1
WHAT IS COO/OD AND HOW CAN I TELL IF I NEED IT?

1.1 INTRODUCTION

This book describes the concepts of conduct of operations (COO) and operational discipline (OD), the attributes of effective COO/OD systems, and the steps an organization might take to implement or improve its COO/OD systems. This chapter should be read by everyone using this book to familiarize themselves with the principles of COO/OD. It will explain the basic COO/OD concepts and help you decide whether your current COO/OD system activities need improvement. It will also define important terms used throughout the book and the relationship between COO/OD and other management systems.

In general, COO encompasses the ongoing management systems[1] that are developed to encourage performance of all tasks in a consistent, appropriate manner. OD is the deliberate and structured execution of the COO and other organizational management systems by personnel throughout the organization. Formal definitions of COO and OD can be found in Section 1.4.

> COO addresses management systems. OD addresses the execution of the COO and other management systems.

1.2 PURPOSE OF THIS BOOK

This *Concept* book is intended to explain the key attributes of COO/OD and to provide specific guidance on how an organization can implement effective systems.

The purpose of this book is to help organizations design and implement COO and OD systems. This book provides ideas and methods on how to (1) design and implement COO and OD systems, (2) correct deficient COO and OD systems, or (3) improve existing COO and OD systems.

1.3 FOCUS AND INTENDED AUDIENCE

The primary focus of this book is on improving process safety management within the process and allied industries. However, the concepts and activities described in this book should be applicable to a broad spectrum of facilities in many industries.

---

[1] Organizations typically use the term "program" or "system" to describe their approach to COO/OD. The term "system is used in this book. One term that should not be used is COO/OD "project"; COO/OD is not a project with a discrete end date, but an ongoing process.

Its intended audience is everyone – from upper management to front-line workers – who will be involved in designing, implementing, maintaining, and improving COO/OD systems. Section 1.5 discusses how the intended audience might use this book.

PSM USAGE

The terms "process safety management" and "PSM," as used throughout this book, refer to the systems used to manage process safety within an organization. They do **NOT** refer to a specific regulation (such as 29 CFR 1910.119 in the United States).

Implementing an effective COO/OD system inevitably produces positive changes in an organization's culture; however, changing the overall culture of an organization is a broader topic than the COO/OD systems addressed herein.

PROCESS SAFETY FOCUS

This book focuses on improving process safety performance, which may also bring occupational safety benefits.

Likewise, the broad application of COO/OD principles will likely produce occupational safety, environmental, reliability, quality, and many other benefits. However, this book focuses on the process safety aspects of COO/OD. The examples used throughout the book and the work activities described emphasize process safety issues.

BP Texas City – An Example of COO/OD Failings

On March 23, 2005, an explosion occurred in the Isomerization Unit (ISOM) at the BP refinery in Texas City, Texas, during a startup after a turnaround (Ref. 1.1). The incident resulted in 15 fatalities, more than 170 people injured, and major damage to the ISOM and adjacent process units.

The vapor cloud explosion occurred after liquid hydrocarbons were ejected from the stack of the blowdown drum serving the ISOM raffinate splitter column, which had been overfilled.

COO/OD-related issues associated with this incident include the following:

- An operational check of the independent high level alarm in the raffinate splitter tower was not performed prior to startup, even though it was required by procedures.
- The operators did not respond to the high level alarm in the splitter (it was on throughout the incident).
- The level indication available to the operators was useless during most of the startup because they deliberately maintained the level above the indicated range of the level instruments.
- When the Day Shift Supervisor arrived at about 7:15 a.m., no job safety review or walkthrough of the procedures to be used that day was performed as required by procedures.

- The board operator printed off the wrong startup procedure (although this was not a significant factor because he never referred to it).
- The splitter bottoms were heated at 75°F per hour despite the procedural limit of 50°F per hour.
- The Day Shift Supervisor left the plant during the startup about 3½ hours prior to the explosion. No replacement was provided during this period.
- The operating procedures were certified as current, although they did not include changes to relief valve settings made prior to the most recent recertification.
- Outside operators did not report significant deviations of operating parameters (such as rising pressure on the splitter bottoms pumps) to the control room.
- Deficiencies first identified in 2003 and 2004 still existed in training programs for ISOM operators.

Other notable examples of incidents with significant COO/OD issues include the following:

- Three Mile Island nuclear plant incident, March 28, 1979 (Ref. 1.2)
- Union Carbide methyl isocyanate release, Bhopal, India, December 3, 1984 (Ref. 1.3)
- Chernobyl nuclear plant explosion, April 26, 1986 (Ref. 1.4)
- Piper Alpha oil production platform fire, July 6, 1988 (Ref. 1.5)
- *Exxon Valdez* oil tanker spill on Bligh Reef near Valdez, Alaska, March 24, 1989 (Ref. 1.6)
- Sinking of the Petrobras P-36 oil production platform in the Roncador Field, May 15, 2001 (Ref. 1.7)

In all of these incidents, the information needed to safely operate the facility was present in the procedures and practices of the facility or known by facility personnel. Yet, in every case, well-intentioned, well-trained workers committed grievous errors. Why didn't the facility personnel perform the work appropriately? One contributor to these incidents was a lack of an effective COO/OD system.

Consider an acid leak that developed unnoticed as a result of poor housekeeping. This book will focus on the process hazards associated with the acid leak, not on the company's culture of using only a proven technology requiring acid instead of an inherently safer, but unproven, acid-free alternative. If the worker was injured as a result of not wearing the proper personal protective equipment (PPE) at the time of the acid leak, this book will focus on the consequences of not being able to isolate the release quickly, not on the injury resulting from the operator being splashed with acid. But, as noted above, preventing the acid leak and routinely wearing the proper PPE would not only have process safety benefits, but also occupational safety benefits.

