1

INTRODUCTION

Companies have been implementing process safety management (PSM) systems for over 25 years. A variety of PSM structures have been used – some based upon regulatory requirements and many more based upon evolving industry good practices. These PSM systems are designed to manage the hazards and risks associated with processes using hazardous chemicals or energy. Management of these aspects requires a PSM system to focus on nurturing the performance of equipment and people throughout the life cycle of their deployment in a facility. The adoption of PSM systems has gone global, offering many new opportunities to improve upon implementation practices of the past.

Moreover, in spite of best efforts and many opportunities for learning lessons, companies are challenged with continually improving process safety performance and efficiency, along with managing all of the other important aspects that a company must concern itself with to be safe and profitable (e.g., occupational safety, environmental, security, economic competitiveness, sustainability). Some companies face the challenge of initial implementation or continual improvement by recognizing that ultimately it is people who must perform – executives, management, staff, operations, maintenance, and contractors – whether it is in designing or executing the intended practices within a PSM system. And, we have learned that organizational and individual behaviors and culture fuel the engine that implements PSM systems – no matter whether the motivation is for regulatory compliance or simply for good business.

Ensuring that people can return home healthy and uninjured at the end of each workday, ensuring that our neighbors are unharmed, and having a safe work environment have driven many companies to pursue PSM implementation with the objective of having zero incidents. It is that goal for which this guideline was developed – to help companies pursue and achieve the "perfect process safety" vision of zero harm.

1.1 OVERVIEW

It is important to differentiate process safety from other different or broader areas (or management systems) dealing with safety at process plants. For example:

- Process safety is focused on prevention of, preparedness for, mitigation of, response to, and restoration from catastrophic releases of chemicals or energy from an industrial chemical manufacturing process associated with a facility.

- Occupational safety is focused on the prevention of injuries/illnesses to employees due to their tasks or work environment. As such, it tends to focus on hazardous energy related to their personal momentum or the momentum of objects they may be manipulating. Injuries/illnesses could result, such as slips, trips, falls, cuts, thermal burns, musculoskeletal injuries, etc.
- HSE (health, safety, and environment), or the equivalent EHS or SHE acronym, is the broader area that, in addition to process safety and occupational safety, includes occupational health (aka industrial hygiene) and management of environmental impacts.
- SHEQ&S (safety, health, environmental, quality, and security) is the broadest view of related (and hopefully integrated) management systems, as introduced and discussed in *Guidelines for Integrating Management Systems and Metrics to Improve Process Safety Performance* (Ref. 1.1).
- Therefore, process safety is much more than just regulatory compliance (e.g., complying with OSHA's PSM regulation or EPA's risk management program [RMP] rule in the United States).

Historically, most long-established petrochemical companies and facilities (1) started with an initial focus on occupational safety (over 100 years ago in some cases), (2) established occupational health programs as illnesses due to chemical exposures became a known hazard, (3) established environmental programs as public concern increased and regulations were promulgated to protect the environment, and (4) established process safety programs by the 1990s, as guidance and regulations proliferated around the world (see Section 1.2). However, many companies primarily focused their earlier accident prevention efforts on improving their process technology and human factors.

In the mid-1980s, following a series of serious chemical accidents around the world (see Table 1.1 for a summary), companies, industries, and governments began to identify management systems (or the lack thereof) as the underlying cause for these accidents. Companies were already adopting a management systems approach in regard to product quality (e.g., various Total Quality Management initiatives). Companies developed policies, industry groups published standards, and governments issued regulations, all aimed at accelerating the adoption of a management systems approach to process safety. These somewhat fragmented, initial efforts gradually evolved into integrated management systems. The integrated approach remains a very useful way to focus and adopt accident prevention activities. In recent years, inclusion of manufacturing excellence concepts has focused attention on seamless integration of efforts to sustain high levels of performance in manufacturing activities. One goal of manufacturing or operational excellence is to deeply embed PSM practices into a single, well-balanced process for managing manufacturing operations.

