[PRACTICE]

D2.2 REFERENCE SET OF CBRN SCENARIOS

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PREPAREDNESS AND RESILIENCE AGAINST CBRN TERRORISM USING INTEGRATED CONCEPTS AND EQUIPMENT

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Summary Work Package 2

The overall aim of the project "Preparedness and Resilience Against CBRN Terrorism using Integrated Concepts and Equipment" (PRACTICE) is to improve the ability to respond to and recover from a Chemical (C), Biological (B), Radiological (R) or Nuclear (N) incident. The objective of the project is to create an integrated European approach to a CBRN crisis – *i.e*. a European Integrated CBRN Response System. This will be achieved through the development of an improved system of tools, methods and procedures that is going to provide EU with a capability to carry out a truly integrated and coordinated operational reaction following the occurrence of a CBRN crisis, whether it is caused by a terrorist act or an accident.

The objectives of work package (WP) 2 "Scenarios and critical event parameters" are to:

- Produce a template for scenarios and requirements, as a basis to make a selection of appropriate and representative CBRN-scenarios.
- Based on the selected scenarios and experience from exercises, real events and experience from earlier relevant projects, identify, describe and organize sets of critical event parameters/observables characterizing the events, which first responders and authorities use as input for selecting, prioritizing and in a number of cases developing appropriate emergency preparedness and response measures.
- To create – as part of a CBRN response toolbox and training kit to be developed in WP4, WP5, WP6 and WP7 – a set of publicly available CBRN scenarios (not classified) which will be used as reference to sort out CBRN-specific parameters/observables and as an aid to the gap analysis to be carried out in WP4. The scenarios can also be used by the European countries for emergency preparedness planning, education, training, and exercises.

WP2 is divided in the following tasks and deliverables:

- Task 2.1. Scenario template and requirements
    - Deliverable D2.1 (a) Detailed scenario template and requirements for consequence assessments and (b) collection of submitted scenarios (those publicly available) and information on accidents
- Task 2.2. Reference set of scenarios
    - Deliverable D2.2 Reference set of CBRN scenarios covering releases of hazardous chemical (C), biological (B), and radiological (R) substances.
- Task 2.3. Consequence assessments and identification of critical event parameters
    - Deliverable D2.3 Consequence assessments of the selected set of reference CBRN scenarios and critical event parameters

This report, "D2.2 Reference set of CBRN scenarios", constitutes the second deliverable of WP2 "Scenarios and critical event parameters" of the EU FP7 project PRACTICE. This WP is led by the Norwegian Defence Research Establishment (FFI).

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Contents

1. Executive Summary

This report, “D2.2 Reference set of CBRN scenarios”, constitutes the second deliverable of Work Package (WP) 2 “Scenarios and critical event parameters” of the EU FP7 project “Preparedness and Resilience Against CBRN Terrorism using Integrated Concepts and Equipment” (PRACTICE). This WP is lead by the Norwegian Defence Research Establishment (FFI). The report contains a reference set of scenarios covering releases of hazardous chemical (C), biological (B), radiological (R) and nuclear (N) substances. The template design is the result of Deliverable 2.1.

The objective is to develop scenarios which will be used within the PRACTICE project to establish critical event parameters, to aid surveys of the current status of CBRN preparedness and response, to help design an improved concept to respond and recover from a CBRN crisis (toolbox), to test, evaluate and demonstrate the toolbox, to be included in training kits and educational programmes and to help analyze societal and human aspects in CBRN crises. The scenarios can also be used by the European countries for CBRN emergency preparedness and response planning, education, training and exercises.

It is not expected that participants will follow absolutely the scenarios given, as these will depend upon actual exercise locations and parameters, but use them as a guideline and basis for further development and adaptation.

The set of reference CBRN scenarios consist of eleven scenarios inspired by or directly based on existing publically available scenarios and historical incidents. They were chosen so as to cover a broad spectrum of CBRN emergency preparedness and response challenges. The scenarios in some cases incorporate international consequences aimed at pan European coordination, using for example a chemical river based contamination, a biological pandemic and a nuclear scenario.

In order to fulfill the objectives, the set of scenarios are kept at an unclassified level. Describing hazardous scenarios, in particular intentional actions can be challenging requiring a balance of sufficient detail which is fit for purpose. The strategy to achieve this was to base the scenarios solely on open information, historical incidents and/or on previously published scenarios, and to keep the scenarios at a generic and general level regarding location and other details. The scenarios are not based on threat assessments, but on a collection of examples of possible CBRN crises. For security reasons, the details for certain scenarios are printed as a Supplement to this report. The supplement is “Exempt from public disclosure” and can be obtained upon request from FFI. It is intended to be used within PRACTICE and for official purposes.

This report has been based on background information and active discussion and revisions among the following WP2 participants:

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2. Introduction

Accidents and intentional acts of terror or sabotage may cause release and dispersion of chemical (C), biological (B), or radiological (R) threat compounds which may constitute a serious health hazard to humans and/or animals or contaminate the environment. The overall aim of the "Preparedness and Resilience Against CBRN Terrorism using Integrated Concepts and Equipment" (PRACTICE) project is to establish measures to improve the ability to respond to and recover from such incidents. For the purpose of this project, chemical (C), biological (B), radiological (R) or nuclear (N) incidents encompass all events in which exposure to C, B, or R threat compounds cause great harm to the health of people or animals (injuries, illness or death) and/or the environment, as well as incidents in which N materials undergoing fission cause harm through dispersed radioactive fission products or by direct irradiation. Such CBRN crises may be caused by intentional acts or by accidents. Since the same emergency preparedness and response measures form the basis for mitigating effects of both accidents and intentional acts (*i.e.* terrorism, sabotage, and other criminal acts), both will be addressed in PRACTICE.

Work Package (WP) 2 is responsible for establishing a set of reference CBRN scenarios and identifying, describing and organizing sets of critical event parameters or observables characterizing various types of CBRN events. The purpose of the set of reference scenarios is to enable PRACTICE to identify emergency preparedness and response measures and operational functions in all phases of a CBRN crisis. The identified parameters and scenarios will prepare the ground for the development and testing of the PRACTICE toolbox that is carried out in all of the succeeding work packages. WP2 is divided in three tasks with associated deliverables:

- Task 2.1. Scenario template and requirements
  - Deliverable D2.1 (a) Detailed scenario template and requirements for consequence assessments and (b) collection of submitted scenarios (those publicly available) and information on accidents
- Task 2.2. Reference set of scenarios
  - Deliverable D2.2 Reference set of CBRN scenarios covering releases of hazardous chemical (C), biological (B) and radiological (R) substances
- Task 2.3. Consequence assessments and identification of critical event parameters
  - Deliverable D2.3 Consequence assessments of the selected set of reference CBRN scenarios and critical event parameters

The work of Task 2.1 is reported in "D2.1 Scenario template, existing CBRN scenarios and historical incidents") (Endregard *et al.*, 2011).

This report constitutes the second deliverable of WP2 (D2.2) and contains the PRACTICE reference set of CBRN scenarios.

3. Objectives and definitions

3.1 Objectives and method of work

The PRACTICE Grant Agreement states that:

> *"The aim of Task 2.2 of WP2 is to create – as part of a CBRN response toolbox and training kit to be developed in WP4, WP5, WP6 and WP7 – a set of publicly available CBRN scenarios (not classified) that can be used by the European countries for emergency preparedness planning, education, training, and exercises."*

The primary objectives and subsequent application of the set of reference CBRN scenarios are their use within the PRACTICE project:

- To identify critical event parameters for CBRN crises which either trigger or influences preventive or mitigating actions by emergency services (WP2 deliverable D2.3)
- To aid preparations for and interviews with emergency services to establish the current status for CBRN emergency preparedness and operational functions, as well as aid the subsequent analyses to identify gaps and ideal operational functions (WP3)
- To help design and test the PRACTICE toolbox concept consisting of an improved system of tools, methods and procedures to respond to and recover from CBRN crises (WP4)
- To test and evaluate the developed tools included in the toolbox, and help validate the overall developed toolbox (WP5)
- To serve as a basis for choice, further adaptation and detailed planning of scenario storylines and exercise injects for the three field exercises in the United Kingdom, Sweden and Poland, respectively (WP6)
- To be included in the CBRN training kits and educational programmes for first responders and emergency response personnel (WP7)
- To serve as a basis for discussions and analyses of human and societal aspects for various types of CBRN crises, and as an aid to develop manuals for the general public (WP8)

A secondary objective is that the reference set of scenarios can be utilized by the European countries for CBRN emergency preparedness planning, education, training, and exercises.

In order to fulfill the above primary and secondary objectives, the reference set of CBRN scenarios must be unclassified. Otherwise, they cannot be used for demonstrations, open discussions among all PRACTICE partners and be included in the training kits and manuals for first responders and the general public. When describing scenarios for undesirable incidents, in particular intentional acts of terrorism and sabotage, it is a challenge to keep the scenarios at an unclassified level. To do so, a delicate balance of sufficient detail, but not too much detail, was sought.

In order to keep the scenarios unclassified, the following strategy was chosen:

The selection of scenarios is **not based on threat assessments**. Hence, aspects such as probability, capabilities of specific actors and ease of production or availability of specific threat compounds have not been used as criteria to choose scenarios.

Chosen scenarios are either inspired by or directly based on accidents, natural outbreaks or CBRN terrorism events that have occurred, or based on scenarios that have already been made publically available through other projects. Hence, new, novel types of scenarios, which can be misused, are not made public through this report. Although the choice of scenarios implies that PRACTICE partners consider described incidents to be possible, we have not made an assessment of the level of difficulty to actually carry out the intentional acts out.

All information in the scenario descriptions are solely based on publically available information.

The scenario descriptions are quite general and generic. The necessary level of detail was discussed internally in WP2 and with the other WP leaders, arriving at the scenario template in the D2.1 report (Endregard *et al*, 2011). Information which may turn the scenario descriptions into recipes is avoided, *i.e.* how to obtain, construct or deliver threat compounds in an optimal way is not included.

In conclusion, the reference set of CBRN scenarios are inspired by, or directly based on, existing publically available scenarios and historical incidents. This ensures that the PRACTICE scenarios are unclassified. For security reasons, some details for certain scenarios are, however, kept in a Supplement to this report which is “Exempt from public disclosure”, and intended for official purposes. The main driver for the choice of scenarios is that the set shall cover a wide variety of emergency response challenges for C, B, R and N incidents, respectively.