NEW ELEMENT OF RISK-BASED PROCESS SAFETY

In its 2007 *Guidelines for Risk Based Process Safety* (Ref. 1.8), the Center for Chemical Process Safety (CCPS) identified COO as an essential element of a comprehensive risk-based process safety (RBPS) management system. Incorporation of COO into the RBPS guidelines was based on a long history of formalized operations concepts at many companies. For this book, the element was split into COO and OD (see Chapter 2 for a more detailed history of COO/OD systems). The RBPS guidelines identified twenty RBPS elements and organized them into four pillars of process safety. The COO/OD element is included in the Managing Risk pillar. Chapter 17 of the RBPS guidelines outlines the key principles and essential features of the COO/OD element, and it lists more than fifty possible work activities related to the element (with associated implementation options), examples of ways to improve the effectiveness of the element, metrics, and management review activities related to the element.

The COO/OD system applies to all personnel in the organization, including direct-hire employees, contractors, third-party personnel, and part-time employees. All personnel must be included in a successful COO/OD system.

A fully implemented COO/OD system touches every level of an organization, from the boardroom to the shop floor. For example, the manner in which a Vice-President of Operations handles weekly management meetings and addresses specific process safety topics falls within the COO/OD system. Table 1.1 lists some examples of how the COO/OD system applies to management personnel.

Thus, this book is initially directed toward an organization's leadership team. The team must decide that the long-term benefits of COO/OD, described in Chapter 2, are worth the initial and ongoing investment. The book then describes COO/OD systems in detail, which enables upper management to estimate the costs and benefits of such systems so that they can make an informed decision on how to proceed. The book also helps management understand that it must make a visible ongoing commitment if the system is to succeed.

Once the organization decides to implement COO/OD, overall responsibility for implementation and maintenance of this system rests with the facility manager[2], although its concepts can also be applied at the corporate level. This book will help facility managers identify systems that they should implement as part of a comprehensive COO/OD system. The bulk of the book is intended for those managers and specialists who will be developing, implementing, and maintaining the COO/OD system. This book describes typical features of a COO/OD system so that the responsible parties can perform a gap analysis of their existing systems and then improve their systems or use the model programs as a starting point for developing their own (see Chapter 7). This book will help site operations leaders

[2] The facility manager is the individual who has overall accountability and responsibility for the safe and efficient operation of an asset. A variety of terms may be used at different types of facilities. For example, at a fixed production facility this person may have the title of Plant or Site Manager. For an offshore oil platform, this individual may be referred to as the Offshore Installation Manager.

and area managers define the framework of controls necessary to ensure that tasks for which they are responsible are performed reliably.

TABLE 1.1. Examples of Management Operational Discipline Resulting from a COO System

- Exploring process safety management performance and efficiency issues in a positive way
- Requiring the collection of key performance indicators for process safety and regularly reviewing them
- Setting process safety performance expectations and providing the resources to achieve them
- Looking for management system failures as root causes for incidents
- Consistently identifying and correcting substandard actions or conditions during field walkthroughs
- Completing management reviews and approvals related to work activities in a timely manner
- Communicating a meeting's purpose and agenda reasonably in advance and conducting meetings efficiently
- Treating peers and subordinates in a respectful manner
- Documenting the results of meetings and transmitting the minutes within a reasonable time
- Holding everyone (including themselves) accountable for commitments and ensuring that issues are resolved in a timely manner
- Ensuring adequate staffing to operate units safely
- Ensuring adequate funding to maintain equipment and safety systems in good condition

Once the COO systems are developed, management must engage the front-line supervisors and foremen to help implement and maintain them. The implementation of the COO systems is the OD portion of the process. In Chapter 3, this book offers advice on ways to overcome the initial resistance to any change in the historic ways of doing business. In Chapter 7 it also suggests ways to reward workers for ongoing commitment to maintaining high levels of operational discipline.

This book is of value to anyone who will be involved in COO/OD activities because it explains what the organization hopes to achieve and why their participation and support is crucial to overall success. Individuals in the organization will recognize the need for setting up specific processes and procedures and then strictly following them.

COO/OD applies to critical work activities of management, employees, and contractors in all departments, not just those of the operations department. It applies every time a worker performs a task throughout the life of a facility or an organization, because it is an ongoing commitment to reliable operations. For example, quality control tests must be performed accurately and reported promptly so that the process can be kept under control.

- Management and executives will understand that their behavior and personal discipline set the standards for the entire organization.
- Technical personnel will understand why it is important to design equipment so that it is easier to operate and maintain.
- Operators will understand why it is crucial that field readings be checked against panel readings.
- Maintenance workers will understand the importance of reliably performing tasks such as routine testing and housekeeping.
- The human resources group will understand their role in fitness-for-duty, progressive discipline, salary, bonus, and retention decisions.
- Support groups, such as information technology, will understand why their support of operations and maintenance is critical to their success.

The facility manager and the facility management team must lead by example for the system to achieve success.

The goal is for everyone to understand how reliable execution of their tasks is essential for the success of the organization.

1.4 DEFINITIONS

This section includes key definitions used throughout this book. A complete listing of definitions can be found in the Glossary.[3]

CONDUCT OF OPERATIONS DEFINITION

The embodiment of an organization's values and principles in management systems that are developed, implemented, and maintained to (1) structure operational tasks in a manner consistent with the organization's risk tolerance, (2) ensure that every task is performed deliberately and correctly, and (3) minimize variations in performance.

- COO is the management systems aspect of COO/OD.
- COO sets up organizational methods and systems that will be used to influence individual behavior and improve process safety.
- COO activities result in specifying how tasks (operational, maintenance, engineering, etc.) should be performed.
- A good COO system visibly demonstrates the organization's commitment to process safety.

[3] Current process safety-related definitions can also be found on the CCPS Web site.

OPERATIONAL DISCIPLINE DEFINITION
The performance of all tasks correctly every time.