Table 1.1 Accidents that Affected PSM Regulatory Development in the USA and Europe

Year	Location	Deaths	Injuries
1974	Flixborough, England	28	?
1976	Seveso, Italy	?	?
1984	Mexico City, Mexico	650	?
1984	Bhopal, India	2,000+	?
1985	Institute, WV	0	135
1988	Norco, LA	5	23
1988	Henderson, NV	2	350
1989	Richmond, CA	0	9
1989	Pasadena, TX	24	132
1990	Channelview, TX	17	0
1990	Cincinnati, OH	2	41
1991	Lake Charles, LA	6	6
1991	Sterlington, LA	8	128
1991	Charleston, SC	9	33

What is a management system? The *Guidelines for Risk Based Process Safety* (Ref. 1.2) define it as:

A formally established and documented set of activities designed to produce specific results in a consistent manner on a sustainable basis.

The *RBPS Guidelines* also emphasize that the management system activities must be defined in sufficient detail for workers to reliably perform the required tasks.

Regarding PSM management systems specifically, the Center for Chemical Process Safety (CCPS) initially compiled a set of important characteristics of a management system, which were published in Appendix A of the *Guidelines for Technical Management of Chemical Process Safety*. Those guidelines were the first generic set of principles to be compiled for use in designing and evaluating process safety management systems. Although Appendix A was groundbreaking, most readers overlooked it as a practical tool because the management systems concept was foreign to them. Since that time, most companies have accumulated significant practical experience in implementing formal process safety, occupational safety, and environmental management systems.

Table 1.2 (originally Table 1.7 in the *RBPS Guidelines*) lists issues that have proven to be most important when designing, developing, installing, revising, operating, evaluating, and improving PSM systems. A PSM framework (such as RBPS) can address one or more of these issues on an element-by-element basis.

The most important thing is that companies thoughtfully consider all of the issues in Table 1.2 when developing a new PSM system, adding new elements, or improving an existing system.

The life cycle of any management system will generally include design, development, rollout, operation, and monitoring/maintenance/improvement. Chapter 4 of these guidelines discusses the overall steps in implementing a new PSM management system:

1. Developing the design specification
2. Creating element and/or system workflows (as appropriate)
3. Estimating element and system workloads and necessary resources
4. Developing the element/system written programs and procedures
5. Rolling out the system
6. Monitoring implementation and initial performance

Similarly, *Guidelines for Integrating Management Systems and Metrics to Improve Process Safety Performance* (Ref. 1.1) discusses the PSM (and overall SHEQ&S) program's life cycles and the Plan-Do-Check-Adjust (PDCA) approach in each chapter. In particular, Chapter 5 discusses how to apply the PDCA approach when implementing a SHEQ&S system, how to set about prioritizing the integration efforts, how to develop integrated systems, and then how to build the concept of continuous improvement into the system's life cycle.

The primary purpose of this book is to provide an update to the original *Guidelines for Implementing Process Safety Management Systems,* recognizing that most companies now have some form of PSM system, but that a number of companies, especially smaller companies or those in developing countries, may need a road map of how to efficiently and effectively upgrade their systems.

Table 1.2 Important Issues to Address in a PSM System

- Purpose and scope
- Personnel roles and responsibilities
- Tasks and procedures
- Necessary input information
- Anticipated results and work products
- Personnel qualifications and training
- Activity triggers, desired schedule, and deadlines
- Necessary resources and tools
- Metrics and continuous improvement
- Management review
- Auditing

1.2 BACKGROUND/HISTORY OF PSM

The American Institute of Chemical Engineers' ' (AIChE's) Center for Chemical Process Safety (CCPS) was established in 1985 as one of the U.S. chemical industry's reactions to a major chemical accident in Bhopal, India. In 1988, CCPS published a motivational advertisement for its forthcoming PSM structure, *Chemical Process Safety Management – A Challenge to Commitment* (Ref. 1.3). This item was intended to educate chief executives in the chemical industry about the importance of implementing PSM activities into their company operations and to motivate them to adopt a management systems approach.

