EU FP 7 SPIRIT project concerning infrastructure protection

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CBRE (counter)terrorism

Terrorist attacks by bombing (E) or Chemical, Biological or Radiological (CBR)-agents are threats with a low probability but with disastrous consequences. There is a strong need to protect people, the societal community and critical infrastructures and utilities of any kind against being damaged, destroyed or disrupted by deliberate acts of terrorism. Solutions have to be developed to realize sufficient resilience of the infrastructure for rare occasions with minimum effect on normality. Hitherto, normal regulations and building guidelines do not take into account the CBRE threat.
Modern society is a complex, intertwined system in which a small disturbance in one area may have a disproportional effect on the system as a whole. In fact, the system character of modern society implies that certain types of attack could cause the system itself to lose stability. E.g. the effect of a large-scale B-attack might, if it remains undetected, grow out of control because infected people travel around looking for medical aid thus infecting more people. The health services may then find themselves unable to cope so that an ever increasing number of societal services are disrupted.
The immense societal reaction that these incidents cause can be subdivided into:

- 1st tier effects (effects on health and first responders' actions) at the site of the attack,
- 2nd tier effects (effects on societal functions shortly after and close to the location of the attack), and
- 3rd tier effects (effects on the economic and political viability of a nation or EU as a whole), in terms of the colossal damages that will consequently incur both in human life (the so-called psycho-social impact) and in economic losses, show how vulnerable a modern society is to a CBRE terrorist attack.

Figure 1 below represents a model of impact area in EU society: it shows both the 1st , 2nd and 3rd tier damage effect layers in society as introduced above. Figure 2 depicts the various countermeasures that could be taken. Both figures, which indicate the system-of-systems nature of CBRE counterterrorism, are taken from the results of the ASSRBCVUL project entitled: 'Assessment of the vulnerabilities of modern societies to terrorist acts employing radiological, biological or chemical agents with the view to assist in developing preventive and suppressive crisis management strategies'. ASSRBCVUL was a prospective study performed by an international consortium of European Science and Technology Observatory (ESTO) members sponsored by the Institute for Prospective Technological Studies (IPTS). Where possible in this paper the impact of CBRE terrorism as well as the impact of CBRE counterterrorism are valued in terms of the multi-tier effect concept as described above, i.e. not only in terms of casualties only.

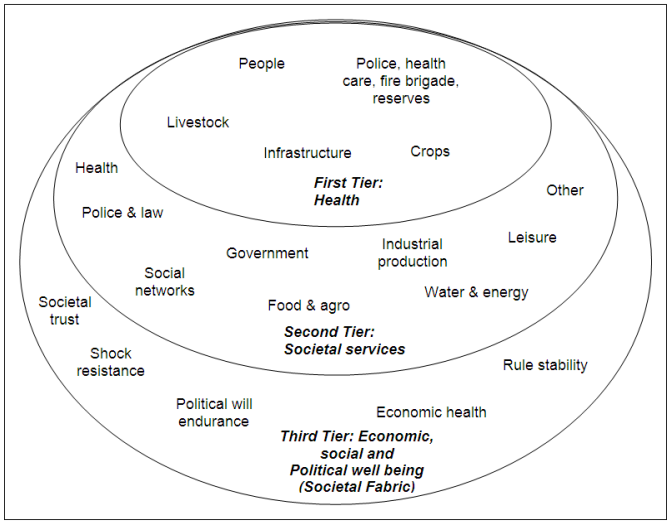

Figure 1. Model of impact areas in EU society

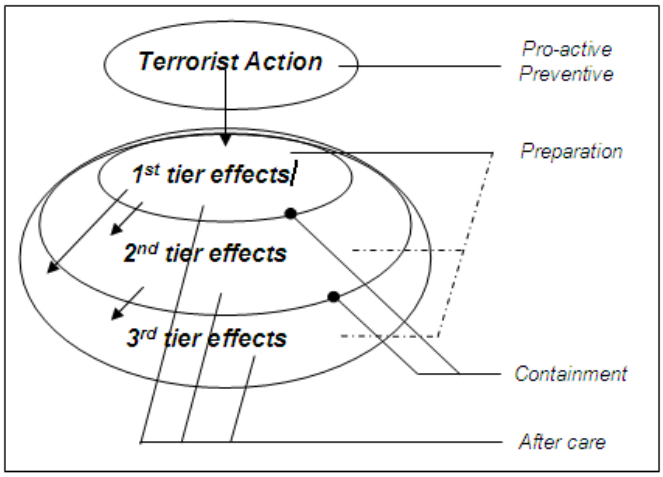

Figure 2. Countermeasures and their relation to effects

CBRE counterterrorism is a concept consisting of the following dimensions:

