Chapter 2
Petroleum Industry Environmental Performance and Risk

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ABSTRACT

The petroleum industry holds long- and short-term environmental risks. Besides production fluids, all petroleum industry activities involve either use of fluids, which contain abundant substances, or waste generation, both associated with potential risk to the environment. The principal environmental risk associated with the petroleum industry is the risk of fluid spill/emission to the environment. Although in recent decades the risk analysis methodologies have matured, to date there is still no universally accepted methodology for environmental risk assessment in petroleum industry. In this chapter, the petroleum industry's environmental incident history and statistics are presented. The environmental impact of the petroleum industry's activities, its extent, and trends are analyzed. The overview of pollution sources with associated environmental risk is given along with the analysis of the causes and consequences of incidents in the petroleum industry.

INTRODUCTION

All petroleum industry's activities hold the potential for a variety of impacts on the environment's components: soil, water, air and consequently all living species. Since different activities in different ecosystems and conditions may result in significant variations in the extend of a potential impact, the potential for oil and gas operations to cause environmental impact has to be addressed on a case- by- case basis. The assessment of the potential impacts and resulting mitigation measures is commonly carried out through Environmental Impact Assessment Study (EIA). Estimation and quantification of the probability of an unwanted consequence of a particular activity's impact on the environment in a specific time period (the environmental risk) is done by Environmental Risk Assessment (ERA). The environmental risk assessment is based on calculating the probability for an ecosystem to come to contact or to receive a dose of pollutant. Though the first application of risk analysis to petroleum industry was done in 1960 by Caryson (Yanting & Liyun, 2011), environmental risk is a relatively recent concept, which has quickly become an important consideration

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in environmental assessment of the new projects, facility and process design and overall petroleum sector management. A number of definitions of environmental risk have been proposed. Most commonly environmental risk is defined as the product of the probability (or frequency) and consequence (Weiner & Matthews, 2003). The consequences are adverse effects on different components of the environment. Crichton (1999) defines the risk as the "probability of loss" including the hazard and the concepts of vulnerability and exposure (Olita et. al., 2012) where vulnerability is a measure of the sensitivity of a specific ecosystem to a given hazard.

Petroleum industry poses a long and short-term environmental risk. Besides production fluids, that pose significant environmental risk (if found uncontested in environment), all petroleum industry activities (oil and gas exploration, production, processing, storage and transportation) involve either use of fluids, that contain abundant and diverse toxic chemicals, or waste generation, all associated with a potential risk to the environment. The imperative of contemporary petroleum industry practice is to understand those risks, evaluate it and quantify, in order to use the best available technical and technological solutions to design facilities and/or processes to prevent or mitigate it.

The principal environmental risk associated with petroleum industry is primary seen as the risk of fluid (production, operating or waste) spill, discharge or emission to the environment. An important part of protecting the environment, and thus minimizing the risk, is ensuring that there are as few spills, discharges or emissions as possible. Along with the mentioned best available techniques and technologies applied to control the risk, other, indirect, risk restrictive clauses are the introduction of new and strict regulations, both on national and international level resulting with high fines, stringent operating codes and high costs of cleanup/restoration processes (20 – 200 $/l of spilled oil depending on type of oil and location (Fingas, 2001). Even though petroleum industry's incidents, resulting with large releases of fluids, rarely occur, they attract particular public and media attention resulting with global awareness of the risks and consequences they cause to the environment, so it is important to identify the sources, size and the frequency of these releases.

Although in recent decades the risk analysis methodologies have matured and there is already a range of methods of risk assessment with different focus, advantages and disadvantages, to the date there is still no universally accepted methodology for environmental risk assessment in petroleum industry. If there is an adequate data base of previous identical or similar events, environmental risk assessment of petroleum industry activities is commonly done by the analysis of former reported spill data for a specific area. However, if there are no sufficient or available data to determine the extents of risks, some of analytical methods for accidental risk are used (Table 1). In 1975 the Department of Interior (DOI) of the United States of America (USA) developed the OSRA (Oil Spill Risk Analysis) model. This model is used for the analysis of possible oil spill impact from offshore oil and gas operations (Price et. al. 2003). On basis of historical spill patterns, meteorological (wind intensity) and oceanographic (ocean currents) data the model enables estimations of oil spill occurrence probability and probability of oil slick contact with biological and economic resources in outer continental shelf of the USA. It is not designed for use in "real time". The OSRA model summarizes the results of thousands of spill trajectory simulations. Recently it has become a common practice by several authors to use modeling tools to study oil trajectories for planning or oil spill hazard estimates purposes.

In order to quantify the environmental risk form either a specific facility or process or from a complete oil/ gas field, a number of steps are required. These are (Dumitran & Onutu, 2010, Woods et. al., 1991):