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## Roles of contractors in process safety

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## ABSTRACT

Process safety starts at the conceptual phase and continues throughout the entire life cycle of an asset. From process selection to de-commissioning, various process safety elements govern the safety and reliability of the total system. Contractors play a crucial role in project execution including detailed design, technology selection, plant layout, commissioning, start-up, and further expansion, modification and maintenance activities. The interface/interaction of the contractor with the operator/owner often defines the importance of process safety throughout this life cycle. Undoubtedly, these are the most critical phases of a plant life cycle which could trigger an unexpected or uncontrolled situation leading to a catastrophic incident. This paper discusses the impact of the contractors' role during major process safety events including the Phillips explosion in Pasadena (1989), Sonat vessel failure (1998), Texas City Refinery explosion (2005), T2 Laboratories explosion (2007) and a few others. Lessons from past incidents are highlighted and an in-depth analysis is conducted to identify essential process safety components for different groups of contractors and for the different phases of projects. Different aspects of process safety functional elements are presented and discussed for both greenfield and brownfield projects. A Comprehensive understanding of process safety and risk management is required by all levels of contractors to ensure risk-based decision making and hazard mitigation. Besides the process safety expertise needed by the contractors, the necessity of having a consistent and harmonized interaction between the operators/owners and the contractors is also emphasized.

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## 1. Introduction

Contractors are an integral part of the modern industrial era due to their role in plant/platform design, construction, commissioning and maintenance. They play a very crucial role in managing risk throughout the plant life cycle and the engineering and design phases are undoubtedly the most crucial stages for incorporating process safety concepts. The choices made during the design phase impact everything in the future from operations to modifications and finally decommissioning. A single flaw during the design phase, could be carried throughout the plant life cycle and with some unfavorable conditions, may eventually cause a catastrophic incident.

In the first section, statistical analyses and incident case studies are presented to demonstrate the involvement of the contractors. The investigation clearly shows the need to engage the contractors

to build awareness in both process and personnel safety. In the following section, a life cycle based approach is discussed where different process safety functional elements are identified for specific design tasks and phases. So far, separate responsibilities have been identified and discussed for the owners and the contractors. However, for best results, both parties need to work together to build a healthy interface with common expectations and understanding in terms of achieving safety goals. The owners and the contractors share some common responsibilities for establishing a harmonized approach to ensure process safety standards. Creating a common baseline of understanding in process safety is the prerequisite for achieving that goal. The third and final section of this article provides a discussion on existing practices and current initiatives to build process safety competency programs for contractors especially for the design engineers. Six learning modules have been identified with appropriate process safety functional elements to allow effective integration of process safety during the engineering and design phases.

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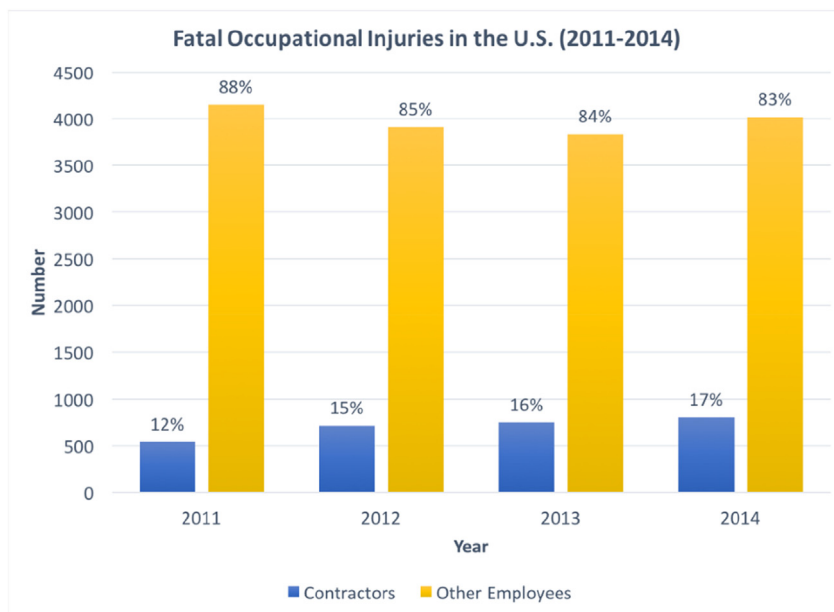


Fig. 1. Comparison of fatality numbers/percentage for contractors and other employees (2011–2014).

