteria. Usually recommendations requiring no and low capital funds are implemented quickly. Recommendations requiring more than a low amount of capital need to be prioritized and scheduled for implementation. This may be done yearly for all such recommendations at a site or business unit, depending on the organization’s capital budget practices. A possible starting point for prioritization/ranking considerations would be to list from highest to lowest the ratios of the estimated likelihood by the tolerable likelihood for a fixed severity level and those with highest values would represent priority candidates.

It should be noted that implementing risk assessment recommendations is technically part of Process Safety Code Management Practices 5 (Comprehensive Process Safety Management System). It is included here to show the interconnected relationship with understanding and prioritizing process safety risks.

**Verify**
The final step is to regularly verify or audit all parts of the system described above to determine they are being executed as specified in the written management system for Understanding Process Risks.

Again, it should be noted that verification is technically part of Process Safety Code Management Practices 7 (Monitoring and Improving Performance). It is included here to show the interconnected relationship with understanding and prioritizing process safety risks.

**What Is the Anticipated Work Product?**
*The main process safety products of a risk system are:*

1. Guidelines for planning and conducting studies;
2. Documented understanding of the risks of the process or activity;
3. Documented risk tolerance criteria,
4. Possible risk control measures, resolutions and implemented actions;
5. Documented understanding of the residual risks after control measures are taken, and
6. Completed risk analysis reports.

(The above items 1-6 *italics*) are excerpted from the CCPS Guidelines for Risk Based Process Safety: [www.aiche.org/ccps/resources/publications](http://www.aiche.org/ccps/resources/publications). ACC suggests that organizations also consider including documented verification that the processes are implemented as intended.)

Other work products may include recommendations for improving asset integrity, procedures, and training as well as up-to-date action item tracking lists and risk communication materials. The results of risk studies are normally kept for the life of the
process and are communicated to those who may be affected. Outputs of the risk element can also be used to facilitate the performance of other elements. For example, identifying potential accidents will help define scenarios the emergency element must address, and understanding the existing risks may enable the management of change element to identify the risks of a change.

**Examples of Leading and Lagging Indicators**

**Lagging:**
- Number of Process Safety Events (PSE) from a previously unidentified risk.
- Number of PSEs from a risk for which mitigation had not yet been applied

**Leading:**
- Number of Process Hazards Analyses not completed per schedule.
- Number of Process Hazards Analysis Action Items not completed per schedule.
- Number of Process Hazards Analysis with less than adequate team composition.
- The site/facility risk index is reduced over time when measured by a generally recognized industry method.
- A metric to track failure rates on mechanical integrity designated equipment and systems are in place. Post-corrective repair reviews are conducted to determine the root-cause of the initial PM failure.
5. Comprehensive Process Safety Management System

Management Practice 5

Comprehensive process safety management system. Development and implementation of a comprehensive process safety management system to manage process risk and drive continuous improvement.

Companies will design systems to manage and mitigate identified risks with adequate safeguards. Management of process safety will take into account passive controls; engineering controls; operational controls; inherently safer approaches; inspection, maintenance and mechanical integrity programs; management of change procedures; and scenario planning.

In the spirit of the Plan, Do, Check, Act cycle, the development and implementation of comprehensive management systems for managing process risk not only include formal written programs but established processes that require documented periodic assessment of the effectiveness of these programs. In short, each element of the company’s program should be periodically reviewed to evaluate whether process risk management systems are in place and functioning as intended. Contractors either have programs consistent with applicable sections of this Code or are included in the company’s program, or some combination of the two. Periodic reviews of the system are linked to the requirements in Management Practice 7 on effective monitoring and measurement. (Additional information on the concept of inherently safer approaches can be found in Appendix 3.)

The following describes a range of considerations specific to the development of systems that support the implementation and maintenance of effective systems for managing process risks throughout the life cycle of a process. These considerations should be commensurate with the company’s understanding of the risk associated with their processes.

Management Practice 5: Implementation Resources

The following are various strategies that companies can consider adopting to fulfill this management practice:

- Develop and implement procedures and work practices so that processes and equipment are operated and maintained in accordance with the company’s process safety expectations.
  - Work is performed in a correct, safe, and consistent manner designed to achieve a desired result and includes equipment operation and maintenance details, associated hazards and controls and special precautions as required. Procedures and permit systems foster communication between employees and between crafts to control hazards and manage risks associated with non-routine work.
Examples:
- Current and accurate written procedures to foster consistent operation during each operational stage (i.e., normal, startup, shutdown, emergency) and during non-routine or infrequent tasks.
- Clearly defined roles and responsibilities for job tasks.
- Clearly defined roles and responsibilities for development, use, and periodic review of procedures.

