



## Do provisions to advance chemical facility safety also advance chemical facility security? An analysis of possible synergies

**Hedlund, Frank Huess**

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# **Do provisions to advance chemical facility safety also advance chemical facility security? - An analysis of possible synergies**

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Prepared Frank Hedlund  
Checked

Dr Frank Huess HEDLUND

COWI; Parallelvej 2, DK-2800 Kongens Lyngby, Denmark. E-mail: [fhhe@cowi.dk](mailto:fhhe@cowi.dk)<sup>a</sup>

Technical University of Denmark, Institute for Mathematical Modelling (DTU/IMM) DK-2800 Kongens Lyngby, Denmark. E-mail [fhf@imm.dtu.dk](mailto:fhf@imm.dtu.dk)

<sup>a</sup> corresponding address

## ***Abstract***

*The European Commission has launched a study on the applicability of existing chemical industry safety provisions to enhancing security of chemical facilities covering the situation in 18 EU Member States. This paper reports some preliminary analytical findings regarding the extent to which existing provisions that have been put into existence to advance safety objectives due to synergy effects could be expected advance security objectives as well.*

*The paper provides a conceptual definition of safety and security and presents a framework of their essential components. Key differences are discussed. A safety framework is examined with the intent to identify security elements potentially covered. Vice versa, a security framework is examined with the intent to identify safety elements potentially covered. It is concluded that Synergies exist at the mitigation level. At the strategic policy level, synergies are obvious. Synergies are largely absent at the preventive level.*

*The security of chemical facilities is important. First, facilities with large inventories of toxic materials could be attractive targets for terrorists. The concern is sabotage causing an intentional release that could endanger neighbouring populated areas. Second, facilities where high-risk chemicals are present could present opportunities for theft. The concern is that relatively small amounts of highly toxic chemicals could be taken to another location selected for higher impact.*

*The Directive on European Critical Infrastructures (ECI Directive) addresses facility security but does not cover the chemical sector. Chemical facility safety at EU level is addressed by way of the Seveso-II Directive. Preliminary estimates by the chemical industry suggest that perhaps 80% of the existing safety measures under Seveso-II would also be instrumental in terms of raising security.*

*This paper finds no support for the idea that such strong synergies exist at chemical facility level.*

## Table of Contents

<b>1</b>	<b>Introduction</b>	<b>3</b>
1.1	Background	3
1.2	Key differences between safety and security	3
<b>2</b>	<b>Defining chemical facility security</b>	<b>5</b>
2.1	Security methodologies from the USA	5
2.2	The German Baseline Protection Concept	5
2.3	Chemical facility security elements, defined	6
<b>3</b>	<b>Examination of synergies</b>	<b>8</b>
3.1	The EU Seveso Directive's safety provisions	8
3.2	OECD guidelines	8
3.3	Security elements potentially covered by chemical facility safety provisions	8
3.4	Safety elements potentially covered in a chemical facility security framework	10
<b>4</b>	<b>Mapping safety-security overlaps</b>	<b>12</b>
<b>5</b>	<b>Concluding remarks</b>	<b>15</b>
<b>6</b>	<b>References</b>	<b>17</b>

# 1 Introduction

## 1.1 Background

The purpose of this paper is to examine the extent to which existing provisions and practices related to enhancing chemical facility safety can be expected to serve the dual purpose of also enhancing chemical facility security.

The context is the growing concern about terrorism which has led to various initiatives to counter the threat from terrorists accessing toxic industrial materials (TIMs) and misusing these for terrorist attacks. The Directive on European Critical Infrastructures (ECI Directive) addresses facility security but does not cover the chemical sector.

Industries that hold large inventories of TIMs are already subjected to much safety legislation in order to control the risks of accidental (unintentional) exposure. Chemical facility safety at EU level is addressed by way of the Seveso-II Directive. Preliminary estimates by the chemical industry (IMPROVE 2010) suggest that perhaps 80% of the existing safety measures under Seveso-II would also be instrumental in terms of raising security. Synergies of this magnitude could have policy implications, implying little need for a new security regulatory regime. An examination of the relationship between safety and security is therefore warranted.

In 2012, the European Commission launched a study on the applicability of existing chemical industry safety provisions to enhancing security of chemical facilities. This paper presents some preliminary analytical findings from this study.

## 1.2 Key differences between safety and security

The key distinction between safety and security relates to malicious intent. Preventive safety precautions relate to the prevention of accidents, i.e. prevention of unforeseen and unplanned events with lack of intention or necessity. In contrast, preventive security is the degree of protection against danger, damage, loss, and crime.