Any discussion on the background and history of PSM would be incomplete without mentioning some other pioneers and pioneering organizations. For example:

Trevor Kletz

After progressing through various positions within Imperial Chemical Industries (ICI), he was appointed as ICI's first Technical Safety Advisor in 1968. During his tenure, ICI developed the hazard and operability (HAZOP) approach and Trevor wrote the first book on this subject. Shortly after retiring in 1982, he expanded an earlier paper entitled "What you don't have, can't leak" into the book that first documented the concept of inherent safety. He is also well known for his many books and presentations emphasizing the importance of learning from previous accidents.

Frank Lees

After working for ICI for a number of years, he joined Loughborough University of Technology and in 1974 was appointed Professor of Plant Engineering. Following the Flixborough disaster that year, he was appointed to the new UK Advisory Committee on Major Hazards. Later, he was a technical assessor for the 1988 Piper Alpha disaster inquiry. He is best remembered for his book *Loss Prevention in the Process Industries*, initially published in two volumes (and over 1,000 pages) in 1980, with the second edition of three volumes published in 1996. (Note that the third edition was published in 2005 by Dr. Sam Mannan and the Mary Kay O'Connor Process Safety Center [discussed below].)

Health and Safety Executive

Shortly after the 1974 Flixborough explosion, the UK promulgated the "Health and Safety at Work" act. This changed the UK approach from one where the authorities defined the procedures for them to follow to one that established goals for operators to meet. Specifically, it replaced the 27 prescriptive acts of parliament with one that transferred the duty for the health and safety of employees and neighbors from the authorities to the employers.

It also established a Health and Safety Executive (HSE) composed of inspectors, specialist scientific, and technical staff to ensure that operators were doing their duty. In order to carry out their responsibilities, inspectors have the authority to enter any facility, take samples, written documents, etc., as they see fit (i.e., without a permit). The HSE and its inspectors follow an enforcement approach that is proportionate to the risks involved, i.e., identifying areas for further improvement through (mandatory) Improvement Notices, Prohibition Notices (to immediately stop operations), and up to prosecutions (for major breaches and/or not following Notices).

The UK implemented the EU's Seveso Directive as the Control of Major Accident Hazard Regulations (COMAH). The HSE reviews documented "Safety Reports," which document the approaches for reducing the risks from Major Accidents Hazards to ALARP (As Low As Reasonably Practicable).

HSE is well known for the technical expertise it demonstrates in regulatory enforcement and development/sharing of guidance documents in this field.

Center for Chemical Process Safety

As discussed in the preface to this book, AIChE created CCPS in 1985 after the chemical disasters in Mexico City, Mexico, and Bhopal, India. The CCPS is chartered to develop and disseminate technical information for use in the prevention of major chemical accidents.

CCPS is a not-for-profit, corporate membership organization within AIChE that identifies and addresses process safety needs within the chemical, pharmaceutical, and petroleum industries. CCPS brings together manufacturers, government agencies, consultants, academia, and insurers to lead the way in improving industrial process safety.

CCPS member companies, working in project subcommittees, define and develop useful, time-tested guidelines that have practical application within industry. The project topics run the gamut of areas important to manufacturers and range from human factor issues to qualitative and quantitative risk analysis to security vulnerability to inherently saferitpm design. With over 100 publications to date, CCPS remains at the forefront of issues relevant to industry.

Mary Kay O'Connor Process Safety Center

The Mary Kay O'Connor Process Safety Center (MKOPSC) at Texas A&M University was established in 1995 in memory of Mary Kay O'Connor, an Operations Superintendent killed in an explosion on October 23, 1989, at the Phillips Petroleum Complex in Pasadena, Texas. Since 1997, the MKOPSC Director has been Dr. Sam Mannan. The Center's mission is to promote safety as second nature in industry around the world in order to prevent future accidents. In addition, the Center develops safer processes, equipment, procedures, and management strategies to minimize losses within the processing industry. It also seeks to advance process safety technologies in order to keep the industry competitive. Finally, the Center (1) seeks to serve all stakeholders (academia, government, industry, and the public), (2) provides a common forum, and (3) develops programs and activities that will forever change the paradigm of process safety. The funding for the Center comes from a combination of an endowment, consortium funding, and contract projects.