3.2 Definitions and delimitations

This chapter provides definitions of key terms used in this report and WP2 as a whole and specifies important delimitations.

For the purpose of this project, Chemical (C), Biological (B), Radiological (R) or Nuclear (N) incidents encompass all events in which exposure to C, B, or R threat compounds cause great harm to the health of people or animals (injuries, illness or death) and/or the environment, as well as incidents in which nuclear materials undergoing fission cause harm through dispersed radioactive fission products or by direct irradiation. CBRN incidents may be caused by an accident or an intentional act.

Numerous chemicals may pose a threat to humans, animals or the environment due to their toxicity, flammability or reactivity, or a combination of these properties. In this project we focus on chemicals that may pose a threat due to their **toxic effects** primarily in humans, in accordance with the definition of a toxic chemical in the CWC (CWC, 1993). This means that incidents involving explosives, highly flammable and reactive substances are not included. These types of chemicals usually fall into the category denoted E (energetic materials, explosives).

We regard both nuclear criticality accidents and releases from nuclear reactors as N incidents. All incidents involving nuclear weapons are out of scope for this project and will not be considered.

The production, acquisition and use of biological threat compounds and toxic chemicals in war, terrorist actions and sabotage have been banned by the Biological and Toxin Weapons Convention (BTWC, 1972) and the Chemical Weapons Convention (CWC, 1993). These international treaties also provide definitions which we use in this project.

Table 1 gives key definitions of terms used in this project.

Table 1. Definitions of key terms used in WP2 of PRACTICE.

Term	Definition
Biological (B) threat compound	Micro-organisms, mainly bacteria and viruses, and toxins, which cause disease in humans, animals or plants.
Chemical, Biological, Radiological and Nuclear (CBRN) incidents	All events in which exposure to C, B, or R threat compounds cause great harm to the health of people, animals and/or the environment, as well as incidents in which N materials undergoing fission cause harm through dispersed radioactive fission products or by direct irradiation. Such incidents may be caused by an accident or an intentional act.
Chemical (C) threat compound	Chemicals that may pose a threat to humans or animals due to their toxic effects. **Note**. Numerous chemicals may pose a threat to humans, animals or the environment due to their toxicity, flammability or reactivity, or a combination of these properties. For the purpose of this project, C threat compounds are delimitated to those chemicals which pose a threat primarily due to their toxic effects.
Nuclear (N) material	Materials able to undergo fission, thereby creating radioactive fission products and giving off direct radiation.
Radiological (R) threat compound	All radioactive substances that can potentially be harmful if people are exposed. The determining factors are the rate and duration of the irradiation, and whether the exposure is internal or external.
Terrorism	The European Union's (EU) Council Framework Decision of 13 June 2002 on combating terrorism defines terrorism as intentional acts which "may seriously damage a country or an international organization" and are " committed with the aim of seriously intimidating a population, or unduly compelling a Government or international organization to perform or abstain from performing any act, or seriously destabilizing or destroying the fundamental political, constitutional, economic or social structures of a country or an international organization" (EU Council Framework Decision, 2002). The same definition was used by FOI in a 2006-report evaluating crisis management capacity in the EU (FOI, 2006)
Toxic chemical	Any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans, animals or plants. This includes all such chemicals, regardless of their origin or of their method of production, and regardless of whether they are produced in facilities, in munitions or elsewhere. (CWC, 1993). The spectrum of toxic chemicals is wide and continues to expand. It spans from highly toxic chemical warfare agents, *i.e*. nerve- and blister agents, to toxic industrial chemicals, pharmaceuticals, bioregulators and toxins.
Toxic Industrial Chemicals (TIC)	Toxic chemicals that are manufactured, stored, transported, and used throughout the world on a commercial basis.
Toxin	Highly toxic chemicals produced by living organisms. The possible illegitimate use of toxins is covered by the prohibitions of both the CWC and the BTWC, thus toxins are, in principle, both biological and chemical threat compounds. However, it is most common to include toxins among the biological threat compounds due to their biological origin.

4. Selection of scenarios

The following overall criteria were applied to arrive at the set of CBRN scenarios:

- The scenarios must either be inspired by or directly based on accidents (bad practice or failure), natural outbreaks or CBRN terrorism events that have occurred, or based on scenarios that have already been made publically available through other projects.
- The scenarios must cover a wide variety of emergency preparedness and response challenges for C, B, R and N incidents, respectively.
- All information in the scenario descriptions must solely be based on open source information.
- The scenario descriptions must be quite general and generic in order to be adaptable to a wide range of applications.
- Information which may turn the scenario descriptions into recipes must be avoided, *i.e.* how to obtain, construct or deliver threat compounds in an optimum way is not included.

As emphasized in Chapter 3.1, the selection of scenarios is not based on threat assessments, thus probabilities, actor capabilities, ease of production or availability of specific threat compounds have not been used as criteria to choose scenarios. Although the choice of scenarios implies that PRACTICE partners consider these incidents possible, the level of difficulty to actually carry out the intentional acts has not been assessed.

Table 2 gives an overview of CBRN scenarios from other relevant projects used in WP2, and Table 3 an overview of historical accidents and examples of CBRN terrorism, respectively. This information is used as a basis to choose and develop the PRACTICE scenarios, and is described in more detail in the PRACTICE D2.1 report (Endregard *et al.,* 2011), which also includes a complete list of references.

Table 2. Overview of unclassified and publically available scenarios from previous projects.

Project	Type of scenarios	Total no.	No. of C, B, R and N	References
EU project GSCT	C	9	9C	Cassel *et al*., 2007
EU project MASH	CR	6	4C, 2R	Cassel *et al*., 2008
EU project CIE Toolkit	CBR	7	5C, 1B, 1R	Cassel *et al*., 2011
Swedish report	CB	3	2C, 1B	Burman *et al*., 2000
US planning scenarios	CBRN	11	4C, 5B, 1R, 1N	Homeland Security Council, 2004
Stockholm planning scenarios	CBR	5	2C, 2B, 1R	Socialstyrelsen, 2006
Swedish planning scenarios	CBR	15	3C, 9B, 2R, 1N	MSB (Swedish Civil Contingencies Agency), 2010
Norwegian report	C	1	1C	Endregard *et al*., 2010

Table 3. Examples of historical cases of CBRN terrorism and accidents.

Type	Total no	Types	References
C terrorism	2	Sarin dispersal in Matsumoto in 1994 Sarin dispersal in Tokyo in 1995	Tucker, 2001 Tu, 2002 Tu, 2007
B terrorism	2	Dispersion of *Salmonella* in Oregon in 1984 Anthrax letters in the U.S. in 2001	Tucker, 2001 Department of Justice, 2010
C accidents	14	4 rail transport accidents 7 chemical plant/facility accidents	See D2.1 report: Endregard *et al.*, 2011
B accidents and outbreaks	4	Anthrax dispersal from B-laboratory in Sverdlovsk Food borne botulism in the UK (6 cases) Severe acute respiratory syndrome (SARS) outbreak in 2003 H1N1 influenza pandemic in 2009	See D2.1 report: Endregard *et al.*, 2011
R accidents	15	4 radiography equipment accidents 7 orphan source accidents 2 irradiation equipment accidents	See D2.1 report: Endregard *et al.*, 2011
N accidents	5	3 nuclear reactor accidents (Three Mile Island, Chernobyl, Fukushima) 2 criticality accidents (Sarov, Tokaimura)	See D2.1 report: Endregard *et al.*, 2011

The goal is to develop a limited set of scenarios which at the same time cover a broad range of emergency preparedness and response challenges following the placement, release and dispersion of C, B or R threat compounds. It is obvious that a scenario set cannot be comprehensive, but the ambition is to cover important aspects and be as representative as possible with a limited set of around ten scenarios.

Emergency preparedness and response challenges are closely linked to the properties of the various threat compounds and the environment and type of location of the incident. Hence, variations of threat compound characteristics and locations were used as the basic parameters for choice of scenarios. Both accidents and intentional acts are included. The incidents may be caused by accidents (technical failure, bad, practice, human error etc.), sabotage or terrorist acts.

The four chemical threat compounds vary from highly toxic chemical warfare agents to toxic industrial chemicals, from volatile to persistent chemicals, and from toxic chemicals with rapid onset of symptoms to delayed effects. The releases of toxic chemicals occur in densely populated locations, both in a building and in a city centre, in a village and in a river system which serves as water supply. The latter has international impact, thus requires international cooperation.

The three biological threat compounds cover both bacteria and viruses, contagious and non-contagious, environmentally highly stable pathogen versus more unstable pathogens. The incident types cover a potential for a pandemic, serious contamination of strategic buildings in capital cities with highly stable anthrax spores and a dispersion of contagious bacteria in food supply.

The two radiological scenarios encompass radiological threat compounds in the form a powder and an encapsulated metallic gamma radiation source. The scenarios cover accidental aerial dispersion of radioactive particles from a known source causing contamination problems in a city, and on the other hand a hidden radiation source exposing random bystanders. The latter causes symptoms which can be mistaken for other ailments, and therefore takes time to realise.

The nuclear accident scenario causes severe direct radiation problems at the facility as well as long-range dispersion of fission products. International impacts call for international emergency response.

After the anthrax attacks in the United States in 2001, Europe was flooded by powder letters, which fortunately all turned out to be hoaxes. The situation where a perceived threat must be verified or disproven is an important additional scenario, which also needs to be dealt with by emergency response services. Therefore, a scenario where unknown powder is discovered inside a building is also included among the scenarios.

Table 4 gives an overview of variations of threat compound characteristics and locations as the basic rationale for the choice of scenarios. These were identified by the WP2 participants during two meetings. These scenarios were further refined and developed to the current set presented in this report.

The reference set of eleven CBRN scenarios are summarized in Table 5. Table 6 gives an overview of the linkage between these scenarios and the historical incidents and scenarios published in previous relevant projects.

The eleven scenarios are described in short in Chapter 5 and in accordance with the PRACTICE scenario template (Endregard *et al.*, 2011) in Appendices I through VII.

Table 4. Variations of threat compound properties and locations as the basic rationale for choice of scenarios.