Preventive safety analysis techniques aim at identifying vulnerabilities in the design and control philosophy of a chemical facility, in particular situations where the failure of a single component could lead to an excursion of the

design parameters. The common method to improve safety is by introducing redundant components. Mitigation safety analysis aim at limiting the amount of material released, for instance the ability to detect a release, close valves and isolate flow to the damaged section; or otherwise reducing the consequences of a release, for instance activating water curtains to disperse or absorb vapours.

In contrast, preventive security analysis techniques aim at identifying vulnerabilities to an adversary attack, be it vandalism or terrorism. Security measures therefore generally relate to physical protection. This includes safeguarding of an asset from unauthorized access and acts of malevolence, as well as surveillance of the site property and security force response capability.

Generally, the concept “risk” expresses a combination of frequency of an unwanted event and the extent of the consequences (Christensen et al. 2003). Within the safety domain, risk is usually expressed as

$$\text{Safety Risk} = \text{Likelihood of accident} \times \text{Consequence}$$

In contrast, within the security domain risk is usually expressed as (McIntyre 2008)

$$\text{Security Risk} = \text{Threat} \times \text{Vulnerability} \times \text{Impact}$$

The differences are profound. Within the safety domain, it is a fair assumption that failures occur randomly and the likelihood of failures can be estimated using statistical methods. In contrast, within the security domain, likelihood estimations present a challenge. Because of the human element - the fact that humans plan, rehearse, learn and modify in order to optimize the attack effectiveness - the events are not random and many of the required mathematical assumptions cannot be met. Human behaviour is difficult to predict and providing a quantified prediction of human behaviour is an even more difficult task (Sandia 2008). The nub of the problem is the unpredictable nature of terrorism and the terrorists’ deliberate efforts to do what is least expected -- that is, to defy prediction (Schierow 2006).

Consequently, this paper argues that while facilities are able undertake a safety risk analysis, they are unable to undertake a security risk analysis, for how should the facility be able to estimate the likelihood of an adversary attack? Information on threats and the capability and determination of adversary groups is scarce, the threat situation is dynamic, and the information sits with the intelligence agencies. Facilities can only examine the site specific vulnerabilities to adversary attack - a so-called security vulnerability analysis (SVA) -- not the risk.

## 2 Defining chemical facility security

### 2.1 Security methodologies from the USA

The USA has produced several guidance documents and codes for facility security, which are available in the public domain. The American Chemistry Council introduced a security addendum to the Responsible Care programme less than a year after the 2001 attack on the World Trade Center (ACC 2002). Later, the American Petroleum Institute issued a security vulnerability assessment methodology for the petrochemical industries (API 2004). The US department of homeland security has developed a web-based chemical security assessment tool (CSAT) (DHS 2008) and a set of chemical facility anti-terrorism performance standards (CFATS) (DHS 2009).

### 2.2 The German Baseline Protection Concept

Germany has developed a security concept and methodology known as the Baseline Protection Concept (BMI 2006) which aims to provide guidelines for infrastructure operators to develop protection measures. The guidelines cover the methodology for adopting protection measures and on minimum protection requirements.

A sample checklist is provided to assist private sector operators in completing or upgrading their infrastructure protection plans in practice. Since special aspects relating to individual locations and situations cannot be taken into account, the disclaimer says, the aspects covered in the checklist must be adapted and supplemented according to the specific needs.

Despite such caveats, the checklist is elaborated to great detail. Examples are:

- Are cellar windows equipped with certified security grids corresponding to resistance class 5 at least in accordance with DIN 18106?
- Are windows without bars equipped with intrusion-resistant fittings of at least resistance class WK 5, projectile-resistant laminated safety glass (in accordance with DIN EN 356, resistance class P 6 A), lockable window handles and screwed-on glazing retaining strips?

- Do all external doors comply with resistance class WK 5 in accordance with DIN ENV 1627?

However, such concepts developed for critical infrastructures covered by the European ECI Directive may present limitations for chemical facilities. First, some EU Member States interpret critical infrastructures in terms of non-interruptibility of service, whereas the concern for chemical facilities would be protection of neighbour communities from chemical releases. Second, while important, the priority is not only to restrict physical access to large facilities (protection) but also to be able to detect if theft has taken place and determine what substance has been stolen, in which quantity and subsequently alert law enforcement agencies. The Baseline Protection Concept is silent on this issue. The CFATS guidelines specifically address the ability to resolve inventory shortages.

