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Good Practices for Managing Process Safety in Major Hazard Installations and Their Networks

Sara K. Lax*[a], Aki S. Ljäs[a], Kirsi M. H. Levä[b]

[a]Finnish Safety and Chemicals Agency, Kalevantie 2, FI-33100 Tampere
[b]Finnish Safety and Chemicals Agency, PL 66, FI-00521 Helsinki
sara.lax@tukes.fi

The aim of this article is to share good practices for process safety management in major hazard installations and to discuss new challenges in the changing business environment. Today, establishments are networking with an increasing number of stakeholders and service providers. As this networking is constantly on the increase in major hazard installations, and as traditional safety management systems and inspection practices seem to be lacking in the networked business environment, there is a real need to better understand the concept and to describe different networks and their safety challenges. The Finnish Safety and Chemicals Agency (Tukes) is responsible for supervising and inspecting process safety issues in Finnish major hazard installations. Tukes has implemented a systematic approach to inspect the functionality of process safety management in major hazard establishments. This article is based on Tukes's inspection data and the results of two separate studies that were carried out firstly, to identify good practices for managing process safety and secondly, to investigate the effects of networking in major hazard installations. The data were collected from Finnish major hazard establishments, but the examples of good practices and recommendations for improvements can also be applied internationally in enhancing process safety.

1. Introduction

The European Commission's directive on the control of major accident hazards involving dangerous substances (96/82/EY) – the so-called Seveso II directive – first required major hazard establishments to develop and implement safety management systems to prevent major accidents involving dangerous substances, and the limitation of their consequences. There are about 700 large-scale chemical and explosives establishments in Finland.

Tukes has developed and implemented a surveillance model to inspect and measure the functionality of process safety management systems. The inspection data are registered and analyzed to measure the changes in the standard of safety at the establishment as well as at the national level. The aim of this article is to discuss good practices in managing safety in the increasingly networked environment surrounding major hazard installations. Networking is a common and ever-increasing trend in any industrial environment. From the safety authorities' point of view there is consequently a need to better understand the phenomenon and how it challenges current approaches to managing and overseeing safety. We also share our findings on the different kinds of networks major hazard installations might have and how extensive these networks actually are. We also discuss some safety challenges and make some recommendations on how companies could better deal with safety risks in a networked environment.

2. Methods

Tukes is responsible for licensing and overseeing major hazard installations in Finland. The oversight of process safety management is based on the Seveso II directive. The directive requires major hazard installations to develop and implement a safety management system and it also requires authorities to

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carry out periodical inspections to ensure the functionality of these systems. Based on the directive and additional national requirements, the major hazard establishments are divided into three different tiers: upper-tier (Safety Report, SR) establishments, lower-tier (Major Accident Prevention Policy, MAPP) establishments, and nationally regulated establishments (National Licence, NL). These establishments are inspected by Tukes either once a year, once every three years, or once every five years depending on the quantity and risk level of the substances involved. This approach also meets new inspection requirements set in the Seveso III directive (2012/18/EU).

Tukes has developed a model for carrying out process safety management inspections. The model consists of seven different areas: 1) Identification of requirements, 2) Decision-making and risk evaluation, 3) Knowledge, 4) Procedures, 5) Technology, 6) Preparedness for deviations and emergencies, and 7) Management and personnel commitment. The functionality of the system is described in a written inspection report and assigned numerical grades in line with the legal requirements. Each area is assessed separately from 0 (severe deficiencies) to 5 (best practices), where 3 indicates that the legal requirements are being met. The average of the grades in the seven areas (the total grade) describes the functionality of the system. Kotisalo et al. (2010) used the same model in their international case study.

The article is based the results of two separate studies that were carried out by Tukes firstly, to identify good practices for managing process safety (Lax, 2012a), and secondly, to investigate the effects of networking in major hazard installations (Ijäs, 2010b). In study I, the inspection data were analyzed in two phases. Firstly, the latest inspection results from a total of 564 Finnish major hazard installations were extracted. The inspections were carried out between 2005 and 2010. In the first phase, the data were statistically analyzed by comparing the averages of the different inspection areas across different tiers (SR, MAPP and NL) and different industrial branches. In the second phase, the inspection reports of those installations which had received at least 4 (good practice) in some assessment area were selected for further analysis. These data consisted of 69 inspection reports for four years from 2008 to 2011. The reports were qualitatively analyzed to identify good practices. (Lax, 2012a)