- The hazardous material:
  - C: almost instant effects, large range of available amounts and toxicity.
  - B: medium term effects, possibility of contagious diseases at the threat agent.
  - R: long term effects.
  - E: instant effects, most widely used by terrorists, and socially more “accepted” than C, B and R.
- The targets:
  - People directly or indirectly affected (goods, food-chain, water supplies, etc.).
  - Transportation (airports, railways, etc.).
  - Symbolic locations (e.g. governmental buildings) or people (e.g. politicians).
  - Infrastructures.
- The scale:
  - Toxicity (from non-toxic hoaxes to pandemic-like B-attacks).
  - Physical effects (from bomb attacks with no victims to nuclear detonations), etc.

- The Security Chain (timeline): threat – prevention – preparation – protection – response - recovery.

As can be seen from the above listing the "Chemical" in Chemical Safety and Security is only one element of a multidimensional complex. Nevertheless the work that was performed in a number of projects in the European 7th Framework Programme exhibits illustrations about how safety and security, not only for "Chemical", can be married.

The DECOTESSC1 project

A first project, coordinated by TNO with a consortium of Research and Technology organizations, was named DECOTESSC1 (DEmonstration of COunterTErrorism System-of-Systems against CBRNE phase 1). The DECOTESSC1 project's objectives were to define a strategic roadmap

- by taking into account relevant completed, ongoing and planned work on CBRNE related issues as well as related areas,
- by assessing the relevant trends in all expertise areas as well as the political situation,
- by defining further research work required, also in conjunction with other bodies working on strategic roadmaps such as European Security Research Innovation Forum (ESRIF) and the European Defence Agency (EDA), as well as national bodies inside and outside the EU.

Among the many outcomes of DECOTESSC1 the following are relevant for the further discussions in this paper. These outcomes can be summarized as follows:

- No single element of the multidimensional complex shown above should be taken into account. In this way zooming in on "Chemical" only is an important but somewhat dangerous limitation. A systems-of-systems approach (all threats, all targets, al scales and full security cycle) is to be preferred.
- Preferably counterterrorism should try to deal with the problems as close to the source as possible (as left as possible from the "boom"), i.e. prevention is of utmost importance.
- No dedicated solutions for CBRE security should be developed. Apart from a growing complexity of treaties, laws, procedures, responsible organizations, technology etc. economy simply does not allow for dedicated solutions for isolated problems. In that respect a marriage between the Security domain and other domains such as Safety, Environment, Health, Defence, Non-proliferation, etc. is welcomed. Chemical Safety and Security is a clear example of such a marriage.
- The so-called Security-by-Design approach is the preferred way of handling terrorism, especially when thinking about the future of society.

The SPIRIT project

Introduction

SPIRIT is an EU 7th framework project entitled "Safety and Protection of built Infrastructure to Resist Integral Threats". The SPIRIT consortium is a collaboration between several European government organizations, academic institutions and companies. TNO is the coordinator.

Within the SPIRIT project a consortium was formed to bring the required expertise regarding protection of infrastructure against terrorist threats together, to make these commonly available and to find solutions that can be integrated into normal life and planning and building procedures. SPIRIT addresses CBRE terrorist attack scenarios. The anticipated main outcome of the project is an integrated approach to evaluate and counter CBRE-threats,

including proposed guidelines for an EU Regulatory Framework. With this approach, government, end users of buildings and designers can define and achieve a desired level of protection.
The SPIRIT project is a clear example of a marriage between Safety and Security. Although the strongest examples of this marriage are in the E-domain rather than the C-domain, by illustrating how SPIRIT works it will in a metaphoric way also become clear how eventually Chemical Safety and Security may become an optimum joint-venture.
The scope of the SPIRIT-project is defined by the type of threats and the type of built infrastructure considered. The threats considered are terrorist threats with use of CBRE-means. Regarding the infrastructural target, SPIRIT limit itself to large modern buildings, often (partly) public buildings, where a lot of people can be present. Modern refers to the fact that only buildings are considered that are designed according to the current standards.
The targeted contribution of SPIRIT to build infrastructure protection will be:

- A methodology to quantify the vulnerability of built infrastructure in number of casualties/injuries, amount of damage and loss of functionality and services.
- A guidance tool to assess the vulnerability of a design/building and select efficient and cost effective countermeasures (ready to use solutions) to achieve a required protection level against terrorist attacks.
- Portfolios of protection products for new and existing buildings.
- Recommendations for draft EU regulatory framework to enable safety based engineering and the incorporation of 'CBRE protection' in the regular building guidelines and regulations.