Type of scenario	Scenario outline	Threat compound and key properties	Environment/ location
Chemical	Highly toxic chemical dispersed in building	Sarin Liquid, volatile Rapid onset of symptoms	Indoor Building
	Persistent highly toxic chemical dispersed by explosion	Sulphur mustard Liquid, persistent Delayed onset of symptoms	Outdoor Urban area Local
	Pressurised TIC dispersed due to train derailment	Chlorine, ammonia or sulphur dioxide Toxic gas	Outdoor Local
	Industrial toxic waste released in river system	Cyanide salts Water soluble	Outdoor Water supply Regional
Biological	Respiratory virus disseminated in airplane cabin	Influenza A virus (H1N1) Contagious Pandemic potential	Indoor International transport system Global
	Anthrax spores disseminated by the postal system	*Bacillus anthracis* Non-contagious Stable, spores	Indoor Postal system Regional (multiple)
	Attack on food supply	Entero Hemorrhagic *Escherichia coli* (EHEC) Contagious	Food supply Regional
Radiological	Radiological dispersal due to explosion and fire	Caesium chloride powder Caesium-137	Outdoor Urban Local
	Hidden radioactive source in train	Encapsulated radiation source Iridium-192	Indoor Public transport
Nuclear	Nuclear power plant accident	Fission products	Outdoor Regional
Hoax	Unknown powder found in building	Unknown	Indoor Building

Table 5. Final selection of the PRACTICE reference set of CBRN scenarios.

Scenario	Title
C1	Chemical attack inside building – Sarin dispersal through ventilation system
C2	Chemical attack in city centre – Explosion and dispersion of sulphur mustard
C3	Chemical transport accident – Train derailment causing chlorine dispersal
C4	Chemical facility accident – Toxic waste release to river system
B1	Biological attack at airport – Influenza virus release in airplane
B2	Biological attack in buildings – Anthrax letters
B3	Biological attack on food supply – Bacterial contamination
R1	Radiological dispersal in city – Radioactive caesium spread in fire
R2	Radiological attack on public transportation – Hidden radioactive source
N1	Nuclear power plant accident – Release of fission products
H1	Hoax – Unknown powder in congress centre

Table 6. PRACTICE scenario linkages to historical incidents and scenarios in previous projects (Endregard *et al.*, 2011).

Scenario	Historical incident	Scenario - previous project
C1	Sarin dispersals (Japan) 1994 and 1995	CIE Toolkit scenario 1, US Planning scenario 7, Project Big City Stockholm scenario 2, scenario 3 in Burman 2000, GSCT scenario 5, Scenario in Endregard 2010
C2		MASH scenario 1, CIE Toolkit scenario 2, US Planning scenario 5
C3	Montana (USA) 1981, Minot (USA) 2002, Macdona (USA) 2004, Graniteville (USA) 2005, Kungsbacka (Sweden) 2005	MASH scenario 3, CIE Toolkit scenario 4, GSCT report Appendix 7
C4	Baia Mare (Rumania) 2000, Ajka (Hungary) 2010	
B1	H1N1 influenza pandemic 2009, SARS outbreak 2003	US Planning scenario 3
B2	Anthrax letters (USA) 2001	
B3	*Salmonella* Oregon (USA) 1984, EHEC outbreak (Germany) 2011	
R1		MASH scenario 5, CIE Toolkit scenario 5
R2	Gilan (Iran) 1996, Cochabamba (Bolivia) 2002, Nueva Aldea (Chile) 2005, India 2005	MASH scenario 6
N1	Three Mile Island (USA) 1979, Chernobyl (Soviet Union) 1986, Fukushima (Japan) 2011	Swedish risk and threat scenarios RN3
H1	Hoax powder letters (Europe) 2001	Swedish risk and threat scenarios B5

5. Reference set of scenarios

This chapter presents short summaries of the reference set of CBRN scenarios to be used in PRACTICE. The template and requirements developed in Task 1 of WP2 are used (see Endregard *et al.*, 2011). The second and third order challenges must be based on a consequence assessment of each scenario, thus are not included in the scenario descriptions in this report. These challenges will be added subsequent to consequence assessments and input from emergency personnel and stakeholders, and will be included in the third and last deliverable of WP2.

The scenarios will be used in PRACTICE to identify critical event parameters, key operational functions for emergency personnel, to develop the PRACTICE toolbox and identify crucial emergency response gaps. The scenarios may also be used in validation exercises and included in the training kits.

5.1 C1 Chemical attack inside building – Sarin dispersal through ventilation system

Historical cases of intentional use of toxic chemicals to cause mass casualties are fortunately very few, the sarin attack in Tokyo in 1995 by the doomsday cult Aum Shinrikyo being the most infamous (Tu, 2002). The cult members dispersed sarin in several Tokyo subway trains. A similar type of scenario is used by the US authorities as one of the national planning scenarios (The Homeland Security Council, 2004). This scenario is based on the above historical events, the U.S. planning scenario, as well as MASH WP4 scenario 4, “Dispersion of unknown toxic liquid in enclosed area”, and CIE Toolkit WP6 scenario 1, “Dispersion of toxic liquid in enclosed area”.

It is an example of indoor dispersion of the highly toxic nerve agent sarin in a large building. Sarin constitutes a representative example of a highly toxic, odour- and colourless, volatile nerve agent, causing rapid onset of symptoms even upon exposure to low concentrations, and thus serves as a challenging case for emergency personnel. Anticipated key emergency response challenges are: (i) the time factor due to rapid onset of symptoms, (ii) the large number of casualties and (iii) the possibly contaminated hazard scene.

The purpose of the scenario is to evaluate:

- The ability of the first responders to rapidly detect and identify the cause of the incident
- The response times and inter-agency cooperation and coordination
- The capacity of the health system to deal with a mass casualty event
- The availability and effectiveness of personal protective equipment and detection and identification systems
- The communication and information strategy towards the public
- Human and social effects

Scenario synopsis: Sarin is dispersed inside the ventilation system of a conference hall during an event attended by 1200 persons. Individuals carry out the attack by breaking into the main ventilation facility. A bottle of sarin is emptied in the ventilation shaft downstream of the heat exchanger. The sarin evaporates, mixes with air and is transported into the hall through ventilation inlets situated close to the ceiling. Mild intoxication effects occur within minutes, while serious injuries and fatalities occur approximately 20 minutes after the release. In recent months several incidents have raised the political temperature in the region. The intelligence services have raised the threat level and increased their international cooperation, but no specific threat against the convention centre has been made.

The description of this scenario is unclassified and included in Appendix I.

5.2 C2 Chemical attack in city centre – Explosion and dispersion of sulphur mustard

Several devastating terrorist bomb attacks have occurred in Europe, for example the London suicide bombings 7 July 2005, the Madrid train bombings 11 March 2004 and the Norway bombing 22 July 2011. What could the effects have been if a persistent toxic chemical was dispersed by an explosion in a city? This scenario is based on scenarios from previous EU projects; the MASH WP4 scenario 1, “Dispersion of persistent agent in urban area”, and the CIE Toolkit WP6 scenario 2, “Dispersion of persistent agent in urban area”.

The chemical warfare agent sulphur mustard was used extensively in the last part of World War I causing thousands of casualties. Since then it was produced and stockpiled as part of chemical weapons arsenals in many countries. During the period 1980-88, there were reports on extensive Iraqi use of sulphur mustard against Iran and in 1988 against its own population. In 1988 Iraq attacked Kurdish villages (Romano, 2008). Subsequent analysis of soil samples proved that sulphur mustard had been used as well as nerve gas (Black, 1994). Knowledge about sulphur mustard, other vesicants and their effects are widely available in the open literature. Sulphur mustard attacks the eyes, the respiratory system and bare skin causing temporary blindness and blisters. The effects are delayed. Symptoms occur 4-24 hours after exposure (Romano, 2008).

This scenario is included to illustrate several emergency preparedness and response challenges after an IED explosion dispersing a highly toxic and persistent liquid in an urban environment. The delayed symptoms of sulphur mustard add an extra difficulty for first responders and medical services. Also, the compound is persistent and will remain on buildings and vegetation for a prolonged period of time. Challenges include detection and assessment of the hazard area, tracking possible victims, dealing with and restoring the contaminated area, and secondary contamination of health care workers and facilities.

The purpose of the scenario is to evaluate:

- The ability of emergency services to handle a mass casualty event
- The ability and plans for registration and tracking of possible victims
- The communication and information strategy to inform the public and possible victims
- Inter-agency collaboration, including also non-governmental organizations

- The health system's ability, capacity and robustness to treat numerous casualties and deal with possible contamination
- Availability and effectiveness of individual protective equipment and detection and identification equipment
- Human and social impact
- The ability to identify the terrorist(s) and prevent further action

Scenario synopsis: It is a sunny Saturday afternoon in a European city. A concert attended by hundreds of spectators is just about to start. It is arranged in a big open square in the centre of the city. The concert is arranged by a news company. Suddenly a detonation is heard. The bomb blast and fragments causes several fatalities and about one hundred casualties. The detonation also disseminates about 5 kg of sulphur mustard in the form of small droplets. The slight breeze carries the cloud of droplets across the square. Droplets are inhaled and also deposited on persons and surfaces. This is, however, not noticed until casualties from the bomb blast, first responders and other persons experience eye irritation, inflammation of the respiratory tract and rashes and blisters on the skin.

There have been several threats against the news company and journalists who published controversial material. However, the police and the intelligence services have no information about the upcoming attack, thus no technical or security strengthening measures have been implemented. Some police and medical personnel are present for safety and security reasons during the concert according to normal procedures at such events.

The description of this scenario is Exempt from public disclosure and included in the Supplement to the D2.2 report.

5.3 C3 Chemical transport accident – Train derailment causing chlorine dispersal

All around the world, and on a daily basis, toxic chemicals are transported by train, road or on water. The transportation lines often pass through cities and other inhabited areas. Mass emergencies involving toxic chemicals are likely to cause an overwhelming burden on local rescue- and pre-hospital care systems. Close history shows that accidents related to transportation of toxic chemicals have happened. In the USA there have been several rail car accidents where chlorine release has caused a major challenge to local rescue operations (Festus in 2002, Macdona TX in 2004 and Graniteville in 2005). In 2005 a freight train derailed in Kungsbacka (Sweden). The train carried 12 wagons containing 65 tonnes of chlorine each. Fortunately none of the wagons were damaged. For more information on these historical incidents see Endregard *et al*. (2011). The scenario is inspired by the above accidents and the MASH WP4, scenario 3, "Release of toxic industrial chemical in open space".