Also, see several articles in the June 2009 edition of *Process Safety Progress* (Ref. 1.4) for additional information on the history of process safety.

1.3 PROCESS SAFETY RESOURCES

In 1989, CCPS began publishing a series of guidelines, starting with *Guidelines for Technical Management of Chemical Process Safety*, to encourage its members to pursue accident prevention in more integrated, holistic ways.

In 2007, CCPS published *Guidelines for Risk Based Process Safety*, which laid out the next generation, 20-element management system for process safety. In total, the CCPS has published more than 100 guidelines, tools, and concept books covering a wide range of PSM-related topics. Table 1.3 lists some of the key guidelines and tools that have paved the way for companies seeking to adopt, implement, and improve PSM management systems.

In addition, Appendix III of this book provides an extensive listing of RBPS implementation tools, along with summaries of the purpose of each tool and examples of many of the tools (typically, by references to Web sites or to the files on the Web accompanying this book).

Other industry groups and government agencies also developed PSM frameworks, and Tables 1.4 and 1.5 list a sampling of these. Most of the frameworks are similar in construction, include identical or similar safety management system elements, and promote similar process safety work activities. However, differences exist in the frameworks, particularly the newer ones. In many cases, the sponsoring country or organization wisely looked around the world and then built its process safety structure based on current best practices within the industry.

In summary, PSM has advanced and today there are many process safety models, support tools, and organizations available to help advance process safety and how organizations and individuals stay engaged and involved (i.e., promote continuous education and innovation). Process safety successes and failures depend upon dedicated knowledgeable individuals throughout our industry, governments, and academia working together toward the common goal of preventing catastrophic incidents.

Table 1.3 CCPS Guidelines and Tools for Chemical Process Safety Management

- *Guidelines for Technical Management of Chemical Process Safety*, 1989
- *Plant Guidelines for Technical Management of Chemical Process Safety*, 1992, 1995
- *Guidelines for Hazard Evaluation Procedures*, 1992, 2008
- *Guidelines for Investigating Chemical Process Incidents*, 1992, 2003
- *Guidelines for Auditing Process Safety Management Systems*, 1993, 2011
- *Emergency Relief System Design Using DIERS Technology*, 1993
- *Guidelines for Safe Automation of Chemical Processes*, 1993
- *Guidelines for Implementing Process Safety Management Systems*, 1994
- *Guidelines for Integrating Process Safety Management, Environment, Safety, Health and Quality*, 1996
- *Guidelines for Writing Effective Operating and Maintenance Procedures*, 1996
- *Guidelines for Pressure Relief and Effluent Handling Systems*, 1998
- *ProSmart: Performance Measurement of Process Safety Management Systems*, 2001
- *Layer of Protection Analysis: Simplified Process Risk Assessment*, 2001
- *Guidelines for Mechanical Integrity Systems*, 2006
- *Guidelines for Risk Based Process Safety*, 2007
- *Guidelines for Performing Effective Pre-Startup Safety Reviews*, 2007
- *Guidelines for Safe and Reliable Instrumented Protective Systems*, 2007
- *Guidelines for the Management of Change for Process Safety*, 2008
- *Guidelines for Process Safety Metrics*, 2009
- *Guidelines for Evaluating Process Plant Buildings for External Explosions, Fires, and Toxic Releases*, *2nd Edition*, 2012
- *Guidelines for Engineering Design for Process Safety*, *2nd Edition*, 2012
- *Guidelines for Enabling Conditions and Conditional Modifiers in Layers of Protection Analysis*, 2013
- *Guidelines for Integrating Management Systems and Metrics to Improve Process Safety Performance*, 2015

