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Nuclear emergency planning and response in industrial areas.

Results of a qualitative study in 9 industrial companies.

BLG-793

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ABSTRACT

Substantial economic losses and potential dangerous situations may result when industrial companies unexpectedly have to shut down their activities in an abrupt way. With respect to the industrial companies located in the Antwerp harbour region, the reason for such an unplanned shut-down could be the decision to (preventively) evacuate their workers, or to have them sheltered, in case of an alarm situation in the nearby nuclear power plants of Doel or in any other adjacent industrial factory. Between January and August 1998, the prevention advisors of 9 of these industrial companies have been interviewed to gain an insight into the scale and the relative importance of the several economic costs and practical difficulties that may arise. Moreover, the appropriateness of the existing nuclear emergency response decision structure and intervention philosophy was verified. In this paper, we report on the main conclusions that can be drawn from these interviews and formulate some recommendations to increase the efficiency of implementing countermeasures in industrial areas.

KEYWORDS

industrial areas, nuclear emergency planning and response, survey

Introduction

In literature [1, 4, 6, 7] often reference is made to the substantial economic losses and potential dangerous situations that under particular circumstances might result when industrial companies unexpectedly have to shut down their activities in an abrupt way. With respect to the industrial companies located in the Antwerp harbour region, the reason for such an unplanned shut-down could be for instance the decision to (preventively) evacuate their workers, or have them sheltered, due to an alarm situation in the nearby nuclear power plants of Doel or in any other adjacent industrial factory.

Doctoral research at the Belgian Nuclear Energy Research Centre (SCK•CEN) and the University of Antwerp (UFSIA) aims to gain an insight into the implications preventive intervention decisions may have in industrial areas. Furthermore, methodologies are being developed to support these intervention decisions and mitigate their adverse effects.

In the framework of this research project, the prevention advisors of 9 industrial companies - affiliated with the Association of Industrial Companies in North Antwerp[1] - have been interviewed. These participating companies are active in petro(chemistry) (5/9), the storage and treatment of hazardous materials (2/9), waste disposal (1/9) and energy production (1/9). Table 1 summarises some important data, characterising these firms.

	employees (including contractors)	Turnover (million Bef[2])	Added Value (million Bef)	Installations (million Bef)
minimum	5	26	4	11
maximum	1170	14.472	9.472	31.059
median	188	3.200	1.210	2.515

Table 1. Some characteristics of the participating companies.

The remainder of this paper proceeds as follows. The next section summarises the research questions that were studied. Section 2 discusses the methodology used to obtain the necessary data. Section 3 presents the main results[3]. Finally, some recommendations are formulated in section 4.

1. Research questions

The purpose of the interviews consisted in finding an answer to the following questions:

1. What is the scale and the relative importance of the several economic costs and practical difficulties that may arise when countermeasures (evacuation, sheltering) are imposed on industrial companies ?
2. Is the current emergency response decision structure and intervention philosophy [2, 5] in which the government unilaterally imposes its decisions on the threatened companies based on pre-defined intervention criteria, rather than a decision structure in which the threatened companies are explicitly involved in the decision process, the most efficient in order to mitigate the costs and potential dangerous situations observed in 1 ?

[1] In dutch: VIBNA, Vereniging van Industriële Bedrijven Noord-Antwerpen.
[2] 1 Bef = 1 Belgian franc (1US$ ≈ 35 Bef, November 1998).
[3] In this document only general or aggregated results are presented; the individual results for each of the participating companies are discussed in a confidential report [8].

2. Methodology

The necessary data was collected by means of semi-structured interviews [3, 9] on the basis of a questionnaire that was compiled in close collaboration with a number of experts in the field of nuclear emergency planning and industrial safety[4]. The use of semi-structured interviews has two important benefits. First, the person-to-person contact between the interviewer and the interviewee could stimulate the latter to 'confide' quite delicate information. Secondly, it allowed us to deal with qualitative information more easily and to ask additional questions for clarification whenever necessary. The number of interviews was limited (one or two per company) and as such, the main disadvantages of this data collection method (costly and time-consuming) were of minor importance.

It must be stressed that only 9 of the 26 VIBNA-companies have been interviewed, while some important VIBNA-companies did not belong to the sample. Furthermore, not all industrial companies in the Antwerp harbour region are affiliated. Finally, some of the obtained answers reflect the opinion of the interviewed prevention advisors who may have a very specific background and professional experience.

