Chapter 50
Decision Support Model for Fire Insurance Risk Analysis in a Petrochemical Case Study

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ABSTRACT

A decision support system was researched and applied to a case study in the petrochemical industry. The participants were an insurance company underwriting the policies of oil and gas refineries located in a major oil producing nation. The Chemical Process Quantitative Risk Analysis methodology was applied as a framework to implement uncertainty quantification and risk analysis using a specialized commercial DSS software product. A gas vapor explosion was simulated at an oil refinery, to predict the fire and radiation damage. Costs and risks were entered into the model based on historical data. Loss estimates were generated for equipment and buildings located various distances (pressures) from the explosion origin. Overall, the DSS model predicted an expected loss of over $14,000,000 USD for equipment located in the 50 meter explosion radius, which represented a loss ratio of almost 52%. The losses predicted from the DSS model were comparable to the literature and to experiences of the case study company. The margin of error from the DSS model was less than ±5% which made it very reliable according to benchmarks.

INTRODUCTION

Companies and citizens located near the oil and gas industry refineries are exposed to major risks like fire-explosions and oil spills due to the combustible nature of the products. Such risks may be caused, not by the product (gas and oil), but by the failure of monitoring hardware systems or operational procedural lapses by refinery employees.

In addition to the manmade disasters, the natural hazards like earthquakes, floods, and hurricane contribute to major losses in the oil and gas sector all over the world. Refinery risk events can lead to consequences like human fatality, sever injury,

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environmental pollution, property damage and business interruption losses (BP, 2011).

An oil refinery petrochemical explosion damage can also lead to huge liability claims from the various stakeholders of the company and also by the third parties. According to the World Bank (IEA, 2012), 41% of the man-made disasters were caused by fire the last ten years; amounting to an average of approximately $16,000,000 underwriting losses for each insurer. Catastrophes caused by equipment malfunction (such as the Chernobyl Nuclear Plant in Russia) amounted to 27% of problems, totaling almost $11,000,000 USD for each insurer.

Gas explosions such as the Bhopal Refinery in India were the source of 21% of crises events, resulting in almost $9,000,000 USD in mitigation costs. Natural disasters such as Hurricane Ike which struck major US cities in 2008 around the Gulf of Mexico west coast (Strang, 2012a) caused around $4,000,000 USD underwriting costs for each insurer but represented only 10% of the hazard types (with the remaining 1% attributed to other factors). Overall, major disaster event losses experienced in the oil, & gas sector during the ten year period (2001-2010) have cost over $100,000,000 USD (IEA, 2012) for each insurer. Approximately $40,000,000 million of those costs were for property damage repair, debris removal and cleanup costs when the costs of business interruption, extra expense, employee injuries and fatalities, and liability claims are excluded (IEA, 2012). Obviously it is important to study risk analysis in the petrochemical industry, and since insurance companies underwrite oil refinery liability policies, it is logical to investigate how the uncertainty can be quantified and used for fire explosion risk management.

The direct, on premises clean up costs are due to asbestos abatement, PCB removal or released hydrocarbons and chemicals flowing a fire explosion. These are traditionally considered part of the property damage loss. This is known as disaster remediation and these costs, to the extent insurance is applicable, are paid by property insurance underwriters (Goodwin, & Strang, 2012). Although nearly all the oil refinery losses involve fire explosions, other crises events could occurred as direct result of flood, windstorm and pressure vessel rupture related events. Risk analysis decision modeling software can be used to estimate the unknown uncertainty in order to quantify the probabilities as risks (Goodwin, & Strang, 2012a). In this paper we will refer to decision support systems (DSS) as the risk analysis model.

Problem Statement

Iran is a major oil producing nation and it has many petrochemical refining plants. There has been some speculation in the media that Iran is expanding oil refining operations and also beginning nuclear production, both of which are risky in terms of potential accidents as well as being prone to natural disasters (such as earth quakes, floods, etc.). Refinery operations in Iran are at risk to explosions simply due to the combustible petrochemical characteristics of oil and gas. Despite being one of the worlds biggest oil producing nations, Iran has very little publications documenting case studies about best-practices. In particular, very little is published about applied oil refinery risk analysis or decision making models (Arendt, Campbell, Casada, & Lorenzo, 1989; Casal, 2008; Mudan, & Croce, 1995; Baker, Doolittle, Fitzgerald,, & Tang, 1998). This is the gap in the literature which this study addresses.

This paper explores how a decision support software system was used in an insurance company (case study) to estimate underwriting risks in the Iranian oil and gas refinery industry. The research questions driving this Iranian oil and gas refinery case study were:

1. Each day, an Iranian petrochemical insurance company will pay a huge amount for disasters occur - however, can a correct diagnosis of risk can be developed to reduce losses?