- **Develop and implement operational controls necessary to prevent loss of containment and to manage the integrity of processes and equipment.**
  - Systematic implementation of design, operating, and maintenance activities so that process equipment will be safe and reliable throughout its service life. Equipment integrity is managed through periodic testing, inspection, analysis, and timely maintenance.

Examples:
- Documentation of process and equipment design basis and safe operating limits.
- Written policy defining program scope and individual roles and responsibilities.
- System to establish and maintain testing, inspection, and/or replacement frequencies based on service conditions, criticality, prior history, or any manufacturer’s recommendations.
- System to establish and maintain routine maintenance testing and inspection procedures.
- System to establish and maintain documentation and recordkeeping systems for all inspection and testing results, including “as-found” and “as-left” data.
- System to review and adjust future testing, inspection, and replacement frequencies.
- System to track all inspection, testing, and repair activity to completion as well as track backlogs.
- System to correct deficiencies that are outside accepted limits before further use or that necessary measures are taken to for safe operation.

- **Manage changes using documented structural programs to identify and address risks associated with new processes and modifications to existing processes.**
  - Hazards and risks associated with changes are understood, controlled, and communicated and include a level of hazard identification and risk analysis commensurate with the scope and complexity of the change. Understanding includes a review and evaluation to determine whether the change inadvertently introduces unforeseen hazards, unknowingly increases the risk associated with a known hazard, or weakens or eliminates an existing management system or engineered control.
Examples:
- Procedures defining review and approval processes, types of changes requiring review and approval, individual roles and responsibilities, and methods for communicating changes to affected individuals.
- System for documenting changes and tracking all follow-up activities resulting from changes.
- Pre-startup safety review (PSSR) so that all process safety system(s) affected by the change have been reviewed to verify that they are in place and adequate prior to the introduction of chemicals or energy to the process.
- System that addresses the following considerations prior to any change: the technical basis for the proposed change; the impact of changes on safety and health; required modifications to operating procedures; the necessary time period for the change; and, authorization requirements for the proposed change.
- The composition of the review team is commensurate with the level of proposed change.

- Preparation and planning for the response and management of incidents that could occur.
  - Planning and response systems to reduce the magnitude of effects of an incident are implemented. Employees are enabled to respond appropriately to unusual conditions or circumstances that are not addressed by the plant’s standard practices or procedures. Incident investigation, data collection, analysis and trending systems are provided to communicate, and share learnings, from internal and external incidents.

Examples:
- Procedure defining notification, investigation, reporting, action item follow-up, and data management requirements incidents, occurrences, or undesired circumstances.
- Procedure defining individual roles and responsibilities.

- Develop and maintain systems to consider inherently safer concepts, applied within risk management processes that address safety, security and environmental protection.
  - Incorporate systems where the possible reduction of frequency or consequences of potential incidents are considered throughout the life cycle of a process utilizing hazard reduction or elimination strategies such as minimizing of hazardous materials, substituting with less hazardous materials, moderating hazardous conditions, or simplifying process or facility design.

Examples:
- Systems at each life cycle stage of a process (i.e., research and development, design and construction, operations, maintenance, and modification, and
decommissioning) to determine if strategies can be applied, commensurate with the level of risk.

- Enhancements to systems such as training, supervision, and job tools designed to reduce errors by those who design, build, operate and maintain processes.

**Examples of Leading and Lagging Indicators**

**Lagging:**
- Number of Process Safety Events (PSEs) with a cause related to Management of Change.
- Number of PSEs with a cause related to Alarm Management.
- Number of PSEs with a cause related to Work Permits.

**Leading:**
- Percentage (%) of Management of Change packages meeting all requirements.
- Initiated changes open past xx months (establish a target) are tracked by management.
- Percentage (%) of compliance with Work Permitting requirements.
- Percentage (%) of Operator Consoles meeting target Alarm/Hour rate.
- Number of past due Incident Investigation recommendations.
6. Information Sharing

**Management Practice 6**

**Information sharing.** Systems to actively share relevant process safety knowledge and lessons learned across the organization, including methods for making information available to relevant stakeholders.

Companies establish processes fostering two-way flow of information between management, employees, contractors and other stakeholders to share process safety information. These processes will provide that experiences from process safety reviews, inspections, audits, and incident and near-miss investigations are shared, as relevant, across the company in a timely manner. The processes should also promote sharing of process safety concerns.

This management practice is based on one of the fundamental concepts underlying the Responsible Care initiative: sharing of information with stakeholders. The practice identifies the need for “systems” for active sharing so this activity is not haphazard or without a clear discipline. The organization may need to develop a procedure which identifies lines of communication on process safety matters; what constitutes process safety knowledge/information/lessons learned; and methods for communicating the information to various stakeholder groups (taking into account differing information needs of each group).