- OD is the execution of the COO system by individuals within the organization.
- OD refers to the day-to-day activities carried out by all personnel.
- Individuals demonstrate their commitment to process safety through OD.
- Good OD results in performing the task the right way every time.
- Individuals recognize unanticipated situations, keep (or put) the process in a safe configuration, and seek involvement of wider expertise to ensure personal and process safety.

Table 1.2 provides examples of COO and OD issues that apply to a variety of situations.

PROCESS SAFETY CULTURE DEFINITION
The common set of values, behaviors, and norms at all levels in a facility or in the wider organization that affect process safety.

- It is possible to have a good culture for occupational safety but a less successful culture for process safety, particularly if the latter aspect does not receive focused attention.
- Different groups within an organization can have different process safety cultures.
- Process safety culture can often be observed in the behaviors that personnel exhibit when they believe that no one is watching them. Process safety culture can also be described as "the way we do things around here" in relation to process safety activities.
- Process safety culture is influenced by (1) organizational factors and (2) factors that are internal to the individual. COO focuses on the first factor while OD focuses on the second. Arguably, culture can also be affected by factors outside the organization (e.g., regulations, economic conditions, social mores), but a strong COO/OD system maintains the culture within the organization despite outside influences.

TABLE 1.2. Examples of COO and OD Issues for Various Situations

Situation	Examples of COO Issues*	Examples of OD Issues
Repair a pump	• Ensure that the work permit process is functioning properly • Ensure that workers are trained in safe work procedures • Use qualified maintenance workers • Ensure that correct repair parts and tools are available in stores (e.g., through an integrated maintenance work order system) • Reinforce good housekeeping practices • Implement maintenance systems (including labeling and lighting)	• Properly isolate the pump from process piping and power sources prior to starting the work • Understand the effects of the work on other work and interfacing systems • Follow work permit procedures and ensure that contract workers also comply • Properly check completed work • Maintain proper housekeeping • Communicate the status of repair work to operations
Start up a unit	• Ensure that operating procedures adequately address startup hazards • Identify any special issues related to the causes of the prior shutdown that might require additional attention – use the change management process where appropriate • Assess any nonfunctional safety systems or process equipment and either ensure that it is repaired or confirm that alternative measures and safeguards are effective • Properly communicate any necessary changes to the startup team in writing • Empower the operator to abort startup if required to resolve safety issues	• Use repeat-backs for all communications • Follow standard procedures and note any management instructions for modifications to the procedure • Properly log the startup sequence in the shift log or in special startup documentation • Identify deviations during startup that do not match the startup procedure, and consult with supervisors as to the correct response • Terminate the startup if safety issues are not resolved or personnel are unsure of how to proceed • If a team is involved, cross check activities with other team members to ensure that the correct sequence is followed

TABLE 1.2. Examples of COO and OD Issues for Various Situations

Situation	Examples of COO Issues*	Examples of OD Issues
Change shifts	• Establish a formal communications protocol for handover between shifts, including time to review logs • Clearly define the expected nature of communications among supervisors, board operators, and field operators • Establish a safety interlock defeat log and ensure that the logs are reviewed at the start of each shift • Establish a printed log form suitable for shift handover, rather than relying on operator notes	• Arrive promptly for shift change to allow time for adequate shift handover, and do not depart until the handover is complete • Properly log important information for the handover – process conditions, work underway, any safety equipment or interlocks out of service, etc. • Jointly review log forms transferred between the two shifts
Upgrade a level instrument	• Formalize the change management process and the forms to be completed by personnel • Assess the training needs of personnel that will arise as a result of the change	• Involve engineers, operators, and maintenance personnel when addressing all issues of concern associated with the change • Complete management of change procedures and all pre-startup assessments prior to using the equipment
Conduct the weekly plant staff meeting	• Establish a general agenda for the meeting so that personnel can be prepared for each meeting • Establish a schedule for the meeting • Track action items that result from the meeting • Assign adequate resources and completion dates for action items	• Attend meetings regularly • Review action items that are past due • Stick to the agenda and schedule • Prepare appropriate meeting notes

*Note: To avoid repetition, all COO activities include system aspects such as Planning, Implementing, Monitoring, and Management Review.

According to Merriam-Webster's dictionary (Ref. 1.9), the term "discipline" can have the following meanings:

1. punishment
2. a field of study
3. training that corrects, molds, or perfects the mental faculties or moral character
4. (a) control gained by enforcing order, (b) orderly or prescribed conduct or pattern of behavior, (c) self control
5. a rule or system of rules governing conduct or activity

Process safety risk-related OD focuses on definitions 4(b) and 5: orderly conduct and behavior and system governing conduct. Certainly one of the goals of an OD system is to establish order using a prescribed pattern of behavior. It does this through a system of rules that govern the performance of tasks in the facility and hold personnel accountable for their behavior. Trusting people to do their jobs, holding them accountable for their failings, and rewarding them for their behaviors are key aspects of a COO/OD system.

The word "discipline" as used in OD does NOT refer to punishment.

However, no set of rules or procedures can anticipate every possible situation and circumstance. Therefore, OD does not require or encourage blind compliance with any set of rules or procedures. OD encourages "thoughtful compliance" (Ref. 1.8).

Personnel are expected to follow the rules and procedures. However, **personnel are also expected to think** about what will happen if the established rules and procedures are applied to the current situation. If they believe the risks of implementing the rules and procedures are unacceptable, they are expected to stop and seek advice from other knowledgeable people. It may be possible to change the situation so that it is safe to proceed. Otherwise, they should work through the organization's process to change the rules or procedure prior to executing the modified procedures. Rules and procedures should not be changed in an uncontrolled manner. However, if an emergency requires an immediate response, then knowledgeable personnel should be trusted and empowered to enact modified procedures as a last resort to protect safety, based on their training and experience.