Study II was established to clarify the concept of networking and its prevalence in Finnish installations. Firstly, a literature review based on recent studies was carried out and as a result of the review, nine partial networks and one whole network were defined. Secondly, to better understand the extent of the networks of installations, an Internet survey was launched. A questionnaire was sent to 146 installations, which garnered a response rate of 35 % (51 responses). The questionnaire focused on network types, their extent, and the strengths and challenges of current process safety management systems from a networking point of view. As a result of Study II, good practices when dealing with different kinds of networks were identified. (Ijäs, 2010b)

3. Results

Study I revealed that the functionality of the process safety management system was seen to be at an acceptable level (with a total grade of 3 or more) in 49.7 % of major hazard installations in Finland. In most of these cases (40.2 %) the total grade was between 3 and 3.5. This means that very few plants have really good practices in place.

The data were analyzed between the three tiers – upper-tier (SR), lower-tier (MAPP), and nationally regulated (NL) establishments, as well as between industrial branches to see if any differences exist. The results revealed that there are statistically significant differences between tiers and between industrial branches. The functionality of process safety management systems was found to be at a higher level in upper-tier establishments compared to lower-tier establishments (Figure 1).

There were also differences between the different industrial branches. The best grades were assigned to explosive plants, chemical plants, as well as pulp and paper mills. On the other hand, the greatest need for improvement was seen to be in refrigeration plants, LPG plants and surface treatment plants (Figure 2).

In Study I, those inspection reports where one or more of the seven inspection areas were assigned 4 or more were selected for qualitative analysis in order to identify good practices. Some examples of these good practices are presented below. The results are listed according to Tukes's inspection model.

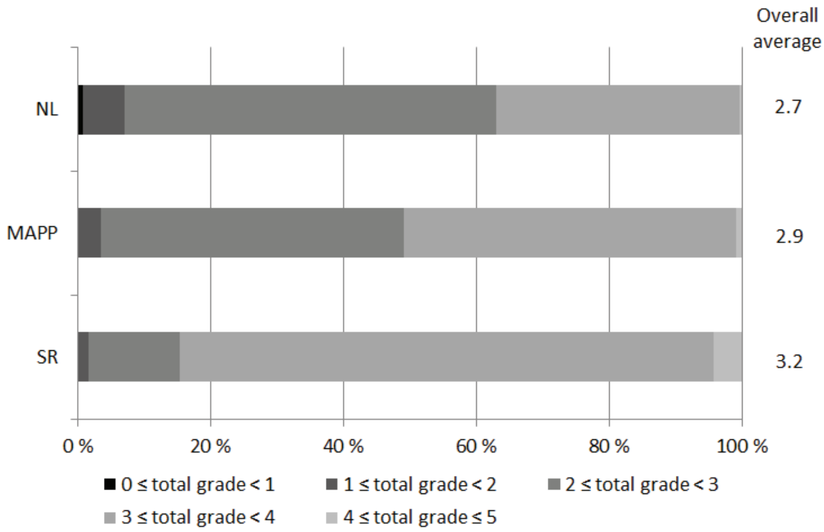

Figure 1: Total grades for the functionality of process safety management systems in the different tiers.