### **2.3 Chemical facility security elements, defined**

In order to examine possible synergies between safety and security, essential security components must be defined. Two distinct categories of chemical facilities can be identified. (1) Facilities where toxic industrial materials are present and from which they could be stolen or otherwise obtained. (2) Facilities which because of large inventories and a location in vulnerable surroundings could be attractive targets for terrorists. Table 1 presents a non-exhaustive listing, defining some security components for the two types of facilities.

*Table 1 Selected components of chemical facility security.  
Note: SVA = Security Vulnerability Analysis*

Facility	Category of chemical facility	
	Facilities with toxic industrial materials (TIMs)	Facilities with TIMs that are targets in themselves
Concern	<ul style="list-style-type: none"> <li>Theft of TIM, misappropriation elsewhere (metro system etc)</li> </ul>	<ul style="list-style-type: none"> <li>Attack with destructive force, intentional release of TIM endangering the nearby community</li> </ul>
Perimeter	<ul style="list-style-type: none"> <li>Fences and gates, access control</li> </ul>	<ul style="list-style-type: none"> <li>Fences and gates, access control</li> <li>Vehicle barriers</li> <li>SVA</li> </ul>
Building	<ul style="list-style-type: none"> <li>Stored under lock</li> </ul>	<ul style="list-style-type: none"> <li>Target hardening</li> <li>SVA</li> </ul>
Intrusion response	<ul style="list-style-type: none"> <li>(not required)</li> </ul>	<ul style="list-style-type: none"> <li>SVA</li> </ul>
Inventory control and response	<ul style="list-style-type: none"> <li>Procedures that identify, investigate, and resolve shortages</li> <li>Procedures for reporting shortages to law enforcement agencies</li> </ul>	<ul style="list-style-type: none"> <li>SVA</li> </ul>
Cyber security	<ul style="list-style-type: none"> <li>(not required)</li> </ul>	<ul style="list-style-type: none"> <li>SVA</li> </ul>
Onsite emergency response, release reduction, release mitigation	<ul style="list-style-type: none"> <li>(not required)</li> </ul>	<ul style="list-style-type: none"> <li>Written plan, rehearsals</li> <li>SVA</li> </ul>
Offsite emergency response, crisis management,	<ul style="list-style-type: none"> <li>(not required)</li> </ul>	<ul style="list-style-type: none"> <li>Written plan, rehearsals</li> <li>SVA</li> </ul>

## **3 Examination of synergies**

### **3.1 The EU Seveso Directive's safety provisions**

In response to some major industrial disasters the EU Seveso Directive came into existence in 1982 to control the safety of facilities that store or process dangerous substances (82/501/EEC). The main requirements of the Directive relate to prevention and mitigation. First, the facilities must engage in industrial accident prevention work, systematically identifying and assessing hazards and taking the necessary safety precautions. Second, steps shall be taken to limit the consequences of an accident, should it occur despite the precautions taken, for instance invoking emergency plans to limit the release or activating a pre-planned emergency response.

### **3.2 OECD guidelines**

In 2003, OECD issued the second edition of its guiding principles for chemical accident prevention, preparedness and response. The aim is to set out general guidance for the safe planning and operation of facilities, to prevent accidents and, to mitigate adverse effects through effective emergency preparedness, land-use planning, and accident response<sup>1</sup>.

### **3.3 Security elements potentially covered by chemical facility safety provisions**

Selected safety elements from Seveso II and OECD are presented in Table 2 below. Each element is annotated with an interpretation of the typical scope of the safety provision and an assessment of how it could serve the dual purpose of also addressing security.

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<sup>1</sup> The 2003 OECD guideline covers some security elements, the subject was given additional attention in a 2011 addendum