An example of the "thoughtful compliance" approach in emergency situations is the U.S. Nuclear Regulatory Commission's (NRC's) rules for nuclear power plant operators. Licensed plant operators are required to follow all of the conditions of their operating license and technical specifications (operating limits). However, the NRC also has a rule [10 CFR 50.54(x) (Ref. 1.10)] that states:

> *A licensee may take reasonable action that departs from a license condition or a technical specification in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent.*

In other words, commercial nuclear power plant operators are required to follow all the rules, except when following the rules in an emergency situation will result in unacceptable risk (i.e., endangering the public health and safety). Thus, a training and competency system that explains the "why" behind the rules is essential to support good OD.

There should be appropriate traditional discipline systems to hold personnel accountable for their actions. These systems are a backup to the COO/OD process and are outside the scope of this book. However, the human resources discipline system should follow COO/OD principles in treating everyone fairly and administering the same discipline for a rule or safety principle violation. In an organization with an effective COO/OD system, managers seldom refer personnel to the human resources discipline system unless they are intentionally or recklessly endangering others. When individuals are formally disciplined, people throughout the organization generally support the decision because they refuse to tolerate willful dangerous acts on the part of their coworkers.

As the effectiveness of the COO/OD system increases, the need for traditional discipline practices should decrease.

In an organization with an effective COO/OD system, personnel work together to encourage appropriate behaviors and discourage inappropriate behaviors through rewards and penalties integrated into work routines. As a result, the use of traditional human resources methods for disciplining people in an effort to correct their behavior is seldom required. Personnel monitor each other's performance and provide positive and negative feedback to other personnel in an effort to continuously improve the group's performance. However, when an individual's behavior makes it necessary, then the organization must take the appropriate disciplinary actions to retain its credibility.

1.5 HOW TO USE THIS BOOK

This book is organized so that readers can focus their attention on specific topics, depending on their role.

Chapter 2 discusses the advantages and expected outcomes of implementing a COO/OD system. Chapter 3 describes the actions that leadership needs to perform to establish an effective system. Chapter 4 outlines key aspects of human factors that affect the implementation of a COO/OD system. Chapters 5 and 6 provide details on the implementation of the COO and OD systems. Finally, Chapter 7 describes the Plan-Do-Check-Adjust process associated with implementing a COO/OD system. Table 1.3 lists the range of people for whom this book was written and suggests those chapters that the authors feel would

If you are just getting started with COO/OD, you should find all of the chapters helpful. If your organization's management is already supportive of COO/OD and you are just looking for specific actions to implement, focus on Chapters 5, 6, and 7.

be most beneficial. A "P" indicates a chapter of primary interest to the group, and an "S" indicates a chapter of secondary interest.

1.6 HOW DO I KNOW IF I NEED TO IMPROVE MY COO/OD SYSTEM?

This section provides checklists to help organizations gauge where they are with respect to COO/OD systems. The checklists are Indicators of Effective COO/OD Systems (Table 1.4), Examples of COO System Characteristics (Table 1.5), and Examples of OD System Characteristics (Table 1.6).

If a COO/OD system is working well, most of the positive indicators in Table 1.4 should be evident, and the system would qualify for Stage 5 maturity as described in Section 7.5.3. Table 1.5 provides examples of COO system strengths and weaknesses. Table 1.6 addresses the same content for OD systems. If you see the symptoms of weakness described in the second column of these tables, COO/OD system improvements could move the performance toward what is described in the third column of the tables.

If you determine that your organization has some of the symptoms listed in Tables 1.5 and 1.6, the remainder of this book will help you identify a path for improvement.

1.7 BASIC COO/OD CONCEPTS

Figure 1.1 shows a process safety pyramid or triangle, where the minor, serious, and catastrophic injuries normally found progressing up to the top of a personal safety triangle have been replaced with appropriate process safety issues, consistent with the process safety focus of this book. Eliminating the issues at the base of the triangle should result in a reduction in process safety incidents. COO/OD activities are typically focused on the bottom portion of the triangle with the goal of reducing the number of issues that occur at higher levels of the triangle.

TABLE 1.3. Key Chapters for Each Job Position

	1 – What Is COO/OD and How Can I Tell if I Need It?	2 – Benefits of COO/OD	3 – Leadership's Role and Commitment	4 – The Importance of Human Factors	5 – Key Attributes of Conduct of Operations	6 – Key Attributes of Operational Discipline	7 – Implementing and Maintaining Effective COO/OD Systems
Executive	P	P	P				S
Plant/Facility Manager	P	P	P		S		P
Site Operations Leaders/Area Managers	P	P	P	P	P	P	P
Environmental, Health, and Safety/ Process Safety Managers/Specialists	P	P	P	P	P	P	P
Site Foreman/Front-line Supervisors	P	S	P	P	P	P	S
Engineers/Project Managers	P		S	P	P		
Operators	P			P	P	P	
Maintenance	P			P	P	P	
Laboratory Technician	P			S	P	P	
Construction Workers	S					P	
Purchasing	P			P	P		
Warehouse	P				P	P	
Human Resources	P	S	S	S	P	P	