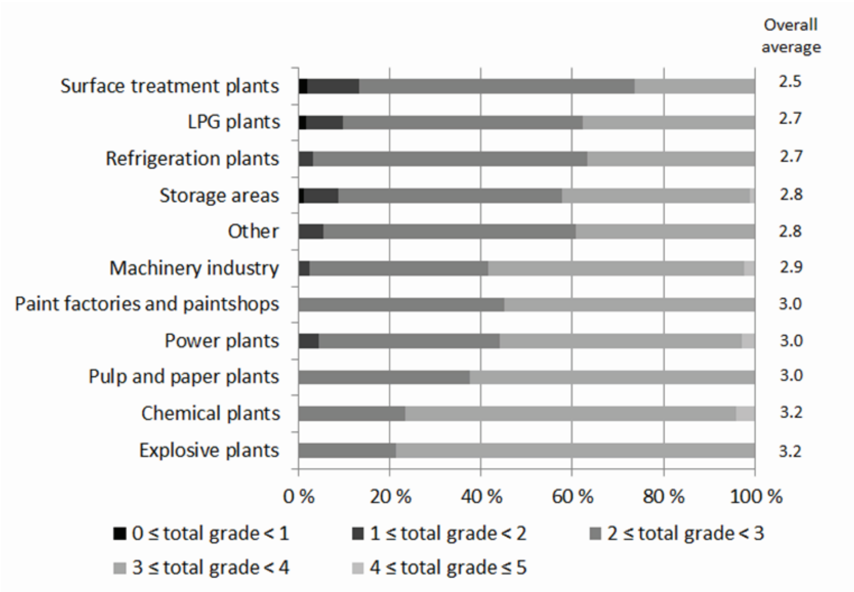

Figure 2: Total grades for the functionality of safety management systems in different industrial branches.

1) Identification of requirements

- All requirements set by the authority as well as reactions are registered in one system, so the status of requirements can be easily checked.

2) Decision-making and risk evaluation

- Risk assessments are focused on process safety in a systematic manner.
- Workers are interviewed as a part of risk identification and risk assessment.

3) Knowledge

- Workers are trained prior to large modification projects.
- Long leaves of absence are taken into account in training and orientation.

4) Procedures

- Safety-critical equipment is identified and instructions and maintenance requirements are set out more precisely for this kind of equipment.

- Lock-out and tag-out procedures are used during change projects and maintenance functions to ensure that a process or a piece of equipment is not started up before the work is completed.
- A worker is asked to explain what he is going to do and why, to ensure that the worker has correctly understood the task requirements and the importance of following the instructions.
- As a part of internal audits, workers observe each other's performance.

5) Technology
- Equipment is classified according to its functions and importance with regard to safety. Maintenance activities and inspections are carried out according to the classification.
- Weekly maintenance meetings are held to improve the flow of communication between the organization and its maintenance personnel.

6) Preparedness for deviations and emergencies
- A fire safety group is established, and holds weekly training sessions.
- A 'chemical map' is drawn up showing the location of chemicals, emergency exits, fire extinguishers, etc.
- Fire-extinguishing instructions are drawn up for specific containers/tanks.

7) Management and personnel commitment
- Current safety information is periodically communicated and shared through the intranet, including data and lessons learnt from recent international accidents or incidents.
- A focus group for safety improvements is established. The focus group consists of workers only, and they are allocated their own budget to innovate and carry out rapid improvements and corrective actions.
- Safety aspects are taken into account in contracts.

In Study II, a network was defined as an entity consisting of all the connections between a major hazard installation and its surrounding plants, companies and other organizations as well as the local community. The study also revealed that organizational structures and connections are far more complex today. Results show that more than 85 % of installations operate within networks and more than 95 % have outsourced at least one of their functions. In many functions, such as maintenance and logistics, these networks are also extensive. The number of external personnel working at hazardous sites is significant. In addition, the contracts made by major hazard installations include several parties and this number seems to be on the increase. The most typically outsourced functions are maintenance, logistics and security. This poses a challenge to the communication and management of safety requirements.

The network pertaining to a major hazard installation can be divided into different kinds of sub-networks such as a maintenance network, a logistics network, a raw-material network, a local community network, a safety, health and environment network, a development network, a competitor network, and the company's internal network. The first four are particularly common and are also safety-critical networks. These networks and some examples of good practices are presented in more detail below.

Those installations which have outsourced their maintenance functions usually have several maintenance contracts. Typically outsourced maintenance services include mechanical, electrical and I&C maintenance. Several maintenance contracts may even exist within the same maintenance area, such as I&C maintenance. A maintenance company also has its own subcontractors, who in turn have their own contractors. These contract chains can consequently become remarkably long. In a maintenance network it is also customary to hire temporary workers to undertake different kinds of maintenance tasks and housekeeping. The hiring manager may be the industrial plant itself or any of its subcontractors, so all parties in the contract chain may employ temporary staff. However, the licensee is ultimately accountable and has to ensure that all partiers can perform their tasks safely.

Examples of good practices in maintenance networks:
- Clear and systematic change management procedures including identification of any changes, the assessment of change risks, clearly identified authorised persons as well as proper change communication and training.
- Clear division of responsibilities in contracts.

- Periodical site meetings between different parties so that everyone is aware of the project phases and critical tasks.