Table 1.4 Significant Industry-Based PSM Initiatives

- Chemistry Industry Association of Canada (formerly Canadian Chemical Producers Association): program, 1986
- American Chemistry Council (formerly Chemical Manufacturers Association): Responsible Care Initiative Process Safety Code of Management Practices, 1987, 2013
- AIChE Center for Chemical Process Safety: Technical Management of Chemical Process Safety, 1989
- American Petroleum Institute Recommended Practice 750 – Management of Process Hazards, 1990
- ISO 14001: 1996 and 2001 – Environmental Management System
- Organization for Economic Cooperation and Development Guiding Principles on Chemical Accident Prevention, Preparedness, and Response, 2003
- American Chemistry Council Responsible Care® Management Systems and RC 14001, 2004
- [UK] Energy Institute: High Level Framework for Process Safety Management, 2010
- Canadian Society for Chemical Engineering: Process Safety Management Standard and Guide, 2012
- The American Fuel and Petrochemicals Manufactures and American Petroleum Institute's "Advancing Process Safety" initiative. (Programs include process safety metrics, event sharing, process safety hazards identification, process safety regional networks, and process safety site assessments.) See www.afpm.org/policy-position-process-safety/ for more information.

Some of these PSM frameworks are discussed in more detail in Chapter 4.

Table 1.5 Partial List of Worldwide Governmental Accident Prevention and PSM Initiatives

- European Commission: Seveso I Directive, 1982; Seveso II Directive, 1997; Seveso III Directive, 2012
- U.S. Occupational Safety and Health Administration Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119, 1992
- U.S. Clean Air Act Amendments: Section 112(r) – Accident Prevention, 1992
- U.S. Environmental Protection Agency Risk Management Program rule (40 CFR 68, 1996
- Mexico: Integral Security and Environmental Management System (SIASPA), 1998
- United Kingdom: Health and Safety Executive COMAH regulations – The Control of Major Accident Hazards Regulations, 1999 (amended in 2005 and 2015)
- Australia: Occupational Health and Safety Act 1985 Occupational Health and Safety (Major Hazard Facilities) Regulations 1999 (SR 1999). National Standard for the Control of Major Hazard Facilities [NOHSC1014(1996/2002)]. Work Health and Safety, 2011
- Canada: Canadian Environmental Protection Act – Environmental Emergency Regulation, Section 200 Part 8, 1999
- Republic of Korea: Korean OSHA PSM standard, Industrial Safety and Health Act – Article 20, Preparation of Safety and Health Management Regulations. Korean Ministry of Environment – Framework Plan on Hazardous Chemicals Management, 2001-2005
- Japan: High Pressure Gas Safety Act, 2006
- Brazil: ANP Oil and Gas industry accident prevention regulations
- Malaysia: Department of Occupational Safety and Health, Ministry of Human Resources, Section 16 of Act 514
- Singapore Standard SS506 Part 3: Occupational Safety and Health (OSH) Management System – Requirements for the Chemical Industry, 2013
- China: Guidelines for Process Safety for Petrochemical Corporations – AQ/T3034, 2010
- U.S. Bureau of Safety and Environmental Enforcement: Safety and Environmental Management Systems, 2011
- International Association of Oil and Gas Producers: Process Safety – Recommended Practice on Key Performance Indicators, 2011
- Mexico: NOM-028-STPS-2004, Process Safety and Critical Equipment Handling Hazardous Chemicals System, 2012
- European Union: EU Directive 2013/30/EU on Safety of Offshore Oil and Gas Operations, 2013

See Appendix I for a complete listing and additional information on these regulations/initiatives.

1.4 PSM IMPLEMENTATION LESSONS

Various factors can continuously or periodically influence a company's PSM system implementation and/or performance; examples include:

- Significant internal or external incidents, which point out actual or potential weaknesses or new areas that need to be addressed
- Economic conditions, which may bring pressure to reduce the costs and resources associated with maintaining systems
- Process changes or mergers/acquisitions that introduce new processes/ chemicals with new hazards and risks. For example, a small site may not have previously been required to implement a PSM system (due to either regulatory or corporate requirements), but now:
    - it increases the quantity of a highly hazardous chemical used in the process and now needs a formal PSM system that will ensure a higher level of attention to process safety, or
    - it is acquired by a different company that requires a formal PSM system to be instituted due to the chemicals/quantities handled in the process, to reduce the risk to employees and neighbors, etc.
- Workforce shifts, where experienced PSM personnel leave or move to different roles, resulting in a reduction of knowledge/experience
- Organizational changes, which either leave some key PSM system responsibilities unassigned or move experienced PSM personnel to different roles
- Hiring of new college graduates with engineering and other professional technical majors but without ensuring adequate PSM training and education for them prior to their involvement in PSM processes
- Regulatory changes, which add new requirements that the PSM system must address
- Global expansion, leading to issues such as maintaining the PSM system robustness and fitness-for-purpose as the company gets larger, integrating the PSM system of a new acquisition, and instilling the desired safety culture in personnel in various countries