P – Chapter of primary interest, S – Chapter of secondary interest

TABLE 1.4. Indicators of Effective COO/OD Systems

Equipment is properly designed and constructed	☐	Operational, maintenance, safety, and environmental considerations are all addressed in the initial design of equipment.
	☐	Proactive risk analysis results and industry standards are used as inputs to the design process.
	☐	End users of the equipment (generally operations and maintenance personnel) are involved in the design process.
	☐	The design process occurs in a controlled manner.
	☐	The construction occurs in a controlled manner.
Equipment is properly operated	☐	The proper method for operating equipment has been developed through proactive analysis of the risks and documented in written procedures. Operators are involved in the development of the procedures.
	☐	Personnel have been trained in normal and abnormal operations, as well as the basis for the procedures and operating limits.
	☐	Equipment is configured and operated in accordance with procedures.
	☐	Equipment is returned to service using a controlled process.
	☐	Changes to operational requirements are appropriately assessed.
Equipment is properly maintained	☐	Equipment is maintained in accordance with predetermined maintenance strategies developed through a structured assessment process.
	☐	Personnel are trained to troubleshoot, repair, and maintain equipment.
	☐	Changes to operational conditions are assessed to determine their impact on maintenance requirements.
	☐	Equipment status is controlled through safe work practices.
	☐	Equipment failures are analyzed to prevent similar failures.
Management systems are properly executed	☐	Management systems are developed based on the results of proactive analyses and industry best practices.
	☐	Management systems are clearly documented.
	☐	Management systems are executed as written.
	☐	Organizational changes are assessed to determine impacts on existing management systems.
Errors and deviations are consistently addressed	☐	The personnel in the system are always seeking to improve their performance. As a result, there is extensive use of self-checking, peer-checking, audits, incident investigations, management reviews, and metrics to identify and eliminate deviations.
	☐	Personnel are actively seeking discrepancies and resolving issues when identified.
	☐	Personnel take ownership of issues and seek to solve the problem themselves. They involve outside resources to assist them in solving the problems, but retain ownership of the issue.
	☐	Personnel embrace feedback from personnel outside their group as opportunities to improve their systems and processes.

TABLE 1.5. Examples of COO System Characteristics

Topic	Indicators of Weakness	Indicators of Strength
Management Systems		
	☐ Management reviews of operations are not conducted or are conducted in an informal manner.	☐ Managers have a structured management review process for process safety elements and key operation/maintenance activities and generate actions to address the issues that are identified.
COO Foundations		
	☐ A new policy or procedure is issued and the first question asked about it is: "OK, I understand what the paper says, but what do you really want us to do?"	☐ Policies describe the behaviors that are expected of personnel.
	☐ Horseplay[4] is tolerated.	☐ The consequences of horseplay and other willful or egregious acts are documented.
	☐ The schedule of maintenance tasks was known to be unrealistic due to the reduced size of the maintenance staff. However, no risk prioritization was performed to identify the most critical tasks. As a result, technicians were told to "do what they could."	☐ Required resources are provided to complete the scheduled work or the scheduled work is prioritized to be consistent with the available resources.

[4] Rowdy or boisterous play; gay or light-hearted recreational activity for diversion or amusement. Also known as skylarking.

TABLE 1.5. Examples of COO System Characteristics

Topic	Indicators of Weakness	Indicators of Strength
	☐ Managers frequently met to identify problems and corrective actions. However, because the corrective actions were not effectively tracked, most of the actions were not completed.	☐ Corrective actions are tracked to completion by the organization. ☐ Corrective actions that are past due are periodically reviewed, and actions are taken to complete the corrective actions.
People		
	☐ Logs are incomplete or inaccurate. During incident investigations, they are of no help in determining what was going on in the facility.	☐ Expectations for keeping logs in a timely manner are enforced. ☐ Logs provide sufficient detail to describe facility operations.
	☐ They let us use our judgment on using safe work practices. If we feel the risk is low, they told us we don't have to use them – "I was only in the confined space for a couple of seconds, so there is no need for all that paperwork and equipment. I just held my breath."	☐ Personnel are trained on safe work practices. ☐ Workers understand the consequences of deviating from safe work practices. ☐ The process for obtaining work permits runs smoothly to reduce the effort required to obtain the right permits. ☐ Personnel are expected to use the proper system even if the system slows the work pace. ☐ Personnel are not punished for apparent delays caused by using the proper safe work practice system.
	☐ Broken equipment, old containers, and trash are found around the facility. ☐ Spills are not controlled or investigated.	☐ Equipment is kept clean so that process upsets and leaks are easily detectable. ☐ Tools and spares are located in specific locations. ☐ Trash is promptly disposed. ☐ Obsolete equipment is promptly removed.

TABLE 1.5. Examples of COO System Characteristics

Topic	Indicators of Weakness	Indicators of Strength
	☐ Personnel are assigned to tasks based on whomever is available, regardless of their qualifications to perform the specific task.	☐ Supervisors are aware of who is qualified to perform each task. ☐ Personnel are assigned to tasks based on their qualifications to perform the specific task, not just their general job title.
	☐ Personnel crowd into the control room, making it difficult for operators to communicate with each other.	☐ Limits on control room access during startups and shutdowns are enforced. ☐ The layout of the control room allows interaction between operators and maintenance staff without compromising operations.

TABLE 1.6. Examples of OD System Characteristics

Topic	Indicators of Weakness	Indicators of Strength
Organizational Aspects		
	☐ The operations manager tells operators to adhere to procedures, but when they get in the way of performing a rapid startup, he tells them to "do what it takes to get it done."	☐ Leadership follows the same rules they preach for front-line personnel. ☐ Leadership gathers and considers input from front-line personnel when making changes to the organization/facility. ☐ Leaders do not tolerate deviations.
	☐ Workers have no real input into the design and development of procedures, training, equipment, policies, and tools. "*Those guys* keep sending us this stuff. Why do we have to follow *their* procedures?"	☐ Front-line workers provide suggestions on improvements to the management systems, equipment, procedures, and tools used in the facility. ☐ Management acts on the suggestions. ☐ Management rewards workers who suggest and help implement improvements.

TABLE 1.6. Examples of OD System Characteristics

Topic	Indicators of Weakness	Indicators of Strength
	☐ Personnel generally follow procedures. But when there are conflicts between the procedure and production, they take shortcuts to get the job done.	☐ A system of structured methods for changing procedures, from informal to formal, is in place and widely used. Each change to the procedure is assessed, using a graded approach, before it is approved. ☐ Correct procedure use is enforced. ☐ There is visible evidence of thoughtful compliance. ☐ If the procedure cannot be followed, the activity is stopped until the procedure is properly changed or an exception is approved. ☐ Management communicates its rationale for exceptions or changes to established procedures so that workers understand the situations.
	☐ Broken equipment, old containers, and trash are found around the facility. There is no drive by workers to keep the workplace clean.	☐ Workers drive the housekeeping process. They correct other workers who deviate from the housekeeping standards.