Much of the infrastructure for this sharing activity should already exist within ACC companies because of their conformance to requirements found in either the RCMS® or RC14001® technical specifications. Both documents identify internal and external awareness and communications requirements that foster the sharing of information/knowledge/lessons learned within the organization and to external stakeholders. It should be noted that the Management Practice identifies specific “experiences” from “process safety reviews, inspections, audits and incident and near-miss investigations are shared in a timely manner.” At a minimum, the system for sharing must include results from these activities.

**Management Practice 6: Implementation Resources**

The following are various strategies that companies can consider adopting to fulfill this management practice:

- Consider how process safety information sharing/dialogue can be incorporated into existing dialogue processes (see RCMS 3.5/RC14001 4.4.6). This may require modification of existing communications procedure(s) to address the Management Practice requirements, including identification of new or additional process safety “owners” within the organization; ensuring lines of communication are established; identifying the types of process safety information to be shared; identifying other “relevant” process safety stakeholders and the types of information they may be
expected to receive. The organization may want to name those stakeholders identified in the Management Practice: management, employees, and contractors.

- Consider methods for educating management, employees, contractors, etc., on how they can participate in the sharing process (if one does not already exist for general Responsible Care issues). Consider benchmarking against ACC companies or other industry leaders.

- Consider whether existing inspection/audit/investigation procedures need to be modified to address the Management Practice’s requirement to share process safety information. Consider how information is to be presented to different stakeholders based on their information needs.

- The organization may want to develop a process to track the sharing of process safety experiences/information. This could be part of formal training programs, distribution of information at worker meetings, etc. Records of this sharing activity should be developed and maintained per the organization’s records retention program. Maintenance of a record of sharing activities/information will be useful evidence when tracking internal progress against the code and for third-party audits.

- The organization should also include this sharing process in its periodic review of the effectiveness of its communications to stakeholder (identified in RCMS® element 4.5 /RC14001 element 4.4.3g)

**Examples of Leading and Lagging Indicators**

**Lagging:**
- Number of Process Safety Events (PSEs) with a cause similar to a previously shared incident.
- Number of PSEs that triggered a new, updated or revised engineering standard.

**Leading:**
- Number of incident investigation reports that have not been shared with affected employees and contractors by target date.
- Number of action items resulting from review of outside-the-unit incidents not complete by target date.
- A policy exists that sets expectations for the time frames to close incident investigations; investigations open past the target timing are tracked by management.
- A list of improvement action items are documented from post-drill critiques and these action items are tracked to closure.
7. Monitoring and Improving Performance

Management Practice 7

**Monitoring and improving performance.** A system to monitor, report, review and improve process safety performance.

*Senior leaders, including the company’s senior operating committee, where applicable, monitor process safety performance. Routine evaluation of process safety management systems, independent of regulatory audits, is performed to confirm that desired results are achieved, using appropriate leading and lagging indicators. Results are reviewed at planned intervals to determine progress against process safety performance expectations and to take action to improve performance when needed.*

This management practice is intended to foster continuous improvement in the area of process safety through the development and use of various measuring and monitoring methods. An effective process safety management system cannot be maintained or improved if its performance is not periodically measured and evaluated. Through regular monitoring of relevant management system performance indicators, deficiencies in systems can be acted upon before significant incidents occur. Deficiencies in systems are identified via both indicators of performance as well as periodic evaluations of the systems themselves for scope and effectiveness independent of regulatory audits.

Each organization will need to identify performance indicators/metrics for use in measuring its progress against its established process safety goals, objectives and targets (as defined by senior leadership in MP #1). Process safety metrics are indicators that can be used to track the occurrence of incidents. They can also track the effectiveness of the execution of key actions or activities of management systems intended to prevent Process Safety Events (PSEs). Performance indicators should be based on the following concepts:

- Indicators should drive process safety performance improvement and learning.
- Indicators should be relatively easy to implement and easily understood by all stakeholders.
- Indicators should be statistically valid at one or more of the following levels: industry, company, and site. Statistical validity requires a consistent definition, a minimum data set size, a normalization factor, and a relatively consistent reporting pool.
- Indicators should be appropriate for industry, company, or site level benchmarking.
**Management Practice 7: Implementation Resources**

The following are various strategies that companies can consider adopting to fulfill this management practice:

*Lagging* indicators identify and track outcomes that require investigation into the management system failures after they occur with the intention of identifying weaknesses or deficiencies. Lagging indicators can also be used to monitor/demonstrate trends and improvement.

Where lagging indicators are too few to provide clear indications or trends of performance, *leading* indicators provide a means of systematic and routine monitoring of key management system actions and activities. Leading indicators should direct corrective actions resulting in improvements in performance. Leading indicators provide proactive opportunities to address deficiencies before they result in serious events.