These and other influences may lead to companies seeking new ways to improve PSM system activities based on strategies such as the following:

- Decreasing or eliminating PSM system activities that are judged as overly demanding or unnecessary, based on risk judgments
- Performing PSM system activities more efficiently
- Using the same resources, but using better practices to generate improved results
- Getting better PSM results, but with fewer resources

- Extending existing PSM system practices and activities into new areas
- Extending existing PSM practices throughout the management system life cycle (e.g., an Operational Excellence approach
- Adding new PSM activities to existing PSM elements
- Creating new PSM elements
- Restructuring the PSM system
- Establishing in-house PSM training curriculums for employees at all levels

In the last 25 years during which PSM systems have become more and more common, many lessons – both positive and negative – about PSM implementation have been learned. Some examples of these lessons are briefly discussed or referenced in the various chapters in this book, but in general the positive lessons include factors such as:

- good planning,
- adequate and knowledgeable resources, and
- continuous learning and improvement/innovation.

In addition, the appendices of this book and/or the files on the Web accompanying it include a number of PSM implementation lessons, as well as PSM implementation resources, including the following:

- A case study of Eli Lilly and Company's PSM implementation experience (Appendix II)
- A number of PSM system tools/resources shared by Eli Lilly and Company (on the Web)
- An extensive list of "RBPS Implementation" tools (Appendix III)
- A description of how to map PSM system/element performance issues to culture features (Appendix XIV)
- An example of a Process Safety Culture Survey (on the Web)
- A detailed PSM project implementation plan example
- A current compilation of PSM-related software
- A set of contractor safety and health guidelines

1.5 THE BUSINESS CASE FOR PROCESS SAFETY

As process safety became more and more common for companies and sites during the 1990s, process safety professionals found that they were often asked – and asked themselves – one question: What is the business benefit for process safety?

The easiest answer to this question comes from the costs of a lack of proper process safety management, i.e. process safety events. The Marsh 100 Largest Losses (1974-2013) estimated the total cost of property damage over this period to be $34 billion. These accidents "generally occur because of the failure of a number of the systems or barriers within the process-safety management systems." The $34 billion figure is for property damage alone. It ignores the fatalities that result and the additional costs to companies and society from the incident; for example: (1) Bhopal (over 2,000 fatalities and $400 million), (2) Flixborough (28 fatalities), (3) Buncefield (£1 billion), (4) Longford (two fatalities and $1.3 billion), and (5) Macondo (12 fatalities and over $30 billion).

In an effort to answer this question and show the business benefits from a strong PSM program, CCPS commissioned a study and developed an initial brochure on "The Business Case for Process Safety" in 2006, which was subsequently upgraded and revised in 2010 (available in Appendix IV). In addition, Project 245 ("Business Case for Process Safety and Sustainability") intends to update the original material with current examples and expand it to include the concept of sustainability.

The study identified two qualitative and two quantitative benefits for process safety:

- Qualitative benefits:
  - Corporate responsibility – process safety protects a company's image, reputation, and brand.
  - Business flexibility – process safety preserves a company's license to operate and gives it increased business options.
- Quantitative benefits:
  - Risk reduction – process safety prevents human injury and avoids significant losses and environmental damage.
  - Sustained value – process safety helps boosts productivity and produce high-quality products, on time and at lower cost, which contributes to shareholder value.

In terms of real, measurable benefits, the companies that participated in this study reported significant direct cost benefits of up to:

- 5% increase in productivity,
- 3% reduction in production costs,
- 5% reduction in maintenance costs,
- 1% reduction in capital budget, and
- 20% reduction in insurance costs.