## 2. Statistical analysis and incident case studies

### 2.1. Statistical analysis of incidents

From 2011 to 2014, a total of 2808 contractors were killed at work in the US accounting for 15% of the total fatal occupational injuries. The U.S. Occupational Safety and Health Administration (OSHA) observed that fatal work injuries involving contractors accounted for 17% of all fatal work injuries in 2014 (OSHA, n.db). Starting from 2011, the U.S. Census of Fatal Occupational Injuries (CFOI) began capturing both the fatalities in the firm that are directly employing and the firm that contracted. CFOI is a sub-branch of the Bureau of Labor Statistics (BLS)<sup>1</sup>. According to the data published by CFOI, Fig. 1 shows the number and percentage<sup>2</sup> of fatalities of contractors versus employees.

The percentage of the contractor fatality increased from 12% to 17% from 2011 to 2014. Also, if we closely look at the data for chemical manufacturing, the percentage of fatal occupational injuries grows to 22% for the contractors (Fig. 2) and for petroleum refineries, the percentage is as high as 67% (Fig. 3). Even though the data provided in Figs. 2 and 3 do not represent the complete statistical data set, they do indicate that the chemical process industries need to take more measures in terms of establishing process safety practices and standards to protect both contractors and employees.

### 2.2. Major incidents

Over the past few decades, the energy and chemical industries have witnessed a significant number of catastrophic incidents, many of which involved contractors. Basic understanding of process safety issues could have prevented the incidents or minimized

<sup>1</sup> The Bureau of Labor Statistics (BLS) is a unit of United States Department of Labor and it serves as a principal agency for the U.S. Federal Statistical system.

<sup>2</sup> Data Sources: Retrieved from BLS-Injuries, Illnesses, and Fatalities, <http://www.bls.gov/iif/oshcfoi1.htm> Miscellaneous CFOI data table- All worker profile, 2003–2014. Miscellaneous CFOI data table- Fatal occupational injuries incurred by contracted workers, 2011–2014.

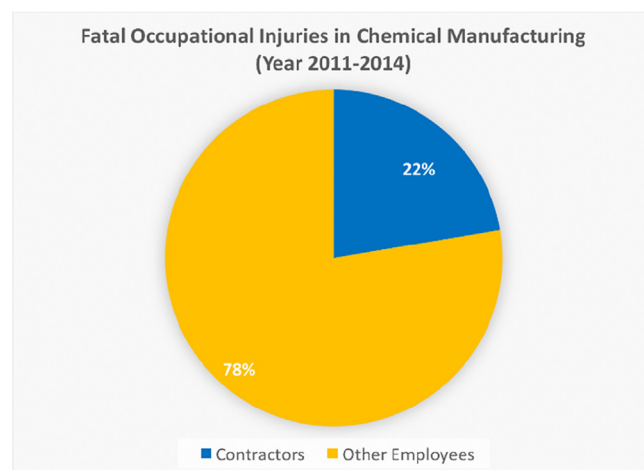


Fig. 2. Comparison of fatalities of the contractors and other employees from 2011 to 2014 in the Chemical Manufacturing Industry.

the consequences. Some of the major incidents involving contractors in different phases of the plants' life cycle are listed and discussed in Table 1.

### 2.3. Case study: Sonat explosion

To demonstrate the importance of having a sound knowledge of process safety for designing a plant/process, we analyzed the catastrophic vessel failure incident mentioned in Table 1. That incident happened on March 4, 1998, near Pitkin, Louisiana, at the Temple 22-1 common point separation facility owned by Sonat Exploration Company. A separation vessel failed catastrophically due to overpressurization which resulted in a fire and killed four people including three contractors. As per the U.S. Chemical Safety Board (CSB) investigation findings (U.S. CSB, 2000), the facility was constructed without detailed engineering design reviews and hazard analyses. As a result, the risk of vessel overpressurization was ignored and the vessel wasn't equipped with adequate

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