The technical work of the SPIRIT project is divided in five work packages. Figure 3 shows these work packages, as well as the interrelation between them.

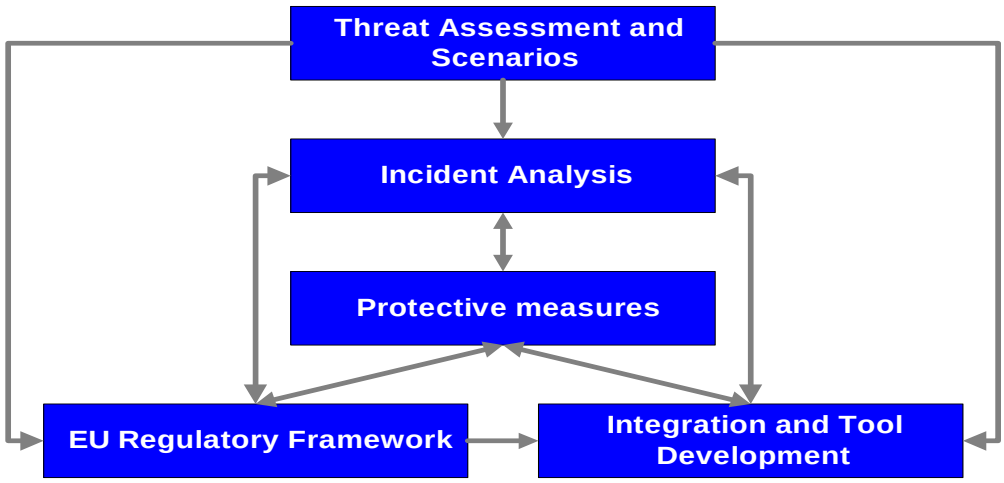

Figure 3. Overall strategy of SPIRIT.

Threat assessment and scenarios

Within the SPIRIT project, scenarios are defined which are specific for attacks on buildings. In total, 20 Chemical, 12 Biological, 9 Radiological and 14 Explosive scenarios have been defined. To be able to make a well-considered choice of the vast amount of available CBR agents, some new concepts are introduced like 'building interaction vectors' and a 'threat space'. Interaction vectors describe how a building interacts with the outside world.

Examples of interaction vectors are shown in Figure 4. By exploiting these interaction vectors, one can get an indication about how a building can be attacked. Also, by reciprocating safety principles (how can I make things go wrong?) additional attack possibilities are defined.