In order to realize these benefits, the study recommends seven steps for achieving business excellence through process safety management:

1. Assign personnel who will be accountable. Typically, either a process safety manager or team should be responsible for (a) ensuring excellence in pursuing process safety throughout the corporation, (b) reevaluating your program's effectiveness, (c) estimating your company's and sites' "process safety return on investment," and (d) communicating it to the employees and the public.
2. Adopt a personalized company philosophy of process safety. Use it to establish a management system along the lines of CCPS guidelines (referenced in this book) and tie it into your company's core values.
3. Learn more about process safety by reviewing the literature and other references, attending training provided by process safety professionals, and interacting with other companies (e.g., networking with them and participating in industry alliances).
4. Take advantage of the strong synergy process safety has with your other business drivers. For example, Total Quality Management (TQM), regulatory requirements, and the American Chemistry Council's (ACC's) Responsible Care® initiative all share common elements.
5. Set achievable process safety goals that will support the business case presented over the next one to five years.
6. Track your performance versus goals periodically (note that this book stresses the importance of monitoring and metrics, and provides references on these subjects).
7. Revisit your process safety program and modify it every three to five years as needed. (Clearly, this book is intended to help guide any PSM system modification or upgrade efforts.)

Keeping in mind the importance of making the business case for PSM periodically within your site/company, it is a good idea to continuously look for and capture PSM implementation benefits as your organization continues its PSM journey.

1.6 IMPORTANCE OF INTEGRATING PSM WITH BUSINESS SYSTEMS

While PSM systems can stand alone, PSM systems reach far beyond process safety objectives and results. PSM systems are well aligned with business systems and achieve business objectives and results, along with process safety risk reduction. Examples include management systems for the following:

- Process safety information (PSI). PSI management systems often go beyond PSI and approach intellectual property (IP) or other technical knowledge.

- Process hazard analyses (PHAs). Companies often use PHAs to go beyond process hazards and also analyze business risks.
- Operating procedures for PSM as well as procedures for business processes
- Contractor management for process safety as well as for business processes
- Mechanical integrity (MI). MI can be extended to increase equipment reliability and plant uptime.
- Incident investigation techniques, which can be applied to "loss of production" and equipment failure incidents
- Management of change (MOC). Similar change management rigor can be applied to business processes.

"PSM systems" are rarely just PSM systems. Their objectives and results go beyond process safety and generally create reliable sustained operations. PSM systems may be looked at as specific or "focused" business systems and should be integrated into the company's business systems and practices at every level. Specific process safety objectives and results should be documented, highlighted, and understood for each business system as well as other objectives and required results.

PSM systems tend to share some common management system needs (e.g., planning, budgeting, training, risk analysis, change management, off-normal event reporting and investigation/analysis, contingency planning, auditing, performance analysis, management review) with other management systems. For many companies, it makes sense to standardize key aspects of these common/similar elements. The more integrated a PSM system is with either the HSE system or the business management system (BMS), the greater the likelihood that the promise of consistency and efficiency can be achieved. (Note that the recent CCPS book entitled *Integrating Management Systems and Metrics to Improve Process Safety Performance* [Ref. 1.1] focuses on this important topic and provides extensive guidance on this subject.)

In addition, most companies face overlapping regulatory, industry and trade association, and certification requirements that can consume significant resources and attention. Combining the synergies among these various business systems will help ensure safe and reliable operations, streamline procedures and cross-system auditing, and support regulatory and corporate compliance requirements. Since some of the systems are common to more than one area, a well-designed and well-implemented integrated management system will help reduce the load on the process safety and other groups. In addition, an integrated system will help improve manufacturing efficiency and customer satisfaction. Further, the importance of integrating process safety, health, environmental, quality, and security performance improvement systems has been noted in recent conferences, webinars, journals, and books.

Whether a facility is regulated or not, if it must handle hazardous materials, a company's success will be favorably impacted when it applies the fundamental elements of a PSM program within its business systems and other risk reduction programs. In addition to regulations, societal and political pressures from the public demand ever-better safety and environmental performance. So, every company needs to find ways to improve its operating efficiency and performance, reduce overall operating cost, and at the same time find ways to maintain and improve its competitive market position.