This scenario will especially illustrate challenges in the emergency response systems connected to rapid release of toxic industrial gas (chlorine) in a populated area. If exposed to high concentrations, chlorine can be immediately fatal. Severely injured people will need immediate emergency care (respirators). Since serious medical symptoms like lung oedema can occur days after exposure, many victims must be monitored by health personnel. This will put a high pressure on the local and regional health care system.

The purpose of the scenario is to evaluate:

- The ability of authorities to alert, warn and advice the local population in a hazardous materials event
- The inter-agency collaboration between first responders, transport authorities, and others
- The management of the injured people and mobilization of resources
- The sufficiency of adequate individual protective equipment (IPE) and training
- Human and social impacts

Scenario synopsis: The accident occurs on a spring evening in early May when a freight train derails and collides with a parked locomotive at a train station. The train is carrying 14 wagons; five contain 65 tonnes of chlorine each. In the collision one of the chlorine wagons is punctured and the content is released during a period of 50 minutes. The main wind direction is straight towards the village living areas. Some variations in gas concentration will appear due to air turbulence, but the continuous release creates a plume of gas with relatively constant concentration. Since it is such a nice and warm spring evening, many of the villagers are enjoying life outdoors in their gardens.

The description of this scenario is unclassified and included in Appendix II.

5.4 C4 Chemical facility accident – Toxic waste release to river system

Among Europe's large rivers, the Rhine runs from high in the Swiss Alps through France and Germany, into the Netherlands, and out into the North Sea. About 50 million people live within that basin, and over 8 million rely on the river for drinking water. Like other rivers, including the Volga and the Danube, the Rhine has great commercial importance. These river basins are densely populated and heavily industrialized with metal manufacturing, as well as with chemical industry. Europe's large rivers and basins are also dotted with a worrying number of old factories and storage facilities.

Several major chemical spills and accidents have occurred previously. In 1986 a fire in a Swiss chemical manufacturing facility caused a major spill in the Rhine. The Danube was hit, both in Rumania 2000 and in Hungary 2010, by large toxic industrial spills (Enzler. 2006, Balkau, 2010, Dunai, 2010).

This scenario will identify critical challenges connected to major chemical spills in rivers and water systems. Major challenges will be linked to transnational response coordination and responsibilities. As far as we know, no similar scenario has been developed in previous EU-projects.

The purpose of the scenario is to evaluate:

- Transnational response coordination and responsibilities
- The alert routines, both at a national and international level

- The crisis management, i.e. effective decisions to mitigate consequences, national and international cooperation, communication to the public, communication to authorities in other relevant countries, the management of the injured people, the mobilization of resources and policies for medical treatment
- The human and social impact

Scenario synopsis: On an early September morning a reservoir wall at a large chemical factory breaks down. The factory is located close to a town with 50 000 inhabitants. Highly toxic waste hits the major river and sweeps away people and possessions. On its way, it also crushes a storehouse for agricultural chemicals. The flood sweeps cars off roads and damages infrastructure and houses. Downstream from the disaster site, the river runs through other villages and cities. The toxic chemicals form a yellowish plume in the river (30 km long) moving downwards at 3 km per hour. On its way to the sea, the river crosses several national borders.

The description of this scenario is unclassified and included in Appendix III.

5.5 B1 Biological attack at airport – Influenza virus release in airplane

This scenario is based on historical cases of naturally occurring flu pandemics such as the 1919 “Spanish flu” H1N1, the 1957-58 “Asian flu” H2N2, and the H1N1 pandemic which started in Mexico in 2009. Different alerts generated by the appearance of new influenza strains in humans were also considered, such as the transmission of H5N1 from birds to humans in Hong Kong in 1997 and 2003. The chaotic response of the Ontario public health system to the SARS (Severe Acute Respiratory Syndrome) in 2003 also provides useful data. Among these different pandemics, only the most ancient caused mass casualties. All were the source of tremendous economical costs. Although it has never happened before, the source of a pandemic could be intentional. This scenario is a fictitious intentional flu pandemic. An intentional act was assumed in order to increase the number of patients in the early stages, and introduce challenges regarding the investigation of intentional biological incidents.

The purpose of the scenario is to evaluate:

- The need for improved bio-security procedures at biological resource centers
- The early warning systems at national and international level and the actions aiming at blocking the spread of the pandemics, including track and trace of potentially infected persons and population warning systems
- The excellence in international coordination
- The harmonization of microbial diagnostic capacity in the EU and partner countries
- The harmonization of communication strategies at the international level, in particular media handling and communication of public procedures
- The mobilization of resources and policies for medical treatment and prophylaxis
- The human and social issues

Scenario synopsis: A junior scientist in North America steals a vial of H1N1 suspension at a faculty bio-safety level 3 (BSL3) facility. He prepares a spray device by introducing a high titer viral stock in a small size perfume flask (<100mL). His objective is to infect the passengers of the transatlantic flight to a middle size European capital that he will fly five days later, and thereby provoke a pandemic flu.

During the preparation of the device, the criminal scientist accidentally infects himself. Despite the development of the first symptoms, he passes the airport gate and sprays the viral suspension in different toilets of the aircraft during the flight. He is himself wearing a light model face mask commonly used by tourists.

The event is occurring in the month of July. National preparedness plans are in World Health Organization (WHO) phase 1, *i.e.* no animal influenza is reported to cause infection in humans.

The description of this scenario is Exempt from public disclosure and included in the Supplement to the D2.2 report.

5.6 B2 Biological attack in buildings – Anthrax letters

This scenario is based on the 2001 mail-borne anthrax attacks in the United States of America (USA), also known as Amerithrax from its Federal Bureau of Investigation (FBI) case name (Department of Justice, 2010). The FBI investigation concluded that a sole perpetrator had mailed letters containing anthrax spores to two Democratic Senators and media on two occasions. He was a microbiologist and anthrax expert working at the United States Army medical Research Institute of Infectious Diseases (USAMRIID). In total at least 22 persons contracted the anthrax disease, of which 11 cases were cutaneous anthrax and 11 the inhalational form. Five persons with inhalational anthrax died. Approximately ten thousand people underwent antibiotic treatment to prevent them from contracting the disease. The attack caused widespread contamination of mailrooms and public buildings. Some buildings were closed for years. The clean-up was extremely costly.

Despite the fact that European countries have treated thousands of suspected anthrax letters at a national level in the past ten years, the European response capacity has never been challenged with real attacks. In 2009 and 2010, outbreaks of anthrax among drug users in the United Kingdom (UK) and Germany resulted from accidental contamination.

The purpose of the scenario is to evaluate the ability of European countries to:

- Rapidly confirm the nature of the threat and to assess the risk.
- Implement medical countermeasures for protection of persons with proven and potential exposure to anthrax including mobilization of the pharmaceutical industry.
- Face closure of major public facilities and paralysis of postal distribution at a European scale.
- Rapidly identify the terrorist(s) and prevent further action.
- Harmonize communication strategies at the European level, in particular media handling and communication of public procedures.
- Define and apply standards for decontamination of contaminated infrastructures and re-occupancy decisions, including microbiological as well as health safety considerations.

Scenario synopsis: In a context of increasing international tension, the support of several European countries to a global military intervention against a third country is extensively debated at the national and European level. A radical group decides to influence European governments by launching a campaign of mail-borne anthrax attacks against governmental buildings in Europe.

With the support of an international terrorist's organization, the terrorists mail 54 letters containing anthrax spores to intermediate level civil servants at the ministries of defence and the main municipal buildings in the 27 EU capital cities. Following the international postal distribution lines, the letters reach their targets in the next days. Each anthrax letter includes a short message announcing mass release of aerosolized anthrax in European urban areas if any European state joins the military intervention. Official buildings where envelopes are detected are partly or completely evacuated. Samples are collected and sent for identification and confirmation of anthrax spores.

One envelope arrived damaged with only residual traces of anthrax powder, suggesting that contamination occurred along the distribution line. After a postal service clerk is diagnosed with anthrax disease, the most likely spot of contamination is later identified as a mail sorting machine at a major postal hub.

The description of this scenario is unclassified and included in Appendix IV.

5.7 B3 Biological attack on food supply – Bacterial contamination

Food and waterborne infectious diseases are a common cause of death in developing countries. In Europe, economical development has been associated with a continuous improvement of the safety of the food chain, from the production site to the fridge of the customer. Public health authorities are maintaining a wide spectrum of quality assurance and quality control measures including the prevention of microbial proliferation in food products. The recent outbreak of EHEC/STEC (Enterohemorrhagic group of *Escherichia coli* / Shigatoxigenic group of *Escherichia coli*) in Germany has demonstrated with 50 deaths and 4000 persons hospitalized that Europe is still vulnerable to food-borne epidemics. In the German case, difficulties encountered by the experts in rapid and non-ambiguous identification of the source combined with suboptimal communication has resulted in an unjustified ban on Spanish food products generating huge economical losses and challenging the EU cohesion.

The food chain would be a target of choice for bio-terrorists as demonstrated by the 1984 Rajneeshee bioterror attack in which food poisoning of more than 750 individuals in Oregon was obtained through the deliberate *Salmonella* contamination of salad bars at ten local restaurants (Endregard *et al*. 2011). This 1984 attack had only minor public health and political consequences due to limited virulence of the strain used. The efficiency of a bio-attack on the food chain using an enteropathogenic agent is indeed strongly depending on the pathogenicity of the agent as well as on the way the food is processed (washing, cooking, etc). Therefore, this scenario is addressing deliberate contamination of pre-washed salads.

The purpose of the scenario is to evaluate the ability to:

- Develop and maintain an early warning system for detection of food-borne epidemics
- Develop and maintain networks of microbiology laboratories able to quickly detect and identify pathogens and scale up their capacity
- Develop and maintain public health inspection teams able to quickly assess source of contamination
- Improve cross-sector collaboration for joint risk assessment and "one voice" communication to the citizens
- Rapidly identify the terrorist and prevent further action
- Ensure optimal European collaboration at an early stage, in particular regarding the crisis communication

Scenario synopsis: A small group contaminates pre-washed salads with a freeze-dried cocktail of EHEC/STEC bacteria characterized by unexpectedly high level of pathogenicity. Two members of the group manage to access the automated packaging equipment weighing and packaging bagged salad mixes (sold as "Ready for eating"). The terrorists do not claim the first series of attacks. They intend to repeat the attacks on a regular basis.

The description of this scenario is Exempt from public disclosure and included in the Supplement to the D2.2 report.