The following depiction shows the hierarchy of leading and lagging process safety indicators:

*LOPC = Loss of Primary Containment

Tier 1 and Tier 2 incidents (indicators) can be thought of as a report card. They are lagging metrics that indicate the occurrence of events that process safety management systems strive to prevent.
Tier 3 indicators reflect the nature of the continuum between lagging and leading metrics as they reflect a measurement of undesirable events that have happened, yet provide an opportunity to take action before significant consequences have occurred. Tier 3 metrics include lesser losses of primary containment and significant near miss events that have occurred and need immediate response and investigation to identify the associated failures of process management systems. However, the leading nature of challenges to safety systems and exceeding safe operating limits provides an opportunity for measurement and trending with time to identify, correct, and/or improve systems before process safety events occur.

Tier 4 indicators are leading metrics that provide insight/trends into the performance. They may be an indication of the effectiveness of the system or the operating discipline with which it is applied. Tier 4 indicators may be unique to individual companies and processes. They may even be unique to individual sites.

The process for developing Tier 4 metrics includes:

- An identification of what can go wrong. What Tier 1 events can occur?
- Identification of process safety management system elements needed to prevent each potential Tier 1 event
- Identification of components/parts of these management systems that specifically address/prevention of the potential incident.
- Identification of components (Tier 4 indicators) that can be measured, monitored, and tracked to effectively evaluate and correct the management systems performance?

Process safety metrics are very much a part of any Plan-Do-Check-Act performance improvement cycle.

Monitoring and improving process safety performance is a management practice that is heavily dependent upon the other Code management practices discussed in this guidance document. A few activities are unique to this management practice; however most are also dependent on the strength of the other management system practices.

**Examples of Leading and Lagging Indicators**

**Lagging:**
- Trend in Process Safety Event (PSE) rate.
- Number of past-due, follow-up items from Management and Senior Leader reviews of Process Safety leading and lagging indicators.

**Leading:**
- Number of Management and Senior Leader reviews of Process Safety performance leading and lagging indicators not performed per schedule.
- Annual analysis of PSE causes performed per schedule.
• A policy exists that sets expectations for the time frames to close audit action items and open action items that fall beyond their target dates are actively tracked and escalated to management for review.
Appendix 1: Responsible Care® Comparison Matrix


<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MP#1</td>
<td>Leadership and Culture</td>
<td>1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 2.5, 3.3, 3.5</td>
<td>4.2, 4.2h, 4.2i, 4.3.3, 4.4.1, 4.4.3e</td>
<td>1, 2</td>
<td>Leadership &amp; Culture Action</td>
</tr>
<tr>
<td>MP#2</td>
<td>Accountability</td>
<td>1.1, 1.3, 1.7, 2.1, 2.3, 2.5, 3.2, 3.3, 3.4, 3.5, 3.6, 4.1, 4.3, 4.6, 5.1</td>
<td>4.2, 4.3.2, 4.4.1, 4.2.2, 4.4.3, 4.4.3d, 4.4.3e, 4.4.6, 4.5.1, 4.5.3, 4.5.5, 4.6</td>
<td>1, 2, 3, 4, 17, 19, 20, 21</td>
<td>Leadership &amp; Culture</td>
</tr>
<tr>
<td>MP#3</td>
<td>Knowledge, Expertise &amp; Training</td>
<td>2.2, 2.5, 3.3, 3.4</td>
<td>4.3.1f, 4.4.1, 4.4.2, 4.4.3, 4.4.3d</td>
<td>8, 17, 18, 19, 20, 22</td>
<td>Information Competence</td>
</tr>
<tr>
<td>MP#4</td>
<td>Understanding and Prioritizing Process Safety Risks</td>
<td>2.1, 2.5, 3.1, 3.2</td>
<td>4.3.1, 4.3.1e, 4.3.3, 4.4.1, 4.4.4, 4.4.5</td>
<td>8, 9, 11, 13</td>
<td>Risk Awareness</td>
</tr>
<tr>
<td>MP#5</td>
<td>Process Safety Management System</td>
<td>2.5, 3.1, 3.2 a-d, 3.7, 4.3</td>
<td>4.4.6, 4.4.6d, 4.4.6e, 4.4.6f, 4.4.7, 4.5.1, 4.5.1a</td>
<td>4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21</td>
<td></td>
</tr>
<tr>
<td>MP#6</td>
<td>Information Sharing</td>
<td>1.5, 1.6, 1.7, 2.2, 2.4, 3.5, 3.6, 4.5, 4.6</td>
<td>4.2i, 4.3.1f, 4.3.3, 4.3.3c, 4.3.3d, 4.4.3e, 4.4.3g, 4.4.3h, 4.5.1, 4.5.1a, 4.5.2, 4.5.3, 4.5.3f, 4.5.3g, 4.5.5, 4.6</td>
<td>3, 4, 5, 6</td>
<td>Action</td>
</tr>
<tr>
<td>MP#7</td>
<td>Monitor and Improve Performance</td>
<td>1.7, 4.1, 4.3, 5.1</td>
<td>4.5.1, 4.5.1a, 4.5.3, 4.5.5, 4.6</td>
<td>2, 3</td>
<td>Leadership &amp; Culture Action</td>
</tr>
</tbody>
</table>
Appendix 2: Additional Risk Matrix Examples for Management Practice 4