Table 2 Examination of security elements covered in some safety provisions

Safety provisions	Interpretation of typical scope	Assessment of security elements (potentially) covered
Safety policy	A Seveso II requirement. Example elements are: To prevent accidents and provide adequate control of risks; to provide adequate training; to engage and consult with employees, etc	The policy concerns prevention of accidental (unintentional) events.  Security elements not covered
Safety Strategy and Control Framework	Typical control elements comprise: formal management of change not to introduce errors into a good design; a formal permit to work system (PtW) to coordinate and manage staff; a mechanical integrity program (e.g. corrosion monitoring); etc	Concerns prevention of accidental (unintentional) events.  Security elements not covered
Safety management systems	A Seveso II requirement. Safety management systems will often employ a Deming Circle (plan-do-check-act) to define and implement the control framework.	Security elements not covered
Hazard Identification and Risk Assessment	A Seveso II requirement. The purpose of a hazard identification is to list potential release concerns	A hazard identification step is the starting point for a list of possible targets -- overlap with security
	Risk assessment employ frequency analysis, assuming random failures of components	Security elements not covered
Inspections, audits, reviews	Typical inspections deal with workplace tidiness, corrossions monitoring,	Security elements not covered
	Typical audits relate to adherence to work to permit procedures, if preventive systematic risk reviews have been carried out,	Security elements not covered
	Typical technical reviews relate to overpressure protection, liquid slugs, adequacy of blow down facilities	Security elements not covered
Maintenance and repairs (incl. screening of personnel)	Safe maintenance is managed by work permit systems and efficient de-energizing of systems prior to starting the work	Security elements not covered
	Safe repairs are managed according to procedure, using certified welders, controlled annealing of HAZ zones, reassembling and fastening equipment according to procedure and specification, carried out by competent personnel	Security elements not covered

Safety provisions	Interpretation of typical scope	Assessment of security elements (potentially) covered
Design, layout, construction of facilities	Safe design is according to standards and good engineering practice; with redundant preventive risk controls	Security elements not covered
	Safe layout traditionally aims to prevent accident escalation	Overlap with security is possible (if it leads to reduced vulnerability to intentional acts)
	Safe construction is weld management and control of construction materials	Security elements not covered
Land-use Planning	A Seveso II requirement. Good land use planning keeps population away from hazardous installations	Very clear overlap with security
Procedures, personnel, internal communication, education and training, human factors	Competent personnel may spot mishaps at an early stage and stop an accident in its tracks	Security elements not covered
	Competent personnel may in some cases mitigate the effects of an intentional act of vandalism	Overlap with security is possible (emergency preparedness)
Emergency preparedness and planning	A Seveso II requirement. Emergency preparedness aims to mitigate the effects of a release, regardless if it is intentional or accidental	Very clear overlap with security
Communication with and information to the Public	A Seveso II requirement. General knowledge enables citizens to take adequate protective measures in case of a toxic release	Very clear overlap with security
Incident reporting and analysis	A Seveso II requirement. Reporting criteria are based on damage, however, only "accidents" are reportable	Security incidents probably not reportable -- depends on interpretation if terror act is an "accident"
Contractor evaluation, selection, training and control	Safe contractor management aim to have competent hired-in personnel that knows procedures for alarm initiation and evacuation	Security elements not covered

### 3.4 Safety elements potentially covered in a chemical facility security framework

The checklist in the German Baseline Protection Concept offers an opportunity to examine the extent to which safety elements are covered in a security framework. While the perspective is slightly different, if security measures enhance safety, not if safety measures enhance security, the results of this analysis are instructive.

Each security checklist item was simply categorized as potentially benefitting or not benefitting safety. Results are shown in Table 3. Slightly more than one out of four items would have the dual effect of also enhancing safety. The synergies are mainly within emergency planning, organization and risk management. Some checklist items covered protection against natural phenomena (e.g. flooding), they were counted as synergies

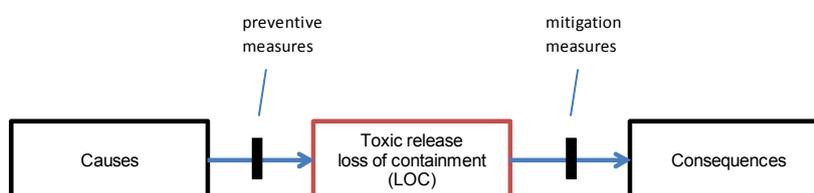
It is noteworthy that negative synergies were identified. They relate to restriction of information, either information on where the toxic material is located at the facility (warning placards), which is a mandatory requirement in most countries, or restriction of information to the public, which is contrary to several right-to-know initiatives. The security concern is that the information could be useful to terrorists.

*Table 3 Examination of safety elements covered in the German security concept, (Baseline Protection Concept)*

<b>Checklist category</b>	<b>Number of checklist items</b>	<b>Synergy</b>	<b>Negative synergy</b>	<b>Unclear</b>
1. Protection of facilities and installations	69	7	1	1
2. Personnel	9	0	0	0
3. Organisation	30	10	1	3
4. Risk management	9	6	0	3
5. Emergency planning and contingency planning	14	13	0	0
<b>Total</b>	<b>131</b>	<b>36</b>	<b>2</b>	<b>7</b>
<b>Percent</b>	<b>100%</b>	<b>27%</b>	<b>2%</b>	<b>5%</b>

## 4 Mapping safety-security overlaps

Barrier diagrams are useful for a broad initial mapping exercise of overlaps between the safety and the security domain. A barrier diagram in its most basic form is shown in Figure 1.