5.8 R1 Radiological dispersal in city – Radioactive caesium spread in fire

The starting point for this scenario is a real event; A major fire in a cancer treatment hospital in London in 2008. Several sources of radioactivity were on the premises, but no releases of radioactive material took place. However, what could the consequences have been if radioactive material had been released? The EU-projects MASH and CIE Toolkit have developed and used a scenario based on this incident assuming that radioactive particles were released. The MASH scenario 5: "Radiological dispersal in urban area" and CIE Toolkit scenario 5: "Release of radioactive material in urban area" are adapted and used here.

This scenario illustrates that an accidental fire in special facilities may disperse dangerous substances, not normally associated with fires.

The purpose of this scenario is to evaluate:

- The effectiveness of emergency authorities to detect and identify radioactive release
- The first responders' competence, training and equipment to deal with a radioactive release event
- The evacuation of patients
- The communication to the public regarding the nature of the threat and what to do
- The management of possibly contaminated people
- Collaboration between the Police, the radiation protection authorities and the hospital staff
- Human and social impacts

Scenario synopsis: A hospital is hit by an accidental fire which starts in the radiological clinic and spreads quickly. The risk that gas tubes could explode prevents proper fire-fighting. An explosion occurs minutes later. A radioactive caesium-137 (Cs-137) source is blown up, and the powder is dispersed by the blast. Radioactive particles mix with combustion gasses and smoke, and are dispersed in the neighbourhood.

The description of this scenario is unclassified and included in Appendix V.

5.9 R2 Radiological attack on public transportation – Hidden radioactive source

Radioactive sources have many industrial and medical applications. Sometimes radioactive sources have been lost from control, and subsequently posing a potential threat that the public may be exposed to radioactive radiation. There was a real event in India in 2005 where a disgruntled employee stole a source from his workplace and brought it unshielded on a train. In Bolivia 2002, there was a similar incident causing radiation exposure of public transport passengers, where a source was sent as cargo on a long distance passenger bus, and accidentally was left unshielded. The EU-project MASH has developed a scenario based on the India-incident; scenario 6 “Improvised radiation device in enclosed area”, and this scenario is adapted here.

The scenario outlines the challenge of a hidden radioactive source, where the exposed people are not aware of the fact. This leads to two different questions: How to find the people exposed, and how to decide who actually were exposed of those reporting as affected? Another difficulty is to estimate exposure doses. From the investigation point of view, it is important to find the origin of the source in order to find the perpetrators.

The purpose of this scenario is to evaluate:

- The emergency responders ability to detect, identify and secure the radioactive source
- The authorities ability to find people who may be exposed
- The ability to estimate exposure doses
- The investigators ability to find the origin of the source
- The crisis management, including communication to the public
- The human and social impacts

Scenario synopsis: A strong gamma emitting source is stolen from a shipyard by an employee, and subsequently purposely placed unshielded under a seat on a local train. The source lies undetected from early morning until it is removed as trash by cleaning staff in the evening. The cleaner develops blisters on the hands and seeks medical attention. The injuries, in conjunction with his report of handling a small metallic object, trigger the general practitioner’s suspicion of radiation damage. A team of radiation experts is sent to the trash collection area, localizes the source and removes it safely. The next day, the perpetrator anonymously claims responsibility for the incident.

The description of this scenario is Exempt from public disclosure and included in the Supplement to the D2.2 report.

5.10 N1 Nuclear power plant accident – Release of fission products

The nuclear accident known as the Three Mile Island accident in 1979 occurred in a pressurized water reactor (PWR) (3000 MWt (1000 MWe)). The reactor was fairly new and had only been operating for about three months. Due to a failure in the cooling system, the fuel elements started to melt, allowing radioactive gases and water soluble materials to be released into the cooling system. Overheating and production of hydrogen gas could have caused explosions in the reactor. However, the reactor containment vessel did not breach, and only relatively small amounts of radioactivity were released into the environment. The accident put auxiliary systems and crisis management plans on the test. Evacuation and remediation was necessary. The accident is described in more detail in Collins *et al*,(1982) and US NRC Backgrounder (2009). A nuclear accident and subsequent release of radioactive material from a nuclear plant could affect more than one country directly, as was demonstrated in the Chernobyl accident in 1986.

This scenario is inspired by the Three Mile Island accident and will give an opportunity to test and train international cooperation, alert-routines, effectiveness of international agreements, etc. for cross-border releases of radioactive material.

The purpose of the scenario is to evaluate:

- Alert-routines, both at a national and an international level
- The effectiveness of detection and identification systems
- Transnational response coordination, communication and responsibilities
- Communication and recommendations to the authorities and to the public
- The effectiveness of the crisis management (the management of the contaminated people, the mobilization of resources and policies for medical treatment, the decontamination of the infrastructure,)
- The human and social impact

Scenario synopsis: A commercial nuclear power plant (3 GW_t/900 MW_e PWR) experiences loss of coolant, with fuel melt-down as result. The reactor is situated in a populated area and close to two cities. The event starts in the early morning before normal work hours, and most people are in their homes.

A feed-water pump fails and steam builds up in the reactor. A relief valve opens, but does not close again, leading to loss of coolant. The operators misinterpret the instrument signals and reduce coolant flow rather than increasing it. The fuel overheats and the encapsulation bursts, releasing volatile fission products to the reactor building. Because of the reactor containment, only gases vent to outside environment.

The description of this scenario is unclassified and included in Appendix VI.

5.11 H1 Hoax – Unknown powder in congress centre

The threat or suspicion of dissemination of a hazardous CBRN material can be enough to inflict fear and call for emergency response actions. After the 2001 anthrax letters in the United States, numerous hoax “anthrax” letters were distributed in Europe. These letters had to be analyzed, and people were put on prophylactic antibiotic medication awaiting analyses results. Fortunately, all letters in Europe proved to be hoaxes. The incidents, however, caused huge costs and psychological effects. Also, they demonstrated the need for procedures and capacities to deal with contaminated mail, secure possibly contaminated areas and a capacity to quickly identify unknown samples.

This scenario is based on the hoax letter cases and other incidents were the police or other emergency services encounter unidentified suspicious material which must be dealt with.

The scenario takes place in a major congress centre during a large political meeting. An activist group calls in a threat and also disseminates an unknown suspicious material in the centre. The purpose of the scenario is to address:

- Preparation of the local facility manager and security officers for a high-profile event
- Collaboration between private and public services
- Ability to manage large cohorts of potential victims
- Decisions and communication about the risk and countermeasures including quarantine, decontamination, prophylaxis or simply registration of potentially exposed to an unknown threat compound (C, B and/or R)
- Procedures, organization and capacities for rapid analysis and identification of unknown samples (C, B and/or R)
- Ability to quickly distinct hoaxes from real threats

Scenario synopsis: Two months before the elections for a European Parliament, a political party is organizing a meeting at a congress centre in the middle of a large city. The congress centre has a local facility manager and security staff with instructions to alert the emergency services in case of any suspicious incidents.

The night before the meeting a group of activists places yellow powder inside three mobile air condition units inside the conference rooms. In the middle of the congress day, the facility manager receives a phone call claiming that a number of disseminating devices have released toxic and infectious agents in different locations in the congress center. In parallel, security staff accidently finds yellow powder in a mobile air condition unit. The facility manager immediately informs the emergency services.

The description of this scenario is unclassified and included in Appendix VII.

6. Conclusions and further work

This report constitutes the second deliverable of WP2 in PRACTICE and presents the set of CBRN reference scenarios developed for use in the PRACTICE project. However, the scenarios can also be used by first responders and authorities for emergency preparedness planning, open discussions, education, training and demonstrations. The scenarios can be included in training kits and manuals for first responders and others.

The Reference set of CBRN scenarios covers the releases of hazardous chemical (C), biological (B) and radiological (R) substances. The scenarios are developed based on real accidents and CBRN terrorism events that have occurred. The scenarios are also inspired by scenarios that have been made publically available through other EU-projects. All the information provided in the scenario descriptions are solely been based on open source information, and the scenarios are on purpose kept quite generic and general, but with sufficient detail for the user to be able to adapt and expand the scenario. The intention is that these scenarios can be adapted and specified in more detail dependent on the purpose. For instance, for use in exercises the scenarios form the basis for the storyline development and exercise injects. To do so, local specific background information is needed. Based on who the players are, information is required on the resources available, operational functions, the emergency response actors and their organization and equipment. Also, assumptions on how it is likely that events will unfold should be used to prepare exercise injects.

The remaining deliverable of WP2 is “Consequence assessments of the selected set of reference CBRN scenarios and critical event parameters”. The second and third order challenges will be included in this third and last deliverable in WP2.

7. List of abbreviations

AEGL	Acute Exposure Guideline Levels
BSL3	Bio-safety level 3
BTWC	Biological and Toxin Weapons Convention
Bq	Becquerel, (event) per second, the SI unit for radioactivity
CIE Toolkit	Chemical Incidents Emergencies Toolkit
CBRN	Chemical, Biological , Radiological, Nuclear
Co-60	Cobalt-60, a radioactive isotope
Cs-137	Caesium-137, a radioactive isotope
CWC	Chemical Weapons Convention
ECDC	European Centre for Disease Prevention and Control
ECt_{50}	Effective Concentration time 50 % (The inhalation dose that for exposure time, t, causes mild effects (miosis or rhinorrhea) in 50 % of the exposed population.)
EFSA	European Food Safety Authority
EHEC	Entero-Hemorrhagic *Escherichia coli*
EU	European Union
FBI	Federal Bureau of Investigation
FFI	Forsvarets forskningsinstitutt (*Eng.* Norwegian Defence Research Establishment)
FOI	Totalförsvarets forskningsinstitut (*Eng*. Swedish Defence Research Agency)
GSCT	Generic Scenarios on Release of Chemicals by Terrorists
HVAC	High Ventilation and Air Conditioning
I-131	Iodine-131, a radioactive isotope
IAEA	International Atomic Energy Agency
IATA	International Air Transport Association
IDLH	Immediately Dangerous to Life and Health
IPE	Individual protective equipment
Ir-192	Iridium-192, a radioactive isotope
KCL	King's College London
LCt_{50}	Lethal Concentration time 50 % (The inhalation dose that for exposure time, t, produces lethal effects in 50 % of the exposed population.)
LD_{50}	Lethal Dose 50 %. (The dose that produces lethal effects in 50 % of the exposed population.)
MASH	Mass casualties and health care following the release of toxic chemicals and radioactive material
mGy	Milligray, 10^{-3} gray, a unit for radiation dose

mGy/h	Milligray per hour, a unit for radiation dose rate
mSv	Millisievert, 10^{-3} Sievert, a unit for radiation dose
mSv/h	Millisievert per hour, a unit for radiation dose rate
MSB	Myndigheten för samhällsskydd och beredskap (*Eng.* Swedish Civil Contingencies Agency)
MW_e	Megawatt electric
MW_t	Megawatt thermal
OPCW	Organisation for the Prohibition of Chemical Weapons
PRACTICE	Preparedness and Resilience Against CBRN Terrorism using Integrated Concepts and Equipment
PWR	Pressurized water reactor
RDD	Radiological dispersal device
RED	Radiological embedded device
SARS	Severe acute respiratory syndrome
SGSP	Main School of Fire Service
SI	International system of units
TBq	Terabecquerel, 10^{12} Bq
TIC	Toxic industrial chemicals
TNO	The Netherlands Organisation for Applied Research
U-235	Uranium-235, a radioactive and fissile isotope
UK	United Kingdom
USA	United States of America
USAMRIID	United States Army medical Research Institute of Infectious Diseases
WHO	World Health Organization
WNA	World Nuclear Association
WP	Work Package