TABLE 1.6. Examples of OD System Characteristics

Topic	Indicators of Weakness	Indicators of Strength
Individual Aspects		
	☐ Workers do not seek out additional knowledge, skills, and abilities. ☐ Not knowing how to do the job right shouldn't hold you back from trying to do the work.	☐ Workers self-regulate their assignment to tasks. They do not perform tasks if they are not qualified.
	☐ "What's the point? You try hard, you don't try – it all works out the same anyway." ☐ "It's not my problem – someone else should fix that." ☐ Three temperature indicators all show different temperatures, but no effort is made to understand and resolve the differences.	☐ Personnel take ownership of problems and drive solutions. ☐ Personnel aggressively seek solutions to operational and maintenance issues.
	☐ Personnel do not perform peer-checking because it is viewed as a way to get other people in trouble. ☐ Personnel do not spend time assessing the hazards associated with tasks. ☐ Personnel do not ask questions about the status of equipment and activities being performed in their areas. ☐ Personnel do not recognize increases in pressure and temperature that indicate a runaway reaction. ☐ Personnel do not recognize dust accumulation in unoccupied spaces, which could be a precursor to a dust explosion.	☐ Personnel actively seek out additional information about the status of equipment and activities. ☐ Personnel seek out process deviations and assess their implications. ☐ During periods of low work activity, workers actively seek to expand their knowledge of the facility through such activities as "what-if" challenges.

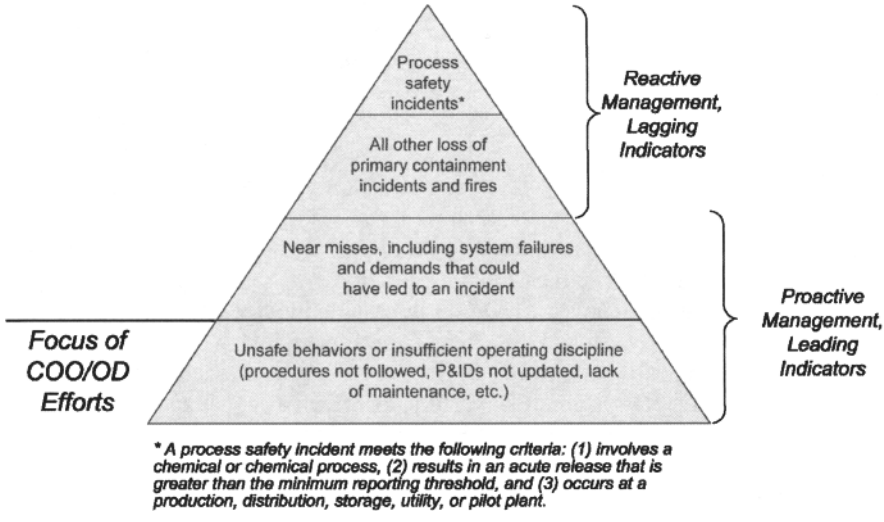

FIGURE 1.1. Typical Process Safety Pyramid

Advantages of focusing efforts near the bottom of the process safety pyramid include the following:

- Problems can be identified quickly.
  - The activities are performed frequently enough that feedback from the observations should identify potential performance gaps in a short period.
  - The undesirable and unsafe acts are leading indicators of process safety performance that can be identified and addressed before significant incidents occur.
- The activities can be easily observed.
  - The performance of most front-line workers produces an observable and measurable result (what the individual does in the field).
  - Corrective actions are handled with local resources and completed quickly. This visible response demonstrates management's commitment to COO/OD.
- Changing behaviors can change thinking.
  - For most personnel, if their behavior can be modified, their attitudes are often improved. When behaviors and attitude differ, most people will attempt to change one to eliminate the discrepancy. If the consistent performance can be maintained long enough, attitudes will usually change to embrace the new standards of performance (Ref. 1.11).

- Changes will leverage across multiple work areas/outcomes.
  - Low level behaviors, such as making rounds or completing paperwork, tend to be common to many work areas. So improvements in one area can be copied widely to improve the outcomes in other work areas.

Disadvantages of focusing efforts in this area include the following:

- The overall organizational culture may make it more difficult to implement an effective COO/OD system.
  - As noted above, COO/OD does not directly address organizational cultural issues. When working with a potentially unsafe organizational culture, it is more difficult to implement an effective COO/OD system. Conversely, an effective organizational culture will facilitate the development, implementation, and maintenance of a COO/OD system.
- PSM systems related to COO/OD may not be effective.
  - Development, implementation, and maintenance of a COO/OD system are facilitated by effective implementation of other PSM systems. If these systems have significant weaknesses, it will make implementation of the COO/OD system more difficult.
- Lagging indicators at the top of the process safety pyramid may be slow to respond.
  - Because COO/OD is focused on the bottom of the pyramid, improvements there may take months or years to demonstrably affect the top-of-the-pyramid statistics. It takes significant effort to recognize and consistently address the lower level behaviors, and consistent attention is key to reducing the base of the pyramid.
  - The legacy of poor COO/OD may be a future accident, even if the new COO/OD system is perfectly implemented.