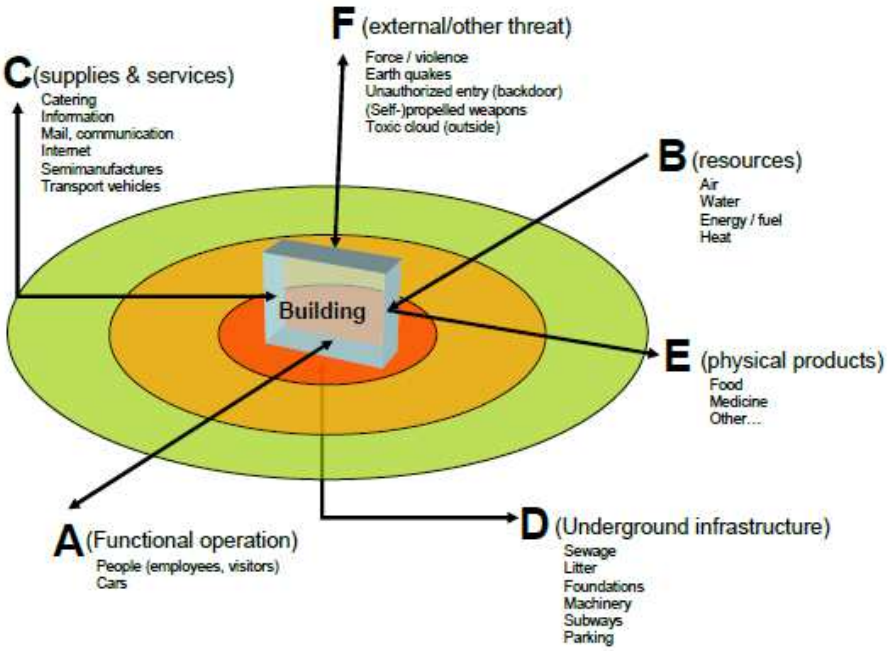

Figure 4. Examples of interaction vectors and carriers of a building with the outside world, that can possibly be exploited as attack vectors.

A CBR threat space is a (visual) representation of agents in a multidimensional space to ensure that the threat has been evenly distributed through the threat spectrum, avoiding clustering around 'known' (already happened/studied in the past) attacks which may cause bias. By superimposing scenarios that have occurred in the past or are considered to be credible in other studies, some 'blind spots' are identified in the interaction vector exploits, i.e. an exploited vector could theoretically be used for an attack on a building, however no occurred or credible scenarios were (yet) found in existing literature. Finally a set of 41 attack scenarios were defined to represent all different CBR attacks.
For explosive attacks, a range of explosive materials are known to have been used in actual terrorist attacks. However, the well-established procedure of TNT-equivalence has been adopted to define representative quantities of high explosives and credible scenarios. In the framework of infrastructure safety, (close-in) blast is assumed to be the dominant phenomenon to be considered in this study, whereas fragments from either casing around or shrapnel in the explosive charge cause effects of second order. Therefore the TNT-equivalency-approach is appropriate.

Incident analysis

It is a challenge to develop a relatively simple, not too detailed consequence analysis methodology for the guidance tool, that still has the ability to discern between different cases, scenarios and buildings, and that also can show the effectiveness of protective measures. The anticipated approach is a kind of three dimensional database method, with a bypass, where possible, based on simple quantitative correlations. The three dimensions are threat

classes, a categorization of the structures and structural elements, and consequence classes, in terms of structural damage, injuries and/or loss of functionality.
The quantitative breakdown will be based on a large number of calculations, both with relatively simple engineering tools, as well as with sophisticated numerical tools, e.g. for analyzing specific details. These analyses are done to understand the phenomena that are dominant for the consequences and to select the proper parameters to consider in the tool. Two generic buildings, that have been defined, are the target constructions for the analyses to be performed: a multi-use high rise concrete frame structure and a large shopping mall of prefabricated elements. The consequence calculations concern blast loading calculations, window breakage analysis, damage zone prediction, injury and lethality prediction, column damage due to close-in charges and residual capacity, analysis of progressive collapse, the dispersion of CBR-agencies through the building and the CBR-lethality. Figure 5 shows an example for explosions.

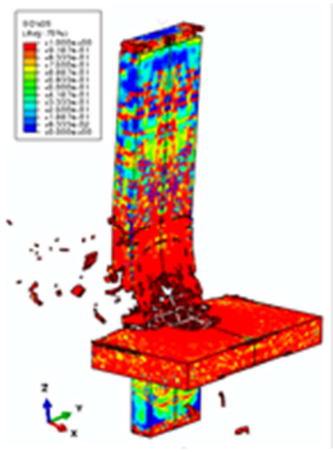

Figure 5. Examples of incident analysis due to close-in detonation.

Protective measures

Protective products will be identified and developed in order to provide architects and building designers with ready-to-use products and solutions to harden infrastructure against CBRE terrorist threats. The innovative products for protection of structural components and indoor air quality are related to the identified CBRE-threats. Countermeasures such as blast proof masonry retrofit systems, blast resistant window/facade systems, micro-reinforced high performance concrete, detectors, monitors and filters for ventilation systems are analyzed with regard to protective effectiveness and economic benefit. New solutions are developed to fill the gaps. Experiments and numerical analysis are used to obtain generalized results. Thus, a protection product portfolio is generated that assists to improve the most vulnerable components of critical infrastructure.

