Journal of Loss Prevention in the Process Industries 39 (2016) 93–105

Contents lists available at ScienceDirect

Journal of Loss Prevention in the Process Industries

journal homepage: www.elsevier.com/locate/jlp

Challenges and proposals for managing major accident risk through the planning process

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ARTICLE INFO

Article history:
Received 15 June 2015
Received in revised form
12 November 2015
Accepted 15 November 2015
Available online 1 December 2015

Keywords:
Planning process
Major accident risk
Industry challenges
Industry proposals

ABSTRACT

Major accidents are characterized by complex causal patterns with many factors influencing the occurrence of such accidents. The causes can be found not just in the execution of the work, but also in the preparations and planning before performing the work. In this paper, we have identified a set of challenges related to planning that may influence major accident risk. The basis is theoretical and partly empirical. The theoretical part is from a study of major accident theories. The empirical part includes studies of investigation reports, interviews and a workshop. The challenges identified can be grouped into four main topics including *inadequate plan, inadequate planning, inadequate shared overview and understanding* and *late risk identification*. The challenges have subsequently been addressed through a set of proposed improvements, which are aimed at improving the planning process *to better manage major accident risk*.

1. Introduction

The Petroleum Safety Authority (PSA) in Norway has a strong focus on major accidents when following up the Norwegian oil and gas industry. Their definition of a major accident is *"an acute incident, such as a major discharge/emission or a fire/explosion, which immediately or subsequently causes several serious injuries and/or loss of human life, serious harm to the environment and/or loss of substantial material assets"* (PSA, 2015). Major accidents are characterized by complex causal patterns and many factors influencing the occurrence of such accidents, and PSA (2012) has pointed out that preparations for performing work activities offshore can play an important role in major accidents. Among the factors that are related to the preparations for performing work are planning. Other factors may be insufficient work descriptions, information transfer during the performance of the preparatory activities, etc. Weaknesses in the preparations can lead to unsafe performance of the work.

The purpose of this study is to propose improvements in the planning process to better manage major accident risk through the planning processes. Risk is defined as "combination of the probability of occurrence of harm and the severity of that harm" (NORSOK Z-013, 2001).

The present study is based on the work reported by Sarshar et al. (2015), which aimed at describing a typical planning process in the Norwegian offshore industry and relate this to major accident causation factors. This study was conducted in three steps: First, the planning process was studied and described. This part of the study was based on information from the industry and represents a typical process as applied in the Norwegian offshore industry. Second, major accident theories were examined to understand their implications as seen from the perspective of planning processes. Finally, investigation reports from offshore accidents and incidents with major accident potential were reviewed, to gather empirical evidence and examples of planning-related factors being contributing causes to major accidents. This study identified thirteen factors that are related to the planning process and that would contribute to increase or reduce risk. These were: information flow, communication, misunderstandings/misperception, documentation, procedures, planning quality, plan quality, competence, overview/situation awareness, work practice, workload, risk assessment and learning.

In the present paper, the above results are combined with more empirical results. The empirical study included a workshop with a major operating company on the Norwegian continental shelf. Ten experts in planning, risk management, management and operation

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http://dx.doi.org/10.1016/j.jlp.2015.11.012
0950-4230/

participated. Challenges and opportunities for improvements in managing major accident risk within the planning process were identified using the thirteen influencing factors as a reference. Further, eight offshore personnel were interviewed (Sarshar et al., 2013).

The scope of this paper is limited to planning. Emerging tasks, e.g. critical corrective maintenance work that is carried out without being part of the plan, is not addressed. Execution of the planned work is also not addressed as such, although an important outcome of a good plan is its safe execution.

The paper is structured as follows: Section 2 provides background. In Section 3, the research methodology applied in this study is described. Section 4 and 5 present the main results from the research, covering the main challenges identified (Section 4) and opportunities (Section 5) for improved management of major accident risk through the planning process. Section 6 provides discussions and Section 7 conclusions and further work.

In Section 4 and 5 references are made to contributing factors identified through investigation reports. The investigations studied (Sarshar et al., 2015) are hydrocarbon leakage incidents on the Norwegian continental shelf and represent many operating companies. The investigations are therefore not specific to the operating companies participating in the interviews and the workshop, but are more generic.