1.8 IMPLEMENTATION OF THE COO/OD SYSTEM

Figure 1.2 outlines the basic process used to implement a COO/OD system and the corresponding chapters where each element is discussed in this book. The process can be entered from two conditions. The entry point at the top of the diagram is appropriate for a new COO/OD system (Chapter 3). The second entry point, at the bottom of the diagram, is better suited to efforts to improve an existing COO/OD system (Chapter 7). The first step for a new system is to establish (or revise) the goals and management leadership to make the system successful (Chapter 3). Next, the COO/OD systems are developed/revised (Chapters 5 and 6) and implemented (Chapter 7). As the COO/OD systems are implemented, their performance is measured (Chapter 7). Based on the performance data, revisions are made to the COO/OD system (Chapter 7). This cycle then continues as the system is monitored and improved over time. Human factors issues may arise in all

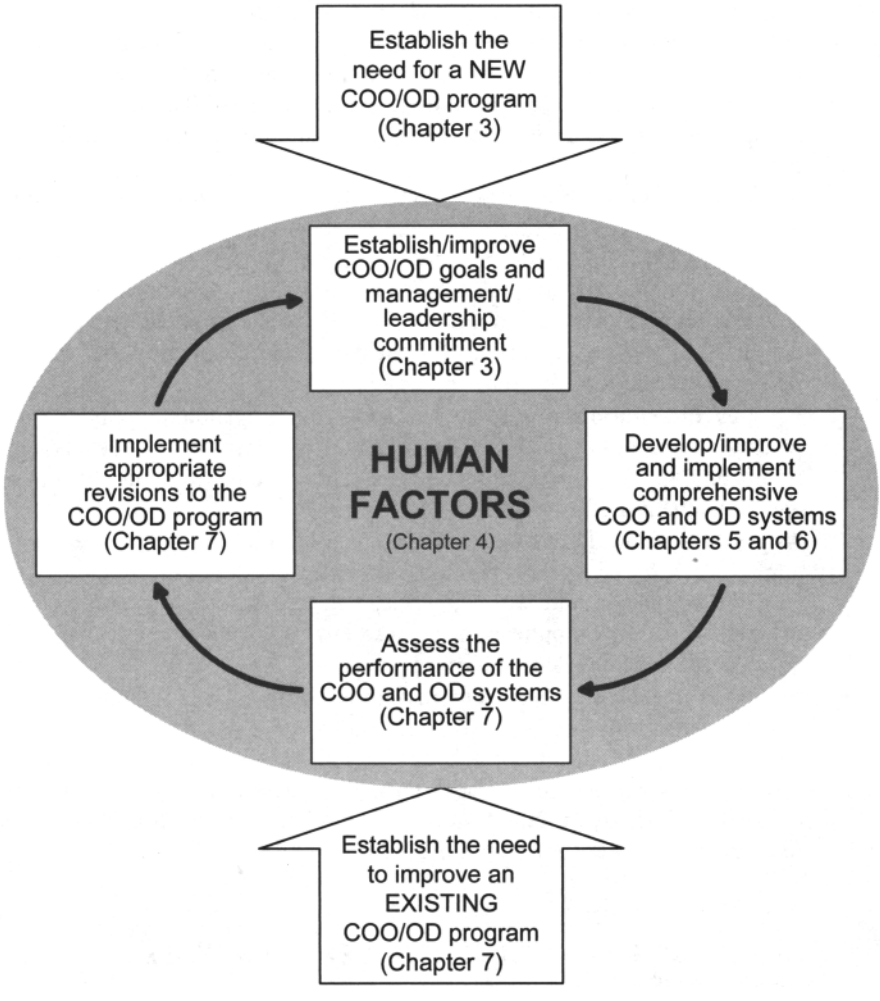

FIGURE 1.2. COO/OD Improvement and Implementation Cycle

elements of the process (as shown in the gray circle encompassing all of the elements), so they are collectively discussed in Chapter 4.

1.9 SCOPE OF THE BOOK

As discussed in Section 1.2, this book is intended to explain the key attributes of COO/OD and to provide specific guidance on how an organization can implement effective systems. Its guidance:

- **Applies throughout all levels of the organization.** The OD work activities are typically focused on the performance of front-line personnel. However, to be successful, personnel at all levels and in all functions of the organization must support and execute the process. The success of the system will be determined by the leadership provided by the facility management.
- **Applies to the total life cycle.** The COO/OD system should be applied to the entire process life cycle. Personnel involved in any aspect of the life cycle of a system (design, construction, operation, maintenance, decommissioning, demolition, and site remediation) should apply the COO/OD concepts. For example, COO/OD concepts should be used by engineering personnel during the design phase and by construction personnel during the construction phase.
- **Applies internationally.** The COO/OD system should apply to any facility, regardless of its location. However, certain aspects of implementing the system will need to be tailored to address facility culture and language issues.
- **Applies to fixed facilities.** This book was primarily developed with applications to stationary facilities in mind. Although many of the COO/OD concepts and work activities are relevant to transportation or maritime situations, application in these environments was not explicitly considered in the development of this book.
- **Focuses on process safety, not personal safety.** The COO/OD system described in this book is focused on process safety improvement. However, application of these concepts and implementation of the work activities described herein should have the added benefits of improving occupational safety, product safety, reliability, and quality, as well as reducing risks to consumers and the public.

1.10 RELATIONSHIP TO OTHER MANAGEMENT SYSTEM FRAMEWORKS

COO is closely related to several other PSM elements identified in CCPS's *Guidelines for Risk Based Process Safety* (Ref. 1.8). Foremost among them are culture, procedures (of all types), training, competency, and management review. One of the most fundamental COO requirements is consistent execution of procedures. For that to happen, (1) there must be written procedures to execute and (2) workers must be trained on the proper execution of the procedures.

Another key interfacing element is management of change (MOC). When properly implemented, OD stops a worker from improvising ways to complete a procedure when confronted with unique situations. The OD answer is to STOP as soon as safely possible, and if the situation cannot be resolved within the bounds of standard procedures and work practices, seek assistance and follow the MOC protocols.

Table 1.7 shows examples of the inputs to the COO/OD system from other elements of the RBPS structure, as well as how the outputs of the COO/OD system feed into the other RBPS elements. A table containing all of the RBPS elements can be found in the online material that accompanies this book.

The COO/OD system is also related to many other commonly applied management system frameworks. Implementation of these related guidelines and regulations is anticipated to overlap with portions of the COO/OD system and reduce the effort required to implement the COO/OD system. Examples of these related guidelines and regulations include the following:

> The effort required to implement a COO/OD system can be reduced by taking advantage of your existing management systems.