Assessment tool development

One of the main aims of the SPIRIT project is to make the specialist knowledge available and easily accessible for the design and planning of the built infrastructure. A safety integrated design is needed in which also the vulnerability of a building, an asset, to CBRE threat is considered. To enable such an integrated design, a method to quantify the potential loss of functionality and structural integrity due to CBRE attacks is needed. Therefore the results of the individual SPIRIT work packages on the threat scenarios, the classification of the

buildings, the consequence modelling and the counter measures will be integrated and combined in a guidance tool.
The basic idea behind the guidance tool is:

- A building, an asset is known and defined.
- The asset might be a target for a CBRE terrorist attack.
- The user wants to know how vulnerable the asset is to various CBRE threats.
- The user wants to know the possibilities and effectiveness of countermeasures.
- The user needs a tool to support the decision on the necessity and the kind of protective measures.

Figure 6. Concept of the assessment tool.

To answer all these questions quantitatively expert knowledge and classified information is needed.
To meet the EU-requirements of public release, it was decided to make the guidance tool a two-step approach with a qualitative first step and a quantitative second step. Also the typical user for the two steps differs.
Step 1 is for the non-expert user to make a rough estimate of the asset vulnerability for threat scenarios covered by the SPIRIT project. Step 1 is qualitative and will be based on non-restricted information and uses no, or only very simple calculations. Basically, in this phase, the critical conditions for the asset, or modules of the asset, are identified. This SPIRIT Step 1 model will have a web-based format and the distribution is non-restricted.
In the second step, the initial vulnerability and the effectiveness of countermeasures are quantified. In this Step 2 restricted information may be used and the results are obtained by numerous calculations. This second part of the tool is intended to be used by experts only and the distribution will be restricted.
The tool provides guidance for the assessment in two parts: 1. asset attractiveness, and 2. threat evaluation. The output is a ranking of the vulnerability of the asset to the various scenarios.
Regarding attractiveness SPIRIT, intended for the Security domain, builds upon Safety related standards and rules for building. In Figure 7 it is clearly observed that for the attractiveness rating an existing DIN standard is used.

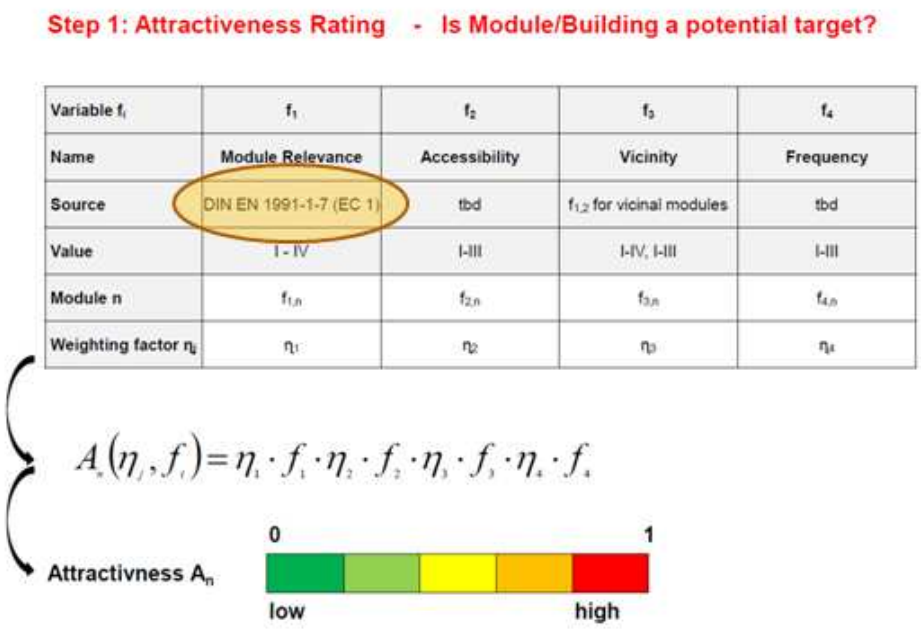

Figure 7. Attractiveness rating method using DIN standards for building.

Concluding remarks

The SPIRIT project will provide the technology and know-how for the protection of buildings and people against terrorist threat and to minimize the consequences of a terrorist attack. The results will be a first step towards this overall aim, with the guidance tool as the tangible result and the instrument for the knowledge transfer.
Regarding Safety and Security (not only for C but also BRE) the technical approach in SPIRIT mimics Safety philosophy. Buildings design rules and norms were “borrowed” from the Safety domain indicating that a marriage between Safety and Security is possible.