Journal of Cleaner Production xxx (2013) 1–7

Contents lists available at ScienceDirect

Journal of Cleaner Production

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

Psychosocial risks and hydrocarbon leaks: an exploration of their relationship in the Norwegian oil and gas industry

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ARTICLE INFO

Article history:
Received 28 June 2013
Received in revised form
17 September 2013
Accepted 25 September 2013
Available online xxx

Keywords:
Hydrocarbon leaks
Psychosocial risks
Oil and gas
Psychosocial risk management
Accident prevention

ABSTRACT

Hydrocarbon leaks have a major accident potential in the oil and gas industry. Over the years the oil and gas industry in Norway has worked hard to find means to prevent hydrocarbon leaks and is today able to report significant progress. In this context, the exploration of accidents in light of human error linked to underlying factors related to the organisation, design and management of work, also called psychosocial risk factors, has been established as a major priority. The objective of this study was to explore to what extent a psychosocial risk indicator obtained from survey data shows a significant relationship with hydrocarbon leaks on Norwegian oil and gas producing platforms and whether it can be used as a proactive indicator for the prevention of such leaks. The context is a major oil and gas company in Norway where the number of hydrocarbon leaks at offshore installations in the period from 2010 to 2011 was considered. This study also explored whether technical factors such as installation age, weight and number of leakage sources have an impact on the number of hydrocarbon leaks at offshore installations. Regression analysis results showed that only the psychosocial risk indicator significantly accounted for variation in hydrocarbon leaks. Only partial support was found for the relationship between technical factors and hydrocarbon leaks on the basis of correlation analysis. The paper offers recommendations for the development of more robust indicator models to prevent hydrocarbon leaks in the oil and gas industry.

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1. Introduction

The major accident potential of hydrocarbon leaks has been highlighted in many instances and more recently by the explosion of the Deepwater Horizon drilling rig on April 20, 2010. The explosion killed 11 workers and injured 16 others. It caused the Deepwater Horizon to burn and sink, and started a massive offshore oil spill in the Gulf of Mexico (National Commission, 2011).

Hydrocarbon (HC) leaks can be divided into three categories: gas leaks, liquid leaks or oil-gas leaks. Gas leaks have the highest potential for causing most damage due to spread of gas and the risk of explosion. HC leaks can have a great environmental impact causing damage to wildlife and ecosystems, and present a major risk for employees working on installations. For example, we still today do not know the full environmental impact of the Deepwater Horizon accident (Committee on the Effects of the Deepwater Horizon, 2013).

In the Norwegian oil and gas industry, the number of leaks per year is documented by the Norwegian Petroleum Safety Authority (PSA) in a yearly report called *Trends in risk level in the Norwegian petroleum activity*. Fig. 1 presents the overall trends in the period 1996–2011 (PSA, 2012). The lowest number was achieved in 2007, after which a stable higher level can be observed for the period 2008–2010. A reduction in the number of leaks is now being reported after a number of years of deliberate efforts within the

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http://dx.doi.org/10.1016/j.jclepro.2013.09.040

Please cite this article in press as: Bergh, L.I.V., et al., Psychosocial risks and hydrocarbon leaks: an exploration of their relationship in the Norwegian oil and gas industry, Journal of Cleaner Production (2013), http://dx.doi.org/10.1016/j.jclepro.2013.09.040

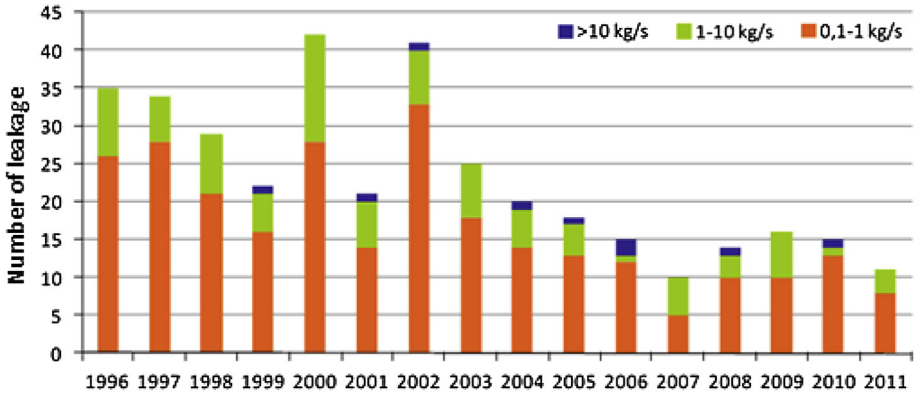

Fig. 1. Overall trends for hydrocarbon leaks in the period 1996–2011.
Source: Norwegian Petroleum Safety Authority, 2012.

industry (PSA, 2012). However, maintaining the present level of risk and achieving further improvements call for continuous commitment and attention. In order to improve, it is crucial that the industry is mindful to continuously develop its indicator models and implement new measures. Purposeful and continuous efforts are needed to achieve this aim (PSA, 2012).