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I Appendix C1

Scenario C1	
Chemical attack inside building – Sarin dispersal through ventilation system	
Scenario justification	
Historical cases of intentional use of toxic chemicals to cause mass casualties are fortunately very few, the sarin attack in Tokyo in 1995 by the doomsday cult Aum Shinrikyo being the most infamous (Tu, 2002). The cult members dispersed sarin in several Tokyo subway trains. A similar type of scenario is used by the US authorities as one of the national planning scenarios (The Homeland Security Council, 2004). This scenario is based on the above historical events, the U.S. planning scenario, as well as MASH WP4 scenario 4, "Dispersion of unknown toxic liquid in enclosed area", and CIE Toolkit WP6 scenario 1, "Dispersion of toxic liquid in enclosed area". It is an example of indoor dispersion of the highly toxic nerve agent sarin in a large building. Sarin constitutes a representative example of a highly toxic, odour- and colourless, volatile nerve agent, causing rapid onset of symptoms even upon exposure to low concentrations, and thus serves as a challenging case for emergency personnel. Anticipated key emergency response challenges are: (i) the time factor due to rapid onset of symptoms, (ii) the large number of casualties and (iii) the possibly contaminated hazard scene. The purpose of the scenario is to evaluate: • The ability of the first responders to rapidly detect and identify the cause of the incident • The response times and inter-agency cooperation and coordination • The capacity of the health system to deal with a mass casualty event • The availability and effectiveness of personal protective equipment and detection and identification systems • The communication and information strategy towards the public • Human and social effects	
Scenario outline	
The highly toxic nerve agent, sarin, is dispersed inside the ventilation system of a conference hall during an event attended by 1200 persons. Individuals carry out the attack by breaking into the main ventilation facility. A bottle of sarin is emptied in the ventilation shaft downstream of the heat exchanger. The sarin evaporates, mixes with air and is transported into the hall through ventilation inlets situated close to the ceiling. Mild intoxication effects occur within minutes, while serious injuries and fatalities occur approximately 20 minutes after the release. In recent months several incidents have raised the political temperature in the region. The intelligence services have raised the threat level and increased their international cooperation, but no specific threat against the convention centre has been made.	
Cause	
Intentional (Yes/No/Both)	Yes
Profile of actor (if intentional)	Actor characteristics and motives are not a research topic of PRACTICE. The project draws on available analyses of historical incidents, in this case the chemical terrorist attacks in Japan.

	The religious doomsday sect Aum Shinrikyo which performed the sarin attacks in Matsumoto (1994) and Tokyo (1995) was established by Shoko Asahara in 1984. At the time of the attacks, the active core members consisted of about 1 400 persons who donated all property to the cult and lived on the cult's premises. The cult had substantial economic resources and many followers with technical-scientific background, thus the resources, competence and ambition to produce chemical and biological threat compounds. The cult used highly toxic substances such as the nerve agent VX to assassinate persons who left the cult. The cult experimented with both biological and chemical agents. From early 1990 the cult started experimental production of both C and B agents. The use of the biological threat agents botulinum toxin and anthrax bacteria did not succeed. The cult built a sophisticated facility for mass production of sarin in tonne quantities and had purchased huge amounts of precursor chemicals. The facility never started full production due to police investigations. Prior to the 1995 attacks the cult quickly produced sarin, which fortunately was unpure.
Description of cause	The possible motive for perpetrators to conduct a chemical attack like this is not known. The PRACTICE project can only draw upon the analyses of the incidents in Japan. The Aum Shinrikyo cult's direct motive for the 1995 attack was to stop police investigations against the cult's activities by attacking the subway station closest to the Tokyo Metropolitan Police headquarters.
Competence and resources	Competence and equipment for chemical synthesis is needed. This includes chemical precursors, laboratory equipment and facilities, and personal protective equipment.
Threat compounds and their properties	
Threat compounds	Sarin, GB, isopropyl methylphosphonofluoridate
Properties	Clear, colourless and tasteless liquid with no odour in pure form. Boiling point 147 ºC. The toxicity estimates (70 kg human) are:

Toxicity	Route and form of exposure	Exposure time (min)	Estimated value (mg min m^{-3})	Minute volume (l min^{-1})
ECt_{50} [a]	Inhalation and ocular, vapour	2 - 10	2	-
LCt_{50} [b]	Inhalation, vapour	2	36	15
LCt_{50} [b]	Inhalation, vapour	10	57	15
LCt_{50} [b]	Inhalation, vapour	30	79	15

	[a] The inhalation dose that for exposure time, t, causes mild effects (miosis or rhinorrhea) in 50 % of the exposed population. [b] The inhalation dose that for exposure time, t, produces lethal effects in 50 % of the exposed population.
Medical symptoms	Symptoms of intoxication are impaired vision (pin-point pupils, *i.e.* miosis), dizziness, headache, vomiting, runny eyes and nose, bloody secretion from mouth, diarrhoea, fasciculation, convulsions, then respiratory arrest and death. Symptoms occur within seconds and minutes.
Availability	Not commercially available. Must be synthesized. Precursor chemicals are subject to export control measures under the Chemical Weapons Convention (CWC) and the Australia Group lists. However, these mechanisms can be circumvented. Production is not straightforward, but possible.
Dissemination	
Amount	The total amount of sarin dispersed is 0.42 kg
Release mechanism	Liquid spill in the ventilation shaft, subsequent evaporation and dispersal through the ventilation inlets.
Equipment	No special equipment needed for dissemination.
Physical state	Liquid which evaporates.
Fate	Sarin vapour will be transported through the ventilation system of the building.
Location	
Location description	Large convention hall. Permanently open access doors to other parts of the centre.
Weather	Cold winter/autumn conditions. Inlet air in the ventilation system is heated (16 ºC). The indoor temperature is 20 ºC.
Population at risk	1200 persons are inside the building. The attack occurs at a tourism trade fair. The population is a mixture of mostly healthy adults in all ages and some children. A CBRN incident has never happened before in this country, and the population at risk is unprepared. The population can be expected to obey police and other authorities' orders in crisis situations. (Note that the compliance may vary between different countries (Ref CIE Toolkit research by King's College London)).
Time	Daytime, during the convention.
Other	

Indication or alert	
Announcement	No announcement is given by the perpetrators. The intelligence services have no specific information about the attack, thus no pre-warning is given.
Observations	The attack is not observed or heard.
Detection	If no detectors are in place, the indications of the attack will be observed symptoms. Exposed persons will quickly show symptoms.
Alert	Attendees will show signs of exposure to sarin, which can be mistaken for a heart attack. First responders will be called. The local security staff will initiate the fire alarm in order to open doors and evacuate the building.
Local safety and security measures	Camera surveillance, evacuation procedures, central fire alarm and associated procedures.
Possible consequences and development	
Reference time	Time zero is defined as the time when the medical dispatch centre receives the first call.
Minutes	Sarin will spread inside the building through the ventilation inlets. Casualties and fatalities will occur. People will start to evacuate the building. Fire alarm is triggered. First responders will arrive at the scene and realize that the incident is an attack due to the number and nature of casualties. The incident commander informs the authorities and the general public about the attack in accordance with the planned crisis communication strategy.
Hours	Sarin vapour will be purged from the building. First responders will complete their tasks.
Days	The investigation will confirm sarin as causative agent. Building will be physically restored.
Months	Some casualties will experience long term medical effects and need long-term medical care. Post-traumatic stress disorder for many of the affected persons. Other psychological effects in the general population.

1st order challenges	
Directly affected population	About 25-50% (300-600) of the population within the facility becomes casualties within the first 10 to15 minutes. There are no casualties external to the building. Incapacitated people may remain in the building and die consecutively. Mobile intoxicated persons are confused and disorientated. Crowding at exits during evacuation of the building may cause secondary injuries. It is likely that those around the immediate perimeter of severe contamination assist the seriously affected (Drury *et al.*, 2009).
First responders Are there plans, methods, equipment, procedures and training available?	Technical measures • Individual protective equipment (IPE) • Detection equipment • Sampling equipment and procedures • Laboratories for identification • Decontamination (if needed) • Perimeter for possible contaminated area must be established and closed off to public (safety zone) • Forensic work Casualty care • Extract the victims from the hot zone • Registration • Decontamination • Triage and first aid • Transport of casualties to hospitals Organisation • Chain of command • Clear division of responsibilities Communication • Emergency services communication • Crisis information • Media communication
Health services	Preparedness to deal with casualties or fatalities among the first responders. Availability of drugs and medical treatment capacity. Plans for alternative locations and handling of worried well. Strategy for health advice which should include: 1) What to do if you are certain you were in the area and exposed; 2) What to do if you think that you were exposed/in the area; and 3) What to do if you were not exposed/in the area. Also, make it clear that exposure MUST take place for individuals to be at risk.