*Figure 1 A basic barrier diagram showing causes and consequences of a toxic release from a high risk chemical facility and measures related to prevention and mitigation*

Figure 2 shows a barrier diagram that has been modified to reflect concerns from the effect of random equipment breakdowns and human error (safety) and concerns from human intent on causing damage and harm (security). The illustration of preventive barriers for safety condenses the analysis in Table 2, which emphasizes that safety is achieved through systematic application of redundancy, mechanical integrity and programmatic practices related to the execution of the work. In contrast, the preventive barriers related to security relate to physical protection and access restrictions. While the exposition is simplified it serves to show that synergies are largely absent at the preventive level.

At the mitigation level synergies are obvious, the value of emergency response efforts and the general knowledge of the public to take adequate protective measures in case of a toxic release are beneficial both for accidental and intentional releases of toxic chemicals.

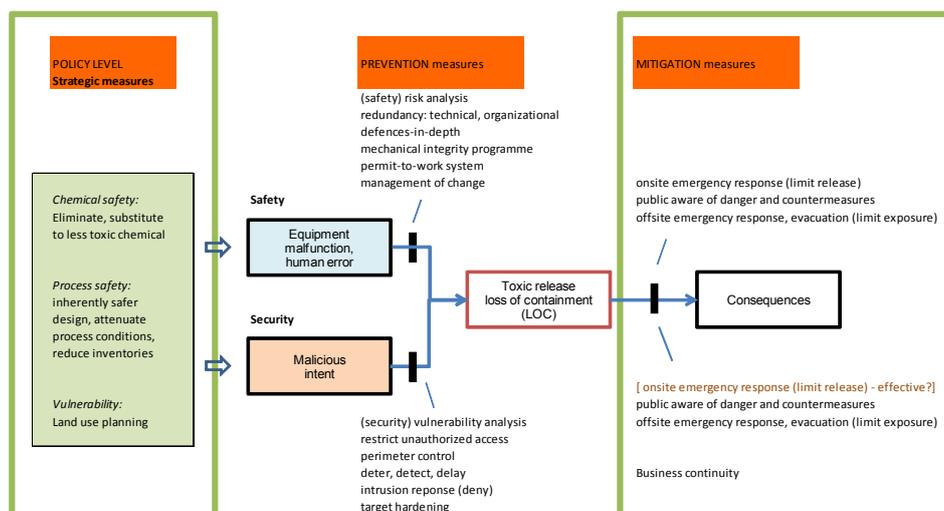


Figure 2 Barrier diagram shows that barriers related to prevention are different for the safety and the security domains, while barriers related to mitigation are largely the same. Prevention measures at the strategic level are equally beneficial for both safety and security. Green boxes mark synergies.

At the strategic level, synergies are obvious:

- *Chemical safety: Eliminate, substitute:* A general chemical safety strategy aimed at elimination of dangerous chemicals, or the substitution to less dangerous chemicals. This equally benefits security, see e.g. Orum (2008) for an excellent exposition of this topic.
- *Process safety: Inherently safer design:* A general chemical process design safety strategy advocated e.g. by Kletz (1984), simplify, reduce inventories, attenuate process conditions (pressure, temperature etc) to lower the hazard.
- *Vulnerability: Land-use planning:* A general strategy to ensure that facilities with major hazard potential are located at distance from the general population to minimize the offsite consequences (impact) of an uncontrolled event.

The Venn diagram in Figure 3 maps synergies from a legislation perspective. The three domains presented are (1) chemical facility security legislation, (2) major accident hazard legislation (Seveso II) and (3) chemical workplace safety legislation. The Venn diagram illustrates that the hazard mapping activity is common for both the safety and the security domain, a clear synergy. Measures to protect unsuspecting individuals from accidental exposure to workplace chemicals (keep under lock) benefit both safety and security, also a clear synergy.