- American Chemistry Council (ACC) Responsible Care® Management System
- CCPS RBPS management system
- Control of Major Accident Hazards, U.K. Health and Safety Executive
- DSEAR – Dangerous Substances and Explosive Atmospheres Regulations, U.K. Health and Safety Executive, 2002
- ISO 9001: 2008, Quality Management Systems, International Organization for Standardization
- ISO 14001: 2004, Environmental Management Systems, International Organization for Standardization
- Occupational Health and Safety Management Systems, OHSAS 18001
- SEVESO-II, Control of Major Accident Hazards Involving Dangerous Substances, Council of the European Union, Council Directive 96/82/EC, 9 December 1996, amended November 2008
- Successful Health and Safety Management (HSG65), U.K. Health and Safety Executive, 1997
- U.K. Food Standards Agency regulations
- U.K. Offshore Installations (Safety Case) regulations 1992 SI1992/2885
- U.S. Department of Energy (DOE) Order 5480.19
- U.S. Environmental Protection Agency (EPA) risk management program (RMP) rule 40 CFR 68
- U.S. Food and Drug Administration (FDA) Federal Food, Drug, and Cosmetic Act, Current Good Manufacturing Practices
- U.S. Occupational Safety and Health Administration (OSHA) PSM regulation 29 CFR 1910.119

TABLE 1.7. COO/OD System Inputs and Outputs for Selected RBPS Elements

RBPS Element	COO – Chapter 5		OD – Chapter 6	
	Inputs	**Outputs**	**Inputs**	**Outputs**
Process Safety Culture	• Visible management support • Assessment of current process safety culture status • Process for defining safety goals • Process safety expectations • Company operational/safety philosophy	• Strengthening the process safety culture • Training programs that (1) emphasize strict adherence to procedures and practices and (2) reinforce a culture of conformance to standards • Systems for accountability for nonconforming behavior • Leadership and supervisor workshops • Establishing a questioning attitude in personnel	• Provide personnel with the authority to implement procedures and processes as designed	• Reduced process safety incidents and injuries • Questioning attitude in workers • Adherence to lines of authority • Willingness to observe and coach other workers • Intolerance of defects and deviations

TABLE 1.7. COO/OD System Inputs and Outputs for Selected RBPS Elements

RBPS Element	COO – Chapter 5		OD – Chapter 6	
	Inputs	**Outputs**	**Inputs**	**Outputs**
Hazard Identification and Risk Analysis	• Risk assessment methods • Risk tolerance levels • Recommendations for operating practices that will reduce the likelihood of human error or improve the effectiveness of administrative controls	• Inherently safer process characteristics • Improved hardware-related controls • Improved procedure-related controls • Improved administrative controls	• Identification of process risks and risk control measures	• Day-to-day implementation of the procedure-related and administrative controls
Operating Procedures	• Procedures that specify the appropriate steps to operate and maintain the process	• Identification of operational and maintenance issues that can be addressed through improved procedures	• Timely updates to procedures	• Implementation of the procedures • Procedural issues requiring resolution
Management of Change	• Revised process descriptions • Revised operational requirements	• Specification of trigger points for MOC assessments	• Revised procedures on which workers will be trained • Criteria for when workers must be trained versus informed	• Using the MOC process whenever it is required • Notification and review of all operational changes (e.g., bypassed alarms) • Worker training before change is commissioned

TABLE 1.7. COO/OD System Inputs and Outputs for Selected RBPS Elements

RBPS Element	COO – Chapter 5		OD – Chapter 6	
	Inputs	**Outputs**	**Inputs**	**Outputs**
Incident Investigation	• Recommendations for operating practices that will reduce the likelihood of human error or improve the effectiveness of administrative controls	• Receptiveness to lessons learned from investigations	• Recommendations for specific front-line personnel practices to improve performance	• Reporting of near misses • Open participation in investigations

1.11 SUMMARY

This chapter introduced the purpose of this book and defined key terms used in the rest of the book. It then described how different individuals should use the book. Example indicators of COO and OD system conditions were listed. The overall COO/OD system model was then presented.

1.12 REFERENCES

1.1 U.S. Chemical Safety and Hazard Investigation Board, *Refinery Explosion and Fire, BP Texas City, Final Report,* Report No. 2005-04-I-TX, Washington, D.C., March 2007.

1.2 Kemeny, John G., Chairman, *Report of the President's Commission on the Accident at Three Mile Island*, Washington, D.C., October 1979.

1.3 Atherton, John, and Frederic Gil, *Incidents That Define Process Safety*, Center for Chemical Process Safety of the American Institute of Chemical Engineers, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.

1.4 World Nuclear Association, "Chernobyl Accident," http://www.world-nuclear.org/info/chernobyl/inf07.html.

1.5 Cullen, The Honourable Lord, *The Public Inquiry into the Piper Alpha Disaster*, HM Stationary Office, London, England, 1990.

1.6 U.S. National Transportation Safety Board, *Grounding of the U.S. Tankership EXXON VALDEZ on Bligh Reef, Prince William Sound Near Valdez, AK March 24, 1989*, Report No. MAR-90-04, Washington, D.C., adopted on July 31, 1990.

1.7 *Final Report, Petrobras Inquiry Commission, P-36 Accident*, Rio de Janeiro, Brazil, June 22, 2001.

1.8 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.

1.9 *Merriam-Webster's Online Dictionary*, http://www.merriam-webster.com/dictionary/discipline.

1.10 U.S. Government Printing Office, *Code of Federal Regulations,* Title 10, Chapter 1, Section 50.54(x), "Conditions of Licenses," Washington, D.C., revised January 1, 2003.

1.11 Cooper, Joel, *Cognitive Dissonance: 50 Years of a Classic Theory*, SAGE Publications Ltd, London, England, 2007.