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The use of current risk analysis tools evaluated towards preventing external domino accidents

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Abstract

Risk analysis is an essential tool for company safety policy. Risk analysis consists of identifying and evaluating all possible risks. The efficiency of risk analysis tools depends on the rigueur of identifying and evaluating all possible risks. The diversity in risk analysis procedures is such that there are many appropriate techniques for any circumstance and the choice has become more a matter of taste. In this paper, we examine the risk analysis tools used by 24 chemical plants in Belgium, mainly located in the port of Antwerp, the second largest chemical cluster in the world after Houston, TX, USA. The aim of this paper is to identify the current practice in the chemical industry subject to European Seveso legislation and to examine how the present methods can be integrated to improve safety policy, especially towards preventing major accidents. Moreover, conclusions on the prevention of catastrophic external domino accidents involving several companies are formulated. This paper also gives impulse to investigating cross-company management implementations concerning external domino accident prevention.

Keywords: Domino accidents; Major accidents; Risk analysis procedures; Risk analysis tools; Chemical Seveso industry; Risk; Domino effects; Seveso Directive

1. Introduction

The design of precaution- and protection measures at a chemical site can be considered to be a two-step risk analysis procedure (Sinnott, 1996). The first step consists of a risk analysis, the systematic examination of all possible risks. The second step is to evaluate these risks and to make a classification. Both hazard identification and risk evaluation have become very important research topics. Developing insights on these subjects force companies to continuously adapt or change company safety management to improve plant safety, as illustrated by Baram (1998).

Further optimization of risk analysis methodologies beyond the current state of the art becomes more and more difficult due to multi-causal dependencies and non-linearities especially in the case of major accidents.[1] Because of the possibility of major accidents occurring, effective safety management is of huge importance to the chemical industry. In Europe, the basic guidelines for preventing such accidents are set out in the Seveso Directive (Council Directive 96/82/EC). The so-called Seveso II Directive stipulates that any establishment storing or handling an amount of dangerous substances exceeding a predefined threshold, has to specify its safety policy in a safety report. In addition, all Seveso II safety reports are public, allowing the public and researchers to check whether the companies conduct or intend to conduct risk assessments in a more systematic way. New amendments and attendant regulations inspired by several recent major accidents such as those of Baia Mare,

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[1] The definition of major accident within the European Directive 96/82/EG is 'an occurrence such as a major emission, fire, or explosion resulting from uncontrolled developments in the course of the operation of any establishment covered by the Directive, and leading to serious danger to human health and/or the environment, immediate or delayed, inside or outside the establishment, and involving one or more dangerous substances'.

Enschede and Toulouse, have lead to an adapted version of the Directive (Seveso II Directive Amendments, 2003).

A lot of major hazards in chemical surroundings are complex phenomena, so-called 'domino effects'. The disasters mentioned above are of that type. While they are known for a long time, literature remains sparse and hazy on the subject of domino effects. However, the interested reader can be referred to several authors such as Bagster and Pitblado (1991), Delvosalle (1996), and Lees (1996). A domino effect can be described as *a cascade of events in which the consequences of a previous accident are increased by following one(s), spatially as well as temporally, leading to a major accident* (Delvosalle, 1996). Thus, a domino accident (caused by domino effects) can have heavy repercussions. Therefore, it is crucial to know and to minimize the pathways that lead to them. Despite the fact that domino effects are important hazards in the chemical industry possibly leading to disasters, risk prevention on these effects has not been a priority of company policy. Various reasons such as organizational learning barriers can explain this behavior (Pidgeon & O'Leary, 2000). Especially, in case of domino accidents, two important reasons are easy to understand. First, such accidents are extremely rare, which reduces the fear of an occurrence within the company and also reduces the visible benefits of domino safety investments. Second, dealing with domino effects needs co-operation between two or more often competing companies.

2. Problem

From the point of view of a company, domino accident risks can be internal or external in nature. Internal domino accidents originate on the enterprise premises, while external (or reciprocal) accidents are induced by neighbouring companies. Internal domino effects are usually automatically accounted for by the design of a solid company safety management system.

Prevention management of an industrial area composed of several Seveso companies[2] should be the shared responsibility of all plants concerned. Although all EU member states acknowledge that domino effects are phenomena that can lead to catastrophic accidents, until now no EU guidelines for preventing reciprocal domino accidents are available, as indicated by Walker, Mooney, and Pratts (2000). As a result, these risks are also less explored at company level. In fact, company research on external domino effects is limited to the compulsory exchange of information on hazard- and system characteristics with adjacent companies.

Successful risk management is based on a comprehensive and detailed hazard mapping and a full understanding of possible accident consequences (Wells, 1999). Risk analysis methods should be chosen carefully based on strengths of each technique, as each may provide different outputs leading to different prevention measures. In The Netherlands a system has been developed based on the risk analysis methodologies used in the regulatory context there (Baksteen, 2003; Bottelbergs & Ale, 1996). This paper tries to identify how Seveso companies select and use risk analysis tools in order to gain insights for developing a standardized risk analysis methodology for the prevention of external major accidents. The remainder of the paper is structured as follows. Sections 3 and 4 outline a survey that was conducted to assess the use of risk analysis methods in the chemical Seveso sector. Section 5 discusses the results of the survey. Section 6 summarizes by formulating recommendations on the development of a standardized external domino prevention scheme for Seveso companies. The framework was elaborated by the authors and was called 'Hazwim' (Reniers, Dullaert, Soudan, & Ale, 2005).

3. Method

3.1. Methodology

In the chemical industry, a wide variety of opinions are held on safety management in general and especially on how to deal with the domino problem topic. The differentiation in company culture and company rules can be considerable. As a result, it is difficult to draw uniform across company conclusions. Therefore, the approach of semi-structured interviewing (De Pelsmacker & Van Kenhove, 1999; Tull & Hawkins, 1993) has been applied to collect data. This data collection method shows two important advantages. First, direct contact between the interviewer and the interviewee stimulates the latter to 'confide' more delicate information. Second, within the list of subject areas of the questionnaire, the interviewer was free to pursue certain questions in greater depth. Interviewing a number of persons is more systematic and comprehensive if the issues taken up in the interview are delimited. Logical gaps in the data collected can be anticipated and closed, while the interviews remain fairly conversational and situational. The main drawbacks of semi-structured interviews are their relatively high cost and their time-consuming nature.

The qualitative information is supported by complementary quantitative data. We contacted 49 plants on a total number of 311 Seveso companies in Belgium. The plants were mainly located in the port of Antwerp, the second largest chemical cluster worldwide. Out of this sample, 24 prevention managers of plants active in the field of chemistry, oil refinement, energy production and the storage and treatment of hazardous materials, were prepared to answer the rather extensive questionnaire.

3.2. The participating company's profile

Multinational companies as well as medium-sized enterprises with major accident hazards were selected to participate in the study. Each group has a specific safety approach and specific prevention standards.

[2] Seveso company refers to the European Seveso II Directive.