Command and control centre	Coordinating response. Methods and procedures for keeping abreast with the development. Communication and resolving practical difficulties between different emergency response organizations.
Site/building/ infrastructure stakeholder(s)	Evacuation plans. Building restoration capacities.
Other authorities	Police investigation and forensic work. Inter-agency communication and cooperation. Correct and verified information to the public and the media. Establishment of crisis centers for relatives and the public. Local and national government.
Media	Plans for cooperation. Advice to the public; both health advice (facts, exposure pathways, concrete advice on what to do) and repeated updates on the unfolding situation (police investigation for terrorism; numbers impacted; etc.).
Infrastructure	Possible physical effects. Establish the possible need for decontamination. Availability of methods for verification of contamination and safe levels by sampling and identification before restoration of the building.
Environment	Assessment of the risk and duration of contamination.
Authorities in other countries	Plans for cooperation with and aid from other countries. Availability of equipment and medical treatment. Possible health issues of citizens in the area. Short and long-term health impacts/support for these individuals upon their return to their home countries.
International organisations	Knowledge of possible support. The Organisation for the Prohibition of Chemical Weapons (OPCW) in the Hague has a capacity to provide expert advice, send experts and analyse samples at designated laboratories.

References	
Relevant literature	Tu A. A. (2002), “Chemical Terrorism: Horrors in Tokyo Subway and Matsumoto City”, Alaken, Inc., Fort Collins, CO. The Homeland Security Council (2004), “Planning Scenarios, Executive Summaries”, July 2004, http://www.globalsecurity.org/security/library/report/2004/hscplanning-scenarios-jul04 exec-sum.pdf (accessed 6 August 2008). Endregard M., Reif B. A. P., Vik T., Busmundrud O. (2010), “Consequence assessment of indoor dispersion of sarin—A hypothetical scenario”, *Journal of Hazardous Materials* **176,** 381–388. Rogers M. B., Amlot R., Rubin G. J., Wesseley S., Krieger K. (2007), “Mediating the social and psychological impacts of terrorist attacks: The role of risk perception and risk communication”, *International Review of Psychiatry*, **19**, (3. June 2007), 279-288. Drury, J., Cocking, C., Reicher, S. (2009) “Everyone for themselves? A comparative study of crowd solidarity among emergency survivors”, *British Journal of Social Psychology*, **48**, 487-506.

II Appendix C3

Scenario C3	
Chemical transport accident – Train derailment causing chlorine dispersal	
Scenario justification	
All around the world, and on a daily basis, toxic chemicals are transported by train, road or on water. The transportation lines often pass through cities and other inhabited areas. Mass emergencies involving toxic chemicals are likely to cause an overwhelming burden on local rescue- and pre-hospital care systems. Close history shows that accidents related to transportation of toxic chemicals have happened. In the USA there have been several rail car accidents where chlorine release has caused a major challenge to local rescue operations (Festus in 2002, Macdona TX in 2004 and Graniteville in 2005). In 2005 a freight train derailed in Kungsbacka (Sweden). The train carried 12 wagons containing 65 tonnes of chlorine each. Fortunately none of the wagons were damaged. For more information on these historical incidents see Endregard *et al*. (2011). The scenario is inspired by the above accidents and the MASH WP4, scenario 3, “Release of toxic industrial chemical in open space”. This scenario will especially illustrate challenges in the emergency response systems connected to rapid release of toxic industrial gas (chlorine) in a populated area. If exposed to high concentrations, chlorine can be immediately fatal. Severely injured people will need immediate emergency care (respirators). Since serious medical symptoms like lung oedema can occur days after exposure, many victims must be monitored by health personnel. This will put a high pressure on the local and regional health care system. The purpose of the scenario is to evaluate: • The ability of authorities to alert, warn and advice the local population in a hazardous materials event • The inter-agency collaboration between first responders, transport authorities, and others • The management of the injured people and mobilization of resources • The sufficiency of adequate individual protective equipment (IPE) and training • Human and social impacts	
Scenario outline	
The accident occurs on a spring evening in early May when a freight train derails and collides with a parked locomotive at a train station. The train is carrying 14 wagons; five contain 65 tonnes of chlorine each. In the collision one of the chlorine wagons is punctured and the content is released during a period of 50 minutes. The main wind direction is straight towards the village living areas. Some variations in gas concentration will appear due to air turbulence, but the continuous release creates a plume of gas with relatively constant concentration. Since it is such a nice and warm spring evening, many of the villagers are enjoying life outdoors in their gardens.	
Cause	
Intentional (Yes/No/Both)	No
Profile of actor (if intentional)	Not applicable

Description of cause	Train derailment and collision with a parked locomotive causing rupture of chlorine wagon.
Competence and resources	Not applicable
Threat compounds and their properties	
Threat compounds	Chlorine (Cl_2)
Properties	Pressurised liquefied toxic gas. Yellow-green colour, pungent characteristic odour. Low boiling point (- 34ºC). Toxicity threshold concentration limits for chlorine (estimated for an exposure time of 10 min) are: IDLH (immediately dangerous to life and health) concentration: 10 ppm, 29 mg/m^3 (Ref. http://www.cdc.gov/niosh/npg/npgd0115.html) Acute Exposure Guideline Levels (AEGL) (EPA, 2010): AEGL 1 = 1.5 mg/m^3 AEGL-2 = 8.1 mg/m^3 AEGL-3 = 145 mg/m^3 AEGL-1 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure. AEGL-2 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape. AEGL-3 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.
Medical symptoms	Immediately fatal (minutes) if exposed to high concentration; lung oedema and suffocation. Irritant and corrosive to eyes, respiratory system and skin. Risk for permanent pulmonary effects and eye injuries. Lung oedema, chemical induced pneumonia and pleurisy can occur up to a few days after the exposure. Severely injured needs immediately emergency care. People that are lightly injured will have symptoms as eye irritation and breathing pathways with cough and chest pain. These people will likely seek medical care because the symptoms are very bothering. The effects can be delayed and the patients will be kept under medical observation for 48 hours.
Availability	Common industrial chemical which is used for water purification,

	production of polymers, and many other industrial processes. Often stored and transported as liquefied gas under pressure. Transported both by road and rail.
Dissemination	
Amount	One wagon containing 65 tonnes of chlorine is damaged. 45 tonnes of chlorine (a mixture of gas and liquid) is released from the wagon during a period of 50 minutes.
Release mechanism	Leakage through a hole (0.005 m^2) in one of the chlorine railcars (liquid phase).
Equipment	Not applicable.
Physical state	Pressurised liquefied gas (6 atm)
Fate	Highly toxic chlorine gas release will create a plume of gas moving straight forward to village living area, giving constant concentration at given distances. Will quickly disperse.
Location	
Location description	Train station located in a middle sized village. The village is surrounded by open farm land.
Weather	Temperature 17 ºC, wind speed 5m/s.
Population at risk	2000 village residents are at risk, especially people that are outdoors (ca 400).
Time	19:00, Friday, spring evening.
Other	
Indication or alert	
Announcement	Not applicable.
Observations	Train collision is seen and heard by people in the vicinity of the train station. The release immediately creates a visible yellow cloud. The railcars are marked in accordance with dangerous goods transport regulations.
Detection	Pungent characteristic smell, even at low concentrations, and visible cloud.
Alert	First responders will detect the gas by the strong chlorine smell and possibly symptoms on the exposed people.
Local safety and security measures	Local general warning routines and local first responder’s procedures are in place.

Possible consequences and development	
Reference time	Time of alert to rescue services is approximately 19:02.
Minutes	Severe injuries will appear immediately when the toxic gas cloud passes people and animals that are outdoors, i.e. at the train station and in the village and nearby fields. Village people will react when they smell the strong chlorine odour and feel the symptoms of exposure. Some people will start running and self evacuate, some hide indoors and some will move closer to the scene driven by curiosity or the need to rescue dear ones. First responders will arrive on scene. The rescue services manage to make relevant technical counter measures to diminish the dispersion to air after 50 minutes.
Hours	The smell of chlorine can remain in the area for a couple of hours, indoors even longer. The gas disperses gradually to the surroundings. The risk distance (30 min exposure) for severe injuries is about 1.4 kilometres, light injuries approximately 2.4 kilometres. No new injuries will occur after the initial phase, but victim's conditions can continue to deteriorate.

Injury level	Risk distance (m)*				
	5 min exposure	30 min exposure			60 min exposure
	outdoor	outdoor	indoor		outdoor
			0,5 vent	0,1 vent	
lethal	300	450	150	30	500
severe	800	1400	400	150	1700
light	1300	2400	600	250	3000
irritation	4000	5500	1500	700	10000

* Risk distance = Outside given distance it is unlikely to find injured people in that category

Days	There will be a very high pressure on local/regional health care system. Serious medical symptoms like lung oedema can occur days after exposure, thus many victims must be monitored by health personnel.
Months	Continuing pressure on health service/hospitals. Many parents are worried about long term effects on their children's health.
1st order challenges	
Directly affected population	Fatalities: Train driver, three train station workers and 10 village residents. Severely injured: 350 village residents Lightly injured: 1500 village inhabitants and 20 first responders
First responders	Technical measures

Are there plans, methods, equipment, procedures and training available?	• Individual protective equipment (IPE) • Stop the gas release • Establishment of the perimeter for the possible hazardous area and cordons (safety zone) • Forensic work <u>Casualty care</u> • Extract the victims from the hot zone • Registration • Decontamination (if necessary) • Triage and first aid • Transport of casualties to hospitals <u>Organisation</u> • Chain of command <u>Communication</u> • Emergency services communication • Crisis information • Media communication <u>Property</u> • Farm animals at risk • Pets at risk <u>Environment</u> • Wildlife at risk
Health services	Mass casualty response plan, including availability of respirators Decontamination equipment and procedures available if necessary
Command and control centre	Emergency communication Logistics and coordination of resources Media communication
Site/building/infrastructure stakeholder(s)	Warning and evacuation of people from train station Alerting and supporting the first responders Alert and stop or redirect incoming trains
Other authorities	Local authorities/crisis management plan
Media	Media communication Information to the public from authorities
Infrastructure	Traffic and pedestrian management Temporary food and accommodation Overload of mobile phone system
Environment	If exposed, fauna can be severely affected