Studies have also shown that some 40 per cent of hydrocarbon leaks occur in connection with normal operation, while the remainder arise during maintenance work at the facility (PSA, 2012). As a result of these studies, the understanding of accidents in light of human error and poor working environment conditions has gained maturity, and has greatly improved our understanding of accident causation (PSA, 2012). There are a number of examples in the oil and gas industry where human errors are linked to underlying factors such as the organisation, design and management of work. One example is the loss of the Piper Alpha oil platform with 167 deaths caused by poor communication at shift handover compounded by leadership failures in 13 emergency responses (Cullen, 1990). Another example is the blow-out on the Ekofisk Bravo platform in the North Sea. Accident research has shown that human error/failure of the front line operator, in many accidents, represents only a superficial cause (Reason, 1997; Vinnem et al., 2010). Upon close analysis, human error often derives from underlying factors that have developed in the system over a period of time. If we are to promote the continued prevention of major accidents and spills, the management of systematic organisational safety efforts must accelerate (PSA, 2012).

2. Factors influencing human performance

The topic of this study is building on a broader tradition in high hazard industries/activities, especially from road and air transport, patient safety, and construction work, among others, where efforts have been made to link factors that are related to human performance with safety results. These factors span from macro level (e.g. organisational structures) to micro level (e.g. design of control displays) aspects (Stanton et al., 2005; Weick and Sutcliffe, 2007).

Within the oil and gas industry the traditional way of approaching safety has been to focus on technical factors, such as the number of leakage sources (i.e. valves, flanges and various types of equipment), age, weight and overall technical condition of the platforms (Aven and Pitblado, 1998; Vinnem et al., 2006). The assumption is that the higher technical complexity of platform lay out and processing facility leads to increased risk of hydrocarbon leaks. Accordingly the first hypothesis of the current study is:

> *Hypothesis 1*: There will be a significant relationship between technical factors such as installation age, weight, and number of leakage sources and number of hydrocarbon leaks.

The importance of human and organisational factors has been researched in the last twenty years, but has not always been regarded as crucial in the industry's safety work. The current study aims to address this gap by exploring the relationship of both possible technical aspects as well as work organisation aspects with hydrocarbon leaks. The increased emphasis on human and organisational factors with regards to safety can also be seen in the scientific literature on safety culture and safety climate (Cooper, 2002; Flin et al., 2008; Hale and Hovden, 1998; Haukelid, 1998, 2001, 2008; Guldenmund, 2000; Reason, 1997; Reniers et al., 2011). Within this literature, studies have often assessed the relationship between safety culture and safety climate and personal safety incidents, i.e. injuries and fatalities data. Fewer studies have assessed the relationship between safety climate and process safety incidents, i.e. escape of toxic substances or the release of flammable materials, such as hydrocarbon leaks, which may result in fires or explosions. However, measures of safety culture and safety climate do not include an assessment of the important type of risk in the modern work environment addressed in the current study: psychosocial risk.

Psychosocial risk is the risk that exposure to psychosocial hazards can result in harm in terms of health and safety. Psychosocial hazards, a concept introduced by the International Labour Organization (ILO) in 1986, are defined as "those aspects of work design and the organisation and management of work, and their social and environmental context, that have the potential for causing psychological, social or physical harm" (Leka and Jain, 2010). They can be categorised in ten broad categories as shown in Table 1 (Leka and Jain, 2010; WHO, 2010).

Exposure to psychosocial hazards can result in the experience of work-related stress with negative impacts that can be psychological, cognitive, social, and physiological and can potentially affect both health and safety in any business context (Griffin and Clarke, 2011; Leka and Jain, 2010). A related concept is that of burnout which is defined as a state of physical, emotional and mental exhaustion that results from long-term involvement in work situations that are emotionally demanding (Schaufeli and Greenglass, 2001). An extensive number of articles have been published on

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