Included in this appendix are additional Risk Matrix Examples which support Management Practice 4. The following are various strategies that companies can consider adopting to fulfill this Management Practice.

Another way to define Tolerable Risk that includes quantitative criteria for likelihood as shown in the following Risk Matrix Table.

<table>
<thead>
<tr>
<th>Severity</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likelihood (events/year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; $10^{-1}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10^{-1}$ to $10^{-2}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10^{-2}$ to $10^{-3}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10^{-3}$ to $10^{-4}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10^{-4}$ to $10^{-5}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; $10^{-5}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Risk is Tolerable**
- **Risk is NOT Tolerable**

The scenario identified from a sample Process Hazard Analysis (PHA) is as follows (for demonstration purpose only):

**Cause**: Failure of a storage vessel’s level control loop

**Undesired Consequence**: Overflow and spill of a flammable liquid from the vessels conservation vent, fire if there is an ignition source, operator injury if there is an operator in the vicinity of the fire

**Consequence Severity** assigned by the PHA based on the most appropriate definition in Table 1 (found in main body of the guidance) = Safety 3

**Layer of Protection**: High Level interlock shuts down feeds to the process vessel.
An example Fault Tree Diagram for this scenario is shown below.

Assuming hypothetically that:

The probability of a source of ignition in the vicinity of the spill = 1.0
The probability of oxygen being present = 1.0
The probability of an operator being in the vicinity of the fire = 0.5

From published failure rate data:

The likelihood of the control loop failing = $5.36 \times 10^{-2}$ failures per year
The Probability of Failure on Demand (PFD) of a high level interlock that is proof checked once a year = $2.3 \times 10^{-2}$

The Likelihood of a spill = Likelihood of control loop failure x interlock PFD = $5.36 \times 10^{-2} \times 2.3 \times 10^{-2}$

= $1.24 \times 10^{-3}$ events per year

The Likelihood of a fire = Likelihood of a spill x probability of a source of ignition x probability of oxygen being present

= $1.24 \times 10^{-3} \times 1.0 \times 1.0 = 1.24 \times 10^{-3}$
The Likelihood of an operator injury = Likelihood of a fire x probability of an operator in
the vicinity of the fire

\[ = 1.24 \times 10^{-3} \times 0.5 = 0.62 \times 10^{-3} \text{ events per year} \]

As shown below, the cell in the Risk Matrix for a Severity of 3 and a Likelihood of \(0.62 \times 10^{-3}\) events per year indicates a Tolerable Risk for this hypothetical scenario.

Therefore, under this hypothetical scenario and sample risk matrix, no additional recommendations or safeguards are needed.

PROCESS SAFETY
CODE OF MANAGEMENT PRACTICES

Purpose
The Process Safety Code is designed to prevent fires, explosions and accidental chemical releases. The Code is comprised of a series of management practices that reflect this goal, with the expectation of continuous performance improvement for each management practice. The practices are based on the principle that facilities will be safe if they are designed according to sound engineering practices, built, operated and maintained properly and periodically reviewed for conformance.

Process safety is an interdisciplinary effort. Consequently, the Code is divided into the following four elements: management leadership, technology, facilities and personnel. Each element is composed of Management Practices. Individually, each Practice describes an activity or approach important to preventing fires, explosions and accidental chemical releases. Collectively, the Practices encompass process safety from the design stage through operation, maintenance and training. The scope of this Code includes manufacturing, processing, handling and on-site storage of chemicals. This Code must be implemented with full recognition of the community’s interest, expectations and participation in achieving safe operations.

The process safety management program in each facility is complemented by workplace health and safety programs, as well as waste and release reduction programs which address and minimize releases and waste generation. These three programs, and others, will help assure that member facilities are operated in a manner that protects the environment and the health and safety of personnel and the public.

Relationship to Guiding Principles
The Code helps achieve several of the Responsible Care® Guiding Principles:

- To seek and incorporate public input regarding our products and operations.
- To make health, safety, the environment and resource conservation critical considerations for all new and existing products and processes.
To operate our facilities in a manner that protects the environment and the health and safety of our employees and the public.