3. Results

The following results were obtained with respect to the first research question.

- The two companies without production processes can almost instantaneously (15 minutes or less) halt their activities and evacuate the workers. The other 7 companies, with mostly continuous production processes, require considerably more time: their production can be shut down in a completely safe and economic justified way[5] in 1 hour to 4 days, and in a safe way[6] in 15 minutes to 8 hours. Although the implications of both shut-down procedures may differ drastically from firm to firm, the following observations are valid in general (Table 2).
  - The potential worker exposure will be smaller in case of a safe shut-down as both the time needed to execute the shut-down and the required number of workers in open air are smaller than in case of a completely safe and economic justified stop.
  - However, a safe shut-down may result in a much longer start-up phase once the countermeasure has been terminated. This does not only imply an increased immediate loss of added value, but also the potential loss of market share (having a prolonged negative effect on the company's results). Moreover, this shut-down procedure may produce considerable costs to the installations and result in larger losses of reagents and reaction products. The occurrence of damage to the environment cannot be excluded in advance, but the implications remain moderate in general.

[4] Some market research professionals were consulted as well in order to optimise the practicability of the questionnaire.

[5] This procedure refers to a shut-down without any residual risks, nor important start-up costs due to damage to the installations.

[6] This procedure refers to an emergency shut-down respecting the safety of the workers and the population, without taking into account, however, the economic implications of this stop. Moreover, some small residual risks may still exist (for instance, due to presence of toxic materials in the installations).

	A. Completely safe shut-down		B. Safe shut-down	
	range	*median*	*range*	*median*
Worker exposure				
■ duration shut-down	15 min → 96 hours	4 - 5 hours	5 min → 8 hours	1 hour
■ number of workers	1 → 40	< 10	1 → 25	< 10
■ activities in open air	<20% → > 80%	40% - 60%	0% → > 80%	20% - 40%
Economic impact				
■ loss of added value	0 - 40 MBef/day	3.5 MBef/day	0 - 40 MBef/day	3.5 MBef/day
■ duration start-up phase	0 - 6 days	3 hours	0 - 30 days	48 hours
■ costs to installations	0 - 0.5 MBef	0	0 - 50 MBef	moderate
■ loss of reagents, reaction products	0 - 0.65 MBef	0	0 - 6.25 MBef	0
■ loss of market share	yes	not applicable	yes (>> A)	not applicable
■ secondary costs	yes	not applicable	yes (> A)	not applicable
■ environmental damage	no	not applicable	moderate	not applicable

Table 2. Comparative overview 'completely safe shut-down' versus 'safe shut-down'.[7]

After the production processes have been shut down in a completely safe and economic justified way, or in a safe way, most companies require one or more workers to guard their territories for economic (prevention of theft) or safety reasons (for instance: to observe and fight any spontaneous combustion of particular products).

- In case the available time to shut down the production processes is smaller than the time needed for a safe emergency stop, important domino-risks (fire, release of toxic materials) may result in all companies with production processes. These secondary risks should be avoided and are of major importance for those companies that require a considerable amount of time to be safely shut down.

- All companies have sheltering possibilities at their disposal that provide similar (or slightly less) protection against ionising radiation than residential houses. 4 companies can continue to produce during a couple of hours with minimal or no losses at all, when a limited number of workers shelter, and the others are evacuated. Production in the other 5 companies can only be continued when it is allowed to have a limited number of workers perform operations in open air during a limited period of time (for instance: manually opening a valve, starting a pump, repair break downs, etc.).

[7] These data should be interpreted carefully as some interrelations are not indicated in this table. As such, it is not (necessarily) that under a worst case scenario 40 workers should mainly (>80%) perform outdoor activities during 96 hours to shut down the production processes in a fully safe and economic justified way.

With respect to the second research question, it can be concluded that the current emergency response decision structure and intervention philosophy probably show some limitations with respect to the implementation of countermeasures in industrial areas.