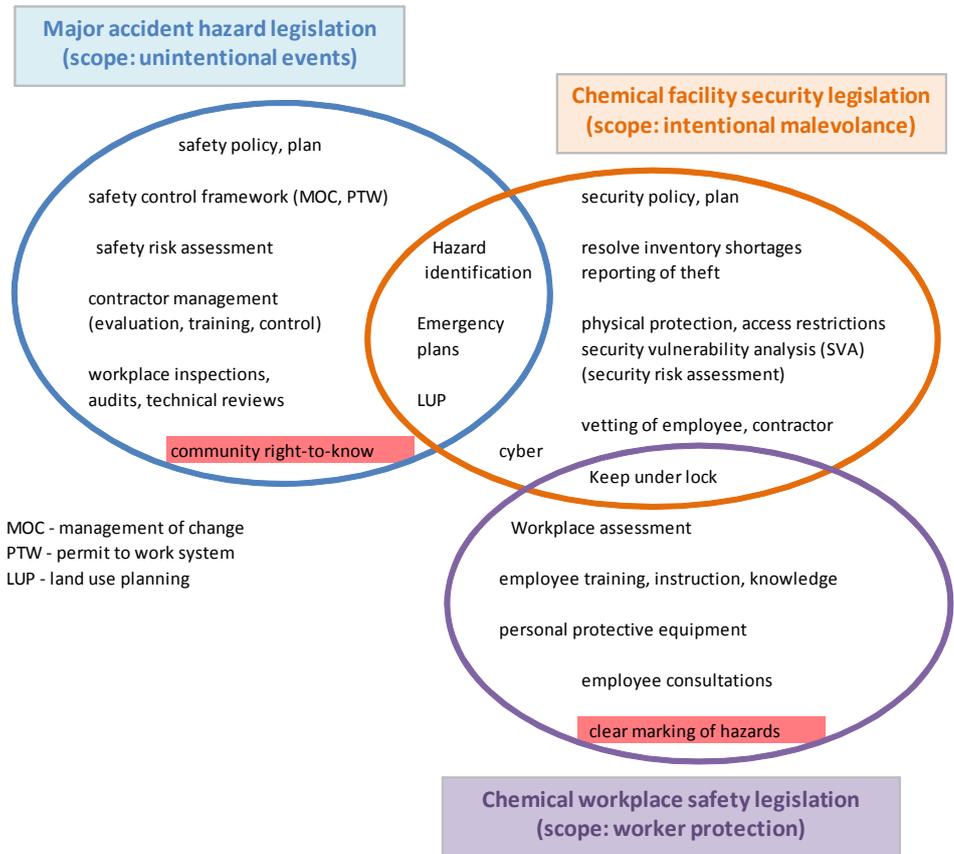


Figure 3 Mapping overlaps between elements within the domains of chemical facility security provisions, major accident hazard provisions (Seveso II) and chemical workplace safety provisions

Figure 3 also illustrates that there are relatively few overlaps between the safety and the security domain. Important security elements are left unaddressed in safety legislation and, vice versa, important safety elements not covered in the security domain.

## 5 Concluding remarks

A complex relation exists between the chemical facility safety and security domain. Within some areas there are evident overlaps, or synergies, with the two domains supporting each other. Within a few areas, priorities are incompatible, leading to conflict. Most of the time, there is limited or no overlap between the two.

The strongest synergies exist at the strategic level. The general chemical safety strategy aimed at elimination of dangerous chemicals, or the substitution to less dangerous chemicals equally benefits security. Inherently safer design strategies (simplify, reduce inventories) also clearly benefit security. Vulnerability reduction strategies by means of land-use planning to keep communities away from hazardous installations similarly present strong synergies.

Regarding preventive measures at chemical facility level, overlaps are minimal. Preventive safety is achieved through systematic application of redundancy, mechanical integrity and programmatic practices related to the safe execution of work. In contrast, preventive security relates to physical protection and access restrictions.

It is noteworthy that negative synergies were identified. They relate to restriction of information: Either information (warning placards) on where the toxic material is located at the facility, which is a mandatory requirement in most countries to warn unsuspecting workers; or restriction of information to the public, which is contrary to several right-to-know initiatives, to support local democracy. The safety objective is that facility knowledge enables citizens to take adequate protective measures in case of a toxic release. The security concern is that facility knowledge could be useful to terrorist.

Major synergies exist at the mitigation level, in particular concerning effective emergency response. The relation is complex however. Within the safety domain, only consequences of "credible worst-case" scenarios may have been considered in emergency planning efforts. This may be perfectly defensible from a safety risk point of view if abundant redundant safety measures make the likelihood of a severe accidental scenario negligible. The safety reasoning, however, ignores the situation with a determined and capable adversary attacker -- the security risk may therefore be much different.

It is important that these issues are identified, that benefits from synergies are supported, that negative synergies are resolved, with the overall policy objective to ensure safe and secure chemical facilities.

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