Management Practices
Each member company shall have an ongoing process safety program that includes:

Management Leadership

1. Leadership by senior management through policy, participation, communications and resource commitments in achieving continuous improvement of performance.

2. Clear accountability for performance against specific goals for continuous improvement.


4. Investigation, reporting, appropriate corrective action and follow-up of each incident that results or could have resulted in a fire, explosion or accidental chemical release.

5. Sharing of relevant safety knowledge and lessons learned from such incidents with industry, government and the community.

6. Use of the Community Awareness and Emergency Response (CAER) process to assure public comments and concerns are considered in design and implementation of the facility’s process safety systems.

Technology

7. Current, complete documentation of process design and operating parameters and procedures.

8. Current, complete documentation of information relating to the hazards of materials and process technology.

9. Periodic assessment and documentation of process hazards, and implementation of actions to minimize risks associated with chemical operations, including the possibility of human error.

10. Management of changes to chemical operations to maintain or enhance the safety originally designed into the facility.

Facilities
11. Consideration and mitigation of the potential safety effects of expansions, modifications and new sites on the community, environment, and employees.

12. Facility design, construction and maintenance using sound engineering practices consistent with recognized codes and standards.

13. Safety reviews on all new and modified facilities during design and prior to start-up.

14. Documented maintenance and inspection programs that ensure facility integrity.

15. Sufficient layers of protection through technology, facilities and employees to prevent escalation from a single failure to a catastrophic event.

16. Provision for control of processes and equipment during emergencies resulting from natural events, utility disruptions and other external conditions.

**Personnel**

17. Identification of the skills and knowledge necessary to perform each job.

18. Establishment of procedures and work practices for safe operating and maintenance activities.

19. Training for all employees to reach and maintain proficiency in safe work practices and the skills and knowledge necessary to perform their job.

20. Demonstrations and documentation of skill proficiency prior to assignment to independent work, and periodically thereafter.

21. Programs designed to assure that employees in safety critical jobs are fit for duty and are not compromised by external influences, including alcohol and drug abuse.

22. Provisions that contractors either have programs for their own employees consistent with applicable sections of this Code or be included in the member company's program, or some combination of the two.
## Appendix 4: Responsible Care® Process Safety Code Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accident</td>
<td>An unplanned, specific combination of events or circumstances that leads to an undesirable consequence.</td>
</tr>
<tr>
<td>Accidental Chemical Release</td>
<td>An unplanned, sudden release of chemical(s) from manufacturing, processing, handling and on-site storage facilities to the air, water or land. It does not include permitted or other releases.</td>
</tr>
<tr>
<td>Acute hazard</td>
<td>The potential for injury or damage to occur as a result of an instantaneous or short duration exposure to the effects of an accident.</td>
</tr>
<tr>
<td>Chronic Hazard</td>
<td>The potential for injury or damage to occur as a result of prolonged exposure to an undesirable condition.</td>
</tr>
<tr>
<td>Commensurate with Risk</td>
<td>Activity prioritized based on relative risk versus other activities. The higher the risk is deemed to be, the higher the priority of the activity</td>
</tr>
<tr>
<td>Hazard</td>
<td>The inherent chemical or physical potential of a material or activity to harm people, property or the environment.</td>
</tr>
<tr>
<td>Hazard and Operability Analysis (HAZOP)</td>
<td>A systematic, qualitative brainstorming approach for hazard evaluation that studies deviations from normal process conditions.</td>
</tr>
<tr>
<td>Human Factors</td>
<td>A discipline concerned with designing machines, operations and work environments so they match human capabilities, limitations and needs. Includes any technical work (engineering, procedure writing, worker training, worker selection, etc.) related to the human factor in operator-machine systems.</td>
</tr>
<tr>
<td>Incident</td>
<td>An unplanned event or series of events and circumstances usually involving equipment failures and human errors resulting in an undesired consequence. If the outcome is severe, it is usually called an accident.</td>
</tr>
<tr>
<td>Likelihood</td>
<td>An estimate of the expected frequency or probability or occurrence of an event.</td>
</tr>
<tr>
<td>Management Practice</td>
<td>The basic component of a Responsible Care Code. It represents goals and objectives rather than prescriptive absolute or quantitative standards.</td>
</tr>
<tr>
<td>Process Safety</td>
<td>Process Safety is the approach that taken to ensure that the assets used in our chemical manufacturing, distribution and handling processes are managed and under control to minimize the likelihood of a loss of containment that could lead to a fire, explosion, exposure, or business interruption. Process safety management starts with a sound design, and requires good systems for operating, maintenance, and inspection procedures; training; hazard identification and mitigation; and</td>
</tr>
</tbody>
</table>
emergency response.

