

Introduction

1.1 Purpose of this Handbook

This book is intended to be used as a reference material for either a stand-alone process safety course or as supplemental material for existing curricula. This book is not a technical book; rather, the intent of the material is to familiarize the student or an engineer new to process safety with:

- The concept of process safety management (PSM).
- The 20 elements of process safety defined by the Center for Chemical Process Safety (CCPS).
- The need for process safety as illustrated by examples of major process safety incidents that have occurred.
- Process safety tasks for other engineering disciplines.
- Process safety concerns with some selected unit operations.
- Show how various aspects of process safety have a direct tie-in to existing chemical engineering curricula.
- Describe the many tasks that can be expected of an engineer new to process safety with respect to process safety in their first few years on the job.

1.2 Target Audience

This primary audience for this publication is junior to graduate level Chemical Engineering students and those entering the workforce and engineers new to process safety. However, since there are no technical pre-requisites recommended, it may also be used by other engineering disciplines at similar levels.

1.3 Process Safety – What Is It?

In the chemical, petrochemical and most other industries, you will find that all companies are required to have an occupational safety program, with a focus on personal safety (this program may be required by regulations in many countries, states and local areas. It can apply to workers in a manufacturing plant, a research laboratory or pilot plant, and even to office locations). That program is going to focus on personal safety. The focus of these programs is to prevent harm to workers from workplace accidents such as falls, cuts, sprains and strains, being

struck by objects, repetitive motion injuries, and so on. They are good and in fact, very necessary programs. They are not, however, what *Process Safety* is about.

Process Safety is defined as “a discipline that focuses on the prevention of fires, explosions, and accidental chemical releases at chemical process facilities”. Such events don't only happen at chemical facilities, they occur in refineries, off-shore drilling facilities, etc. Another definition is that process safety is about the prevention of, preparedness for, mitigation of, response to, or restoration from catastrophic releases of chemicals or energy from a process associated with a facility.

After an explosion in a BP Texas City refinery in 2005 that killed 15 people and injured over 170 others, an independent commission was created to examine the process safety mind-set, or culture, of BPs refinery operations, this commission came to be known as the Baker Panel. The Baker Panel said this about process safety:

“Process safety hazards can give rise to major accidents involving the release of potentially dangerous materials, the release of energy (such as fires and explosions), or both. Process safety incidents can have catastrophic effects and can result in multiple injuries and fatalities, as well as substantial economic, property, and environmental damage. Process safety refinery incidents can affect workers inside the refinery and members of the public who reside nearby. Process safety in a refinery involves the prevention of leaks, spills, equipment malfunctions, over-pressures, excessive temperatures, corrosion, metal fatigue, and other similar conditions. Process safety programs focus on the design and engineering of facilities, hazard assessments, management of change, inspection, testing, and maintenance of equipment, effective alarms, effective process control, procedures, training of personnel, and human factors.” (Ref 1.1)

The term “refinery” in that paragraph can be replaced by “petrochemical plant”, “chemical process facility”, “solids handling facility”, “water treatment plants”, “ammonia refrigeration plants”, “off-shore operations” or any number of terms for a plant that handles or processes flammable, combustible, toxic, or reactive materials. For the rest of this book, the term process facility or just facility will be used to mean the previously mentioned facilities and any other operation that handles or processes flammable, combustible, toxic, or reactive materials.

The quote from the Baker report states that process safety is not limited to the operation of a facility. During the basic research and process research phases,

process safety programs cover the operation of pilot facilities. They also cover the selection of the chemistry and unit operations chosen to achieve the design intent of the process. During the design and engineering phase, process safety is involved in choices about what type of unit operations and equipment items to use, the facility layout, and so on. Running a facility involves, as was mentioned above, “hazard assessments, management of change, inspection, testing, and maintenance of equipment, effective alarms, effective process control, procedures, and training of personnel”. The choices made about process features during research and development and pilot work can make these activities easier or more difficult.

1.4 Organization of the Book

Chapter 2 gives a brief history of process safety and of process safety management. The evolution of process safety management principles from the initial twelve elements of process safety management developed by CCPS, and the process regulatory framework of the Occupational Safety and Health Administration’s (OSHA) PSM regulations to the current twenty elements of the CCPS Risk Based Process Safety (RBPS) management system is discussed.

Chapter 3 describes several process safety incidents that demonstrate the need for a good PSM system. Each incident is described, and then the relevance of a few relevant RBPS elements are listed.

Chapter 4 describes the role of several engineering disciplines, Chemical, Mechanical, Civil, Instrumentation and Electrical (I&E) Engineers, and Safety Engineers with respect to how new engineers will be involved in process safety. PSM is a team effort between many disciplines.

Chapter 5 covers a few key process safety concerns with respect to some unit operations and equipment found in the chemical, biochemical and petrochemical and industries that could handle hazardous materials. Combinations of these unit operations are many and varied across the process industries. In the petrochemical industry there are several common operations that are used, and this book describes the process safety concerns of some of those operations. This chapter also introduces the concept of Inherent Safety (IS) and Inherently Safer Design (ISD). ISD focuses on eliminating or reducing hazards inherent in a process as opposed to trying to manage the hazards.

Chapter 6 lists training modules available from the Safety and Chemical Engineering Education (SACHE) Committee through the AIChE and describes the courses and their relevance to some Chemical Engineering courses. This chapter can be used as a guide for supplementing existing courses.

Chapter 7 describes process safety related duties that a new engineer can expect to encounter during the first year to two years in the process industry. For a PSM system to work well, all people involved in the process must execute their roles and responsibilities in a deliberate and structured manner to achieve a high level of human performance. This is called Conduct of Operations. Chapter 7 describes many tasks of engineers with respect to Conduct of Operations, as well as what the engineer should expect operators, maintenance and management with respect to their roles.

1.5 References

- 1.1 The Report of the BP U.S. Refineries Independent Safety Review Panel, January 2007.
(http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/SP/STAGING/local_assets/assets/pdfs/Baker_panel_report.pdf).