- The traditionally applied intervention levels insufficiently take into account the economic implications and potential risks described above. Whether these costs and risks should effectively be taken into account or not, depends on the phase and severity of the release:
    - The majority (7/9) of the prevention advisors thinks that for industrial workers other intervention levels than those applicable in residential areas must hold in situations where utilisation of the latter may result in important domino-risks. In such situations, even the implementation of distinct countermeasures can be considered for the different business units. In order to avoid serious domino-risks, it may be appropriate to expose a limited number of workers during a limited period of time to ionising radiation, provided that they are equipped with the necessary individual respiration protection and protective clothing[8] on the one hand, and that the severity of the release does not exceed a particular threshold on the other hand. The aim of these exposures must be to minimise the total (nuclear and chemical) risks.
    - The majority (6/9) of the prevention advisors finds that socio-economic aspects must be taken into account during the pre-release phase, i.e. when the safety of the workers is not (yet) endangered. This conviction is less pronounced with respect to the decision making process during an effective release.

  The majority of the prevention advisors thinks that the workers will be prepared to execute the necessary actions in case of a threat of a chemical release (6/9) or an effective chemical release (7/9), provided that the necessary individual protective measures are foreseen. The opinions of the prevention advisors are dissenting with respect to the behaviour of the industrial workers in case of a nuclear threat or effective release. Nuclear risks are perceived to be more dangerous than chemical risks, due to the workers' unfamiliarity with the nuclear (8/9). Merely 2 companies have a fully elaborated nuclear emergency plan; both companies dispose of personnel that is limited nuclear skilled, as well as elementary nuclear measuring devices.

- The support of intervention decisions in industrial areas requires information the federal authorities cannot dispose of in a fast and efficient way: the status of the industrial facility (for instance: 'in operation' versus 'in revision'), the time needed to shut down at least safely, the maximum possible duration of sheltering, etc. Moreover, the threatened industrial companies will be the very last to be informed on the severity of the situation and on the necessary actions, in case the existing information and communication procedures are strictly followed. This may result in loss of time (some hours), that may be very costly to firms with a longer shut-down duration, or may even provoke dangerous situations. All prevention advisors indicate the need for technical information with respect to the severity of the (possible) release, as well as specific advise with respect to the necessary protective actions.
    - The majority of the prevention advisors prefers to be informed by the nuclear power plant operator (8/9) and the regional authorities (7/9), because of the directness of the resulting communication and as a sign of being 'good neighbours'. Moreover, the nuclear power plant operator and the regional authorities are assumed to be better informed on the specific characteristics of the industrial companies and their operational status at the moment of the crisis.

[8] All companies have sufficient respiration protection devices and protective clothing at their disposal.

- Nevertheless, the majority of the prevention advisors (6/9) also attaches great interest to the information obtained from the federal authorities because of its objective character.

4. Recommendations

The following actions could be considered to increase the efficiency of countermeasures in industrial areas:

- Every industrial company in the emergency planning zone of a nuclear power plant could prepare specific and applicable actions in a well-elaborated 'industrial' nuclear emergency plan. When drawing up these emergency plans, the advice of a nuclear expert is indispensable.
- The members of the safety service and the intervention workers could be trained in the field of nuclear risks, possible countermeasures, etc. This could improve communication during a nuclear crisis, diminish confusion and as such, increase the probability of successfully implementing particular actions.
- It could be considered to have the nuclear power plant operator not only immediately inform the government's crisis centre in case of a (possible) release, but also the surrounding industrial companies as indication of being 'good neighbours'. This would allow these companies to initiate a number of preliminary actions (as clearly described in their 'industrial' nuclear emergency plans), in anticipation of the competent authorities' advice. As such, the loss of costly time could be strongly reduced.
- In the pre-release phase, it is important not to implement too intervening countermeasures too conservatively, from the point of view that they can be easily scaled-down afterwards. In industrial regions, this policy might result in important economic losses and/or create considerable secondary risks.
- Finally, it has been found that in particular circumstances important secondary risks can be avoided by shortly exposing a very limited number of workers to radiation (for instance: short operations in open air during sheltering, or during safe shut-down), resulting in doses possibly exceeding the traditional intervention levels. It can be considered to draw up a distinct set of intervention levels for this small group of workers, taking into account the following principles:
  - every exposure must be necessary to avoid or reduce important (chemical) risks;
  - the intervention workers should dispose of the necessary individual respiratory protection devices and protective clothing;
  - deterministic effects should be avoided.

It is important not to treat the issue of (preventively) implementing countermeasures in industrial areas as such, but to integrate it in a global (nuclear) emergency management policy. This implies the integration of the 'industrial' nuclear emergency plans in the national nuclear emergency plan, the optimisation of the information and communication streams between the nuclear power plant operator, the industrial company and the regional and national authorities, etc.

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