A logistics network consists of subcontractors distributing various items and partners delivering a company's products to customers. A logistics network also includes storage services, which are commonly outsourced today. From the process safety point of view, those companies which have responsibilities and tasks related to the loading and unloading of chemicals are particularly important.

Examples of good practices in logistics networks:

- Joint safety audits between the service provider and the licensee
- Service provider's participation in risk assessments
- Training and induction with regard to local equipment, conditions and chemicals

By means of a raw-material network, a licensee acquires raw materials, goods, and energy. This network is usually closely linked to a company's logistics network, through which the delivery of raw materials and goods as well as energy distribution is carried out. If the same service provider is responsible for both selling and delivering items, it belongs to both the raw-material network and to the logistics network. Raw-material networks can constitute broad and complicated chains. Raw materials and equipment have a significant impact on process safety.

Examples of good practices in raw-material networks:

- When selecting and ordering raw materials, process requirements and conditions are taken into account.
- The person responsible for placing the order identifies safety-critical equipment and raw materials.
- The raw-material supplier ensures that the customer has adequate knowledge concerning the consignment of hazardous chemicals, for example.
- The customer reports users' operating experiences and hazardous situations to the supplier.

A local community network includes all the companies located in the common risk area, in other words in such proximity to each other that a potential accident could have domino effects on another company. A local community network also covers neighbouring schools, kindergartens, business premises, apartments and other buildings that people frequent on a regular basis. Harbour areas are also an example of areas which are outside the plant site but which are located in a common risk area. In the event of an oil spill, for instance, water can spread the effects far beyond the plant. Similarly, the surrounding local community can face a significant risk if hazardous chemicals leak into the atmosphere from a major hazard installation.

Examples of good practices in local community networks:

- Partners clearly define their responsibilities and the limits of their liability with regard to common facilities and areas.
- Regular meetings and effective communication are emphasized to ensure that all partners are aware of safety risks.
- Co-operation when it comes to drawing up an emergency plan, implementing emergency drills, informing the general public and providing data for the preparation of an external emergency plan.

4. Discussion

Approximately 85 % of upper-tier (SR) and half of lower-tier (MAPP) establishments in Finland meet the safety management system requirements set in the Seveso II directive. When it comes to nationally regulated establishments (NL), less than 40 % meet the legal requirements. Differences were also registered between industrial branches. The best situation was found in explosives and chemical plants, while more shortcomings were registered in refrigeration plants, LPG plants and surface treatment plants. Some of the nationally regulated establishments could cause a major hazard on or off site. Therefore, it is also important to identify accident scenarios related to smaller quantities of dangerous substances (Pey et al. 2009). The core of process safety management is the identification and shared understanding of the risks at the plant in question. Large chemical plants usually have specific resources and the expertise to handle, use and store hazardous chemicals. LPG plants and surface treatment plants, on the other hand, are rather small organizations which use hazardous chemicals to support their core business, so their skills in chemical risk might be lacking and they may need more guidance. Gerbec and Kontic (2008) have reported that in some cases the documents and mechanisms required by the directive may not be straightforward and effective tools for safety management. It is essential to adjust requirements on existing hazards. Many of the identified good practices are linked to the need to increase workers' participation and safety training and systematically pay greater attention to process safety-critical issues. These results are online with findings of Kotisalo et al. (2010). In addition, they have reported on sophisticated risk management ICT tools used to enhance shared understanding of risks.

In the safety-critical business environment, the organization has been seen as the most important dimension of the safety management system (Hsu et al., 2010). However, major hazard installations operate within increasingly complex networks. Chemical plants select their contractors based mainly on competence and price as well as the familiarity and reliability of the contractor. Safety does not appear to be a significant factor when selecting a contractor. When it comes to the management of networks, contractors' participation, risk communication and communication practices should be particularly emphasized. Networking also poses challenges both to current safety management system requirements and authorities' inspection practices. New approaches are therefore needed to ensure safety in new, internationally networked business environments. Even the new Seveso III directive seems to be lacking from the networked organizations' point of view.

5. Conclusions

Major hazard establishments can enhance their process safety management by applying good practices identified in other establishments. Although the data for these studies were collected in Finland, the examples of good practices can also be applied in other countries. In addition, it is essential that major hazard installations thoroughly analyze their networks and develop new approaches to managing and enhancing safety in what is becoming an increasingly complex business environment. Legal frameworks and inspection practices also need to be developed to meet the safety challenges posed by the networked business environment.

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