Risk  An estimate of human injury or economic loss in terms of both the accident likelihood and the magnitude of the loss or injury. The combination of the expected frequency (events/year) and consequence (effect/event) of a single accident or a group of accidents.

Risk Assessment  The systematic evaluation of the risk associated with potential accidents at complex facilities or operations.

Risk Management  The systematic application of management policies, procedures and practices to the tasks of analyzing, assessing and controlling risk in order to protect employees, the general public and the environment as well as company assets, while avoiding business interruptions. Includes decisions to use appropriate engineering and administrative controls for reducing risk.

**Acronyms which may be encountered in Process Safety discussions and within related Process Safety Resources**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAA</td>
<td>Clean Air Act</td>
</tr>
<tr>
<td>CCPS</td>
<td>Center for Chemical Process Safety</td>
</tr>
<tr>
<td>CO</td>
<td>Compliance Officer (OSHA NEP inspection)</td>
</tr>
<tr>
<td>CSB</td>
<td>Chemical Safety Board</td>
</tr>
<tr>
<td>CWS</td>
<td>Coalition for Workplace Safety (OSHA)</td>
</tr>
<tr>
<td>DG</td>
<td>Dangerous Goods (term used in Canada which includes Hazardous Materials)</td>
</tr>
<tr>
<td>GDC</td>
<td>General Duty Clause (Clean Air Act)</td>
</tr>
<tr>
<td>HAZMAT</td>
<td>Hazardous Materials</td>
</tr>
<tr>
<td>ISA</td>
<td>Inherently Safer Approaches</td>
</tr>
<tr>
<td>IST</td>
<td>Inherently Safety Technology</td>
</tr>
<tr>
<td>LOPA</td>
<td>Layers of Protection Analysis</td>
</tr>
<tr>
<td>MOC</td>
<td>Management of Change</td>
</tr>
<tr>
<td>NEP</td>
<td>National Emphasis Program (OSHA-PSM)</td>
</tr>
<tr>
<td>OCA</td>
<td>Off-site Consequence Analysis (security and EPA)</td>
</tr>
<tr>
<td>OIIR</td>
<td>Occupational Injury and Illness Rate</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>PSM</td>
<td>Process Safety Management</td>
</tr>
<tr>
<td>RAGAGEP</td>
<td>Recognized and Generally Accepted Good Engineering Practices (OSHA/PSM)</td>
</tr>
<tr>
<td>RMP</td>
<td>Risk Management Program (EPA)</td>
</tr>
<tr>
<td>SBREFA</td>
<td>Small Business Regulatory Enforcement Fairness Act (OSHA)</td>
</tr>
<tr>
<td>SHARP</td>
<td>Safety and Health Achievement Recognition Program (Small business OSHA/analog of VPP)</td>
</tr>
<tr>
<td>SVA</td>
<td>Site Vulnerability Assessment</td>
</tr>
<tr>
<td>TRI</td>
<td>Total Recordable Injury Frequency</td>
</tr>
<tr>
<td>WCS</td>
<td>Worst Case Scenario (EPA/RMP)</td>
</tr>
</tbody>
</table>

1. Why did the American Chemistry Council (ACC) develop a Process Safety Code?

   In 2010, ACC initiated a Strategic Review of its Responsible Care initiative. One of the recommendations which emerged from the Strategic Review called on ACC to “reinforce Responsible Care fundamentals in the areas of process safety....” As result, ACC’s Board of Directors determined that a new Process Safety Code would provide enhanced focus on this discipline and drive continual improvement.

2. Does the Process Safety Code apply to all ACC members?

   Yes. As with other Responsible Care program elements (e.g., Security Code, metrics reporting, new Product Safety Code, etc.), all ACC member companies are obligated to implement the Process Safety Code within their ACC dues base.

3. Does the Process Safety Code apply to Responsible Care Partners?

   Yes. As with other elements of Responsible Care, Partner companies are obligated to implement the Process Safety Code within their ACC dues base.

4. What is the implementation schedule for the Process Safety Code?

   ACC members and Partners are expected to have the Process Safety Code implemented in their organizations for the 2014-2016 certification cycle. ACC acknowledges that some organizations will move more quickly than others in achieving full implementation of the Code.

5. Are ACC members required to report implementation progress to ACC via a self-assessment process or a CEO attestation?

   No. Unlike previous Codes, there is no annual self-assessment process or CEO attestation of implementation associated with the Process Safety Code.

6. If our company is not subject to local, state or federal Process Safety regulations, are we still required to implement the Process Safety Code?

   Yes. Implementation of the Process Safety Code is not dependent on an organization’s regulatory status.