Although the management programs for process safety and other business systems may have been developed separately, they have similar program-related expectations, such as:

- a formal, implemented program;
- specific program-related recordkeeping requirements; and
- metrics used to demonstrate performance program improvements.

Due to the different, sometimes conflicting goals for each group, the demands on an operating facility may inadvertently prompt unsafe program changes and contribute to an increased process safety-related operating risk. A formalized, integrated, and well-managed system helps provide the controls that prevent such changes from occurring.

The potential high-level benefits of integrating PSM with other business management systems include lower costs, improved problem solving, work process consistency, continuous improvements, clearly identified measures, sound statistical data analyses, and satisfied and engaged customers (Ref. 1.1). Other benefits of integrating PSM into business systems are those discussed in Section 1.4 ("The Business Case for Process Safety") of these guidelines and in the CCPS brochure provided in Appendix IV.

In summary, there are many benefits to integrating PSM into business systems, and doing so is vital to successful PSM system. The most successful companies will be the companies that integrate process safety into their business systems and practices, understanding how each business system impacts process safety and highlighting it to ensure that process safety is sustained over the life cycle.

1.7 INTENDED AUDIENCE AND HOW TO USE THESE GUIDELINES

These guidelines are intended for use by facility or corporate personnel responsible for designing, implementing, or monitoring the performance of PSM systems for facilities. Typical facility personnel job roles would include plant engineers or technical specialists involved with executing specific PSM element activities, element coordinators, and PSM/HSE managers. Typical corporate personnel would include PSM element subject matter experts and PSM/HSE managers.

In addition, anyone who is in a position to evaluate, plan, coordinate, advise, or execute PSM/HSE implementation, integration, or improvement efforts may benefit from these guidelines; for example:

- Corporate PSM/HSE coordinators
- Corporate PSM element subject matter experts
- Facility/asset PSM/HSE managers and coordinators
- PSM/HSE element champions and subject matter experts
- Plant engineers
- Engineering and construction firms
- PSM/HSE consultants

Companies can use the information provided in this book to help perform one or more of the following tasks:

- Determine process safety implementation and performance status
- Prepare for PSM system change
- Implement a new PSM system
- Incorporate new elements into an existing PSM system
- Improve an existing PSM element or system
- Integrate PSM/HSE with a business management system
- Manage future process safety performance

This book devotes chapters to each of these PSM activities. Personnel involved in any of them can consider the features described for each activity. Several appendices provide additional information useful to those personnel.

Table 1.6 lists perceived user needs and provides guidance on how to use this book to best meet those needs.

Table 1.6 Roadmap for Using This Book to Implement PSM

User Need Description	Contents to Review to Meet Needs
Want to know the basics	1
Evaluate PSM implementation and performance	1, 2
Want to prepare the organization for the change	1, 3, Appendix VII
Develop and/or implement a new PSM system	1, 4, Appendices II and III
Add new elements to an existing PSM system	1, 5, Appendices II and III
Improve an existing PSM element or system	1, 2, 6, Appendix III
Integrate PSM with other business systems	1, 7, Appendix IV
Sustain or improve PSM performance	1, 8

1.8 REFERENCES

1.1 Center for Chemical Process Safety of the American Institute of Chemical Engineers, *Guidelines for Integrating Management Systems and Metrics to Improve Process Safety Performance*, John Wiley & Sons, Inc., Hoboken, New Jersey, 2015.

1.2 Center for Chemical Process Safety of the American Institute of Chemical Engineers, *Guidelines for Risk Based Process Safety*, John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.

1.3 Center for Chemical Process Safety of the American Institute of Chemical Engineers, *Chemical Process Safety Management – A Challenge to Commitment*, New York, New York, 1988.

1.4 American Institute of Chemical Engineers, "History of Process Safety" (several articles), *Process Safety Progress*, New York, New York, Vol. 28, Issue 2, June 2009, pp. 103-207.