2. Background

Smith and Harris (1992) analysed the causes of several major accidents with the aim of understanding how the maintenance function was involved. A key conclusion was that prior to major accidents, there is often a lack of detailed safety objectives and long-term safety control. In the absence of a tight safety and reliability control and consequent corrective actions, a mismatch can develop between the management's perception and the actual condition of the plant. The study further revealed that the lack of an internal department, responsible for reviewing plant safety matters, and independent of production pressures can have a serious detrimental effect on plant safety.

HSE (1987, p.14) reports a study of 502 maintenance related incidents: “Sixty four of the investigated incidents were identified as due to lack of, or failure of, permit-to-work systems. Nearly half of these incidents occurred during work on pipes, pumps and valves. The study indicates that permits are not being used as they should. Many cases were noted where a permit system failed when the checks required were not implemented. These circumstances point to the need for greater attention being paid by management to checking the use of the permit systems. Areas where current permits need to be improved relate mainly to the procedures for signing off a permit and handing the plant back to production staff. Greater attention also needs to be paid to physical isolation of plant.”

Øien et al. (2010) focus on equipment criticality classification and how wrong classification or wrong use of classification can either result in critical equipment being insufficiently maintained or less critical equipment being overly maintained, thus increasing the probability of maintenance induced failures. Through the BP Texas City Refinery accident the authors exemplify that insufficient classification will increase the risk of major accidents and may lead to disasters.

Okoh and Haugen (2013) present a classification scheme for causes of maintenance related major accidents. The scheme is based on a combination of accident process and work process classification where the process based classification is further divided in active and latent failures. Many of the causes for latent failures correlate with the contributing factors in Section 2.2. Further, the authors correctly point out that major accidents are not caused by one causation factor alone, it is the combination of “lack of maintenance” or “lack of maintenance error” with “new hazard” or “initiating event” or other non-maintenance related causes that can cause major accidents (Okoh and Haugen, 2013, p.1064).

The Risk OMT project (Risk Modelling – Integration of Organisational, Human and Technical factors) (Gran et al., 2012; Vinnem et al., 2012) model the risk of hydrocarbon leakages using event trees to explain the relationship between planning and performance tasks, and the risk of leakages. Sarshar et al. (2012) study visualization of safety hazards, such as hydrocarbon leakage, on a geographical map of an installation and how this can contribute to raise awareness of potential hazard in a given situation.

Sanders (2005) study several maintenance induced accidents and process piping problems within the process industry and conclude as Wallace and Merrit (2003) that fundamentals of good practices for safe maintenance are:

1. Proper preparation for maintenance begins during the mechanical design of the process
2. The operating stuff must properly prepare for maintenance
3. Identify potential hazards and plan well in advance
4. Good communication are critical

The remaining of this section gives a brief overview of the planning process and the contributing factors that can affect the planning process based on major accident perspectives and investigation reports. Further details can be found in Sarshar et al. (2015).

2.1. Typical planning process in the Norwegian petroleum industry

The presented planning process described in this section is typical for the Norwegian petroleum industry. It has been developed and shaped by Integrated Operations (IO CENTER, 2015). One result is that much more administrative work is performed onshore than in the earlier days. Other results are that more of the time offshore is dedicated to execution of operation and maintenance and less to planning. Integrated operation builds on the capability to collaborate; via video conferencing; remote data and information sharing, and through fast access to expert advice from global support centres.

In accordance with this, the planning process is divided into a number of steps that are performed onshore, before the plan is sent offshore for execution. Fig. 1 illustrates the planning process ranging from operational plan (three months perspective) (step A–H) to work order (one–two weeks perspective) (step I–P) and work permit (day to day focus) (step Q–T) to execution of work (step U) offshore. The green roles represent onshore personnel and those with blue helmets represent offshore personnel. As can be seen, offshore personnel are only involved in the late phases of planning.

2.2. Factors that may influence major accidents

Factors that may influence major accidents were identified based on a theoretical review of major accident theories and a review of 24 accident investigation reports to identify direct and indirect causes of hydrocarbon leakages (Sarshar et al., 2015). A set of thirteen influencing factors was defined (Sarshar et al., 2015):

- Information flow – When information is missing, inadequate or not passed from one step to another in or across planning phases
- Communication – When communication channels are inadequate between roles and actors