7. If our company is subject to local, state or federal Process Safety regulations, are we still required to implement the Process Safety Code?

   Yes. As stated in the “Purpose and Scope” section of the Code, “it (the Code) is intended to complement regulatory requirements.” Companies subject to regulations may be
able to build upon their experiences/activities in complying with these regulations when implementing the Code.

8. How can I confirm that my company/facility/process is subject to local, state or federal (e.g., OSHA’s process safety management (PSM) standard)?

ACC recommends that you contact the appropriate individual(s) in your organization (e.g., EHS professional, legal department or other designated authority) to confirm the organization’s regulatory status.

9. What is the relationship between the Process Safety Code and the requirements found in RCMS® and RC14001®?

As with the Security Code, new Product Safety Code, metrics reporting, etc., the Process Safety Code is another commitment which companies subscribe to as condition of ACC membership/Partnership. The Process Safety Code is written in a Plan-Do-Check-Act format which should allow for integration into an organization’s overall management system. When implementing the Code, ACC members and Partners are encouraged to identify existing processes into which Process Safety activities can be incorporated. For example, the Process Safety Code identifies certain training requirements. Similarly, the RCMS and RC14001 technical specifications have requirements for establishing and maintaining training programs. Rather than dedicate a separate training regimen to meet the Process Safety requirement, organizations should consider how they can build on existing programs by adding Process Safety components.

10. What is the relationship between the new Process Safety Code and ACC’s legacy Process Safety Code which was implemented in the 1990s?

ACC’s legacy Process Safety Code (adopted in 1990) is a “tool in the Responsible Care® toolbox” along with the other original Responsible Care Codes (Distribution, CAER, Pollution Prevention, Employee Health & Safety, Product Stewardship) which members and Partners can use as part of their continual improvement processes. Implementation of these legacy codes is not required, but key concepts from them have been incorporated into the RCMS® and RC14001® technical specifications. The relationship between the new Process Safety Code and the legacy Process Safety is listed under each Management Practice in this document. Organizations are encouraged to consider how they can build on previous experiences with the legacy Code when implementing this new Process Safety Code.

11. Is this Code intended for implementation only at facilities or does a headquarters/management component exist in the Code?

The Process Safety Code states that it addresses “issues at a more universal level, such as across a division or corporation.” The Code’s management practices include a number which are directed at senior leadership and its role in establishing a process
safety culture and expectations for the organization. Other management practices have a facility focus or identify shared responsibilities between facilities and headquarters/management.


As with any other element of Responsible Care, the Process Safety Code may be subject to review on a RCMS or RC14001 audit as another commitment to which the organization subscribes. This does not mean that an auditor will be required to review each management practice however any auditor will have the ability to sample from the Code and follow relevant audit trails. ACC is currently developing additional guidance for auditors on how the Process Safety and new Product Safety Codes will be addressed on future audits (beginning with 2014-2016 certification cycle). ACC members and Partners are encouraged to focus their attention on implementation of the Code and integration of its management practices in their existing management systems.

13. What do we anticipate the resource requirements to be for proper implementation of the Process Safety Code?

Each company’s experience and resource requirements will be different based on their relative starting point. Factors which will influence resource requirements include: hazards and risks associated with operations; regulatory status; management commitment; previous experience with process safety management; etc.

14. What resources are available through ACC to assist in code implementation?

In addition to this guidance document, ACC will be developing additional supplemental implementation materials based on learnings from member/Partner experiences and/or requests. ACC staff and Responsible Care® Special Advisors will be available to provide assistance to individual companies as necessary. Member-to-member mutual assistance will also be encouraged.

During 2013, ACC will hold Process Safety Implementation Webinars and Workshops for members and Partners and several Process Safety sessions will be on the agenda at the annual Responsible Care Conference.
Appendix 6: Additional References

The American Chemistry Council’s Process Safety Code Task Force recommends these documents as excellent sources of Process Safety information. ACC welcomes suggested additions to this list.


- **Inherently Safer Concepts** – American Chemistry Council (July 2010) [http://memberexchange.americanchemistry.com/Programs-and-Services/Responsible-Care/Subpages/Responsible-Care®-Process-Safety-Code/](http://memberexchange.americanchemistry.com/Programs-and-Services/Responsible-Care/Subpages/Responsible-Care®-Process-Safety-Code/)

Useful Websites

- American Chemistry Council (ACC): [http://www.americanchemistry.com](http://www.americanchemistry.com)

• Chemical Institute of Canada’s Process Safety Management Division: http://www.cheminst.ca

• U.S. Chemical Safety Board (CSB): http://www.chemsafety.gov/

• European Process Safety Centre: http://www.epsc.org

• International Council of Chemical Associations (ICCA): http://www.icca-chem.org/