Authorities in other countries	Not applicable.
International organisations	Not applicable.
References	
Relevant literature	Cassel,G.; Eriksson, H.; Sandström, B. (2008): *Mass-casualties and health care following the release of toxic chemicals or radioactive materials. Scenarios.* Swedish Defense Research Agency, FOI U.S Chemical Safety and Hazard Investigation Report Board. 2002:30-31. “Investigation Report. Chlorine release”. Report No.2002-04-1-MO. May 2003 Mitchell, J. T. et al (2005): *Evacuation behavior in Response to the Graniteville, South Carolina*. University of South California, www.colorado.edu/hazards/reasearch/qr/qr178.pdf Eriksson, H., Persson, S-V., Berglind, R., Cassel, G. (2007): *Tågurspårningen I Kungsbacka 2005-02-28. En genomgång av beredskapen om det som inte hände-ändå hade hänt.* FOI report, R-SE, 2007 United States Environmental Protection Agency (EPA) (2010), "Acute Exposure Guideline Levels (AEGLs)”, www.epa.gov

III Appendix C4

Scenario C4	
Chemical facility accident – Toxic waste release to river system	
Scenario justification	
Among Europe's large rivers, the Rhine runs from high in the Swiss Alps through France and Germany, into the Netherlands, and out into the North Sea. About 50 million people live within that basin, and over 8 million rely on the river for drinking water. Like other rivers, including the Volga and the Danube, the Rhine has great commercial importance. These river basins are densely populated and heavily industrialized with metal manufacturing, as well as with chemical industries. Europe's large rivers and basins are also dotted with a worrying number of old factories and storage facilities. Several major chemical spills and accidents have occurred previously. In 1986 a fire in a Swiss chemical manufacturing facility caused a major spill in the Rhine. The Danube was hit, both in Rumania 2000 and in Hungary 2010, by large toxic industrial spills (Enzler. 2006, Balkau, 2010, Dunai, 2010). This scenario will identify critical challenges connected to major chemical spills in rivers and water systems. Major challenges will be linked to transnational response coordination and responsibilities. As far as we know, no similar scenario has been developed in previous EU-projects. The purpose of the scenario is to evaluate: • Transnational response coordination and responsibilities • The alert routines, both at a national and international level • The crisis management, i.e. effective decisions to mitigate consequences, national and international cooperation, communication to the public, communication to authorities in other relevant countries, the management of the injured people, the mobilization of resources and policies for medical treatment) • The human and social impact	
Scenario outline	
On an early September morning a reservoir wall at a large chemical factory breaks down. The factory is located close to a town with 50 000 inhabitants. Highly toxic waste hits the major river and sweeps away people and possessions. On its way, it also crushes a storehouse for agricultural chemicals. The flood sweeps cars off roads and damages infrastructure and houses. Downstream from the disaster site, the river runs through other villages and cities. The toxic chemicals form a yellowish plume in the river (30 km long) moving downwards at a speed of 3 km per hour. On its way to the sea, the river crosses several national borders.	
Cause	
Intentional (Yes/No/Both)	No
Profile of actor (if intentional)	Not applicable.
Description of cause	Direct cause: break in reservoir wall. Indirect cause: strong rumours of factory managements' maintenance avoidance

	due to private economical interests.
Competence and resources	Not applicable
Threat compounds and their properties	
Threat compounds	A “cocktail” of toxic chemicals (organic mercury, agricultural chemicals, cyanide etc.). It will take some time before laboratory tests will be able to tell exactly what kinds of chemicals the toxic waste contains.
Properties	Coloured (yellowish) liquid waste water with a bad smell.
Medical symptoms	Burns and eye ailment if skin contact.
Availability	Many possible sites storing liquid waste.
Dissemination	
Amount	Large amounts of toxic waste water.
Release mechanism	Break in reservoir wall.
Equipment	Not applicable.
Physical state	Liquid mixed toxic chemical waste water.
Fate	Toxic chemical spill reaches the large river, and contaminated water crosses several national borders.
Location	
Location description	Industrial toxic waste water reservoir close to major river and city with 50.000 inhabitants.
Weather	Cloudy, temperature 12 ºC.
Population at risk	Immediately at risk: Workers in the factory area, and all people between the toxic waste reservoir and the river Subsequently at risk: All people directly or indirectly utilizing river water
Time	06:30, work day.
Other	The river is major water supply for people living in the area.
Indication or alert	
Announcement	No
Observations	Huge flood of toxic wastewater from reservoir hits and destroys everything in its way close to the site.

Detection	Colour and smell, symptoms on skin (bruises), eyes (running), vomiting, headache, dizziness.
Alert	Local authorities raise the alarm (civil defence siren) after being notified by first responders (fire department). Authorities issue a warning to monitoring stations downstream. No exact info on what kinds of toxic chemicals the flood contains.
Local safety and security measures	Local warning routines must be in place. Contaminated areas need to be closed off to public access.
Possible consequences and development	
Reference time	Time zero is at 06:30 when the reservoir wall breaks.
Minutes	When the reservoir wall gives in, a tide of toxic water hits the nearby environment and buildings. First responders reach the flooded area and start to rescue people.
Hours	First responders try to rescue people that are stuck in crushed buildings and cars. They must wash off chemicals on exposed people and animals and evacuate people trapped in contaminated living areas close to the accident site. Still several persons are missing. Other tasks are to alert local and national health services and warn neighbouring countries. First responders observe symptoms on victims, rescued workers and people living close to the accident. Livestock (cows and sheep) are also affected. Local authorities add substances to the river to reduce the toxicity. There is immense media pressure. Other countries' authorities take actions to prevent people and industry from using the contaminated water. Water samples are sent for laboratory analysis and identification.
Days	A lot of dead, injured and contaminated wildlife (fish and birds) found near and in the river Fisheries are affected. Breweries and other industry using river water in production are affected.
Months	Toxic chemicals settled in the sediments of the river, especially close to the point of discharge. Exposed people are scared of moving back. Lost trust in waste industry company, politicians and local authorities. Company managing director detained on suspicion of crime.

	Tourist industry shut down. The river is still polluted downstream.
1st order challenges	
Directly affected population	Workers at the chemical facility reservoir and people in the close vicinity when the accident occurs (toxic tide/flood) 12 people are killed and 50 people severely injured. Several persons are missing.
First responders Are there plans, methods, equipment, procedures and training?	Technical measures • Individual protective equipment (IPE) • Perimeter for possible contaminated area must be established and closed off to public (safety zone) • Forensic work • Public water supplies should be shut down Casualty care • Extract the victims from the hot zone • Registration • Decontamination • Triage and first aid • Transport of casualties to hospitals Organisation • Chain of command • Security measures (if intentional) Communication • Emergency services communication • Crisis information • Media communication Property • Livestock at risk Environment • Wildlife at risk
Health services	Decontamination necessary? Mass casualty response plan
Command and control centre	Emergency communication Logistics and coordination of resources Media communication
Site/building/infrastructure stakeholder(s)	Warning and evacuation of personnel Alerting and supporting the first responders Safety of personnel

Other authorities	Invoking preparedness plans Local, regional, national and international authorities
Media	Keep people informed about the accident, but also puts a major physical and psychological pressure on first responders and local authorities.
Infrastructure	In flooded area (accident site) all infrastructure is down
Environment	Severe effect, also long term effects on fauna and wildlife
Authorities in other countries	Severe pressure on test results from waste water
International organisations	Severe pressure, especially from environmentalists
References	
Relevant literature	Hernan, R.E (2010), “This borrowed earth. Lessons from the 15 worst environmental disasters around the world”, Palgrave Macmillan. NY. Balkau, F. (2010) “Learning from Baia Mare” The Environmental Times. Enzler, S. M. (2006), “The Baia Mare Cyanide Spill. Environmental disasters”, Lenntech BV, The Netherlands Dunai, M. (2010) “Toxic Hungarian sludge spill reaches River Danube” GYOR, Hungary

IV Appendix B2

Scenario B2
Biological attack in buildings – Anthrax letters
Scenario justification
This scenario is based on the 2001 mail-borne anthrax attacks in the United States of America (USA), also known as Amerithrax from its Federal Bureau of Investigation (FBI) case name (Department of Justice, 2010). The FBI investigation concluded that a sole perpetrator had mailed letters containing anthrax spores to two Democratic Senators and media on two occasions. He was a microbiologist and anthrax expert working at the United States Army medical Research Institute of Infectious Diseases (USAMRIID). In total at least 22 persons contracted the anthrax disease, of which 11 cases were cutaneous anthrax and 11 the inhalational form. Five persons with inhalational anthrax died. Approximately ten thousand people underwent antibiotic treatment to prevent them from contracting the disease. The attack caused widespread contamination of mailrooms and public buildings. Some buildings were closed for years. The clean-up was extremely costly. Despite the fact that European countries have treated thousands of suspected anthrax letters at a national level in the past ten years, the European response capacity has never been challenged with real attacks. In 2009 and 2010, outbreaks of anthrax among drug users in the United Kingdom (UK) and Germany resulted from accidental contamination. The purpose of the scenario is to evaluate the ability of European countries to: • Rapidly confirm the nature of the threat and to assess the risk. • Implement medical countermeasures for protection of persons with proven and potential exposure to anthrax including mobilization of the pharmaceutical industry. • Face closure of major public facilities and paralysis of postal distribution at a European scale. • Rapidly identify the terrorist(s) and prevent further action. • Harmonize communication strategies at the European level, in particular media handling and communication of public procedures. • Identify and address the human and social issues. • Define and apply standards for decontamination of contaminated infrastructures and re-occupancy decisions, including microbiological as well as health safety considerations.
Scenario outline
In a context of increasing international tension, the support of several European countries to a global military intervention against a third country is extensively debated at the national and European level. A radical group decides to influence European governments by launching a campaign of mail-borne anthrax attacks against governmental buildings in Europe. With the support of an international terrorist's organization, the terrorists mail 54 letters containing anthrax spores to intermediate level civil servants at the ministries of defence and the main municipal buildings in the 27 EU capital cities. Following the international postal distribution lines, the letters reach their targets in the following days. Each anthrax letter includes a short message announcing mass release of aerosolized anthrax in European urban areas if any European state joins the military intervention. Official buildings where envelopes are detected

are partly or completely evacuated. Samples are collected and sent for identification and confirmation of anthrax spores. One envelope arrived damaged with only residual traces of anthrax powder, suggesting that contamination occurred along the distribution line. After a postal service clerk is diagnosed with anthrax disease, the most likely spot of contamination is later identified as a mail sorting machine at a major postal hub.	
Cause	
Intentional (Yes/No/Both)	Yes
Profile of actor (if intentional)	Members of a radical group supported by an international organization seek to influence European states foreign policy.
Description of cause	Terrorists mail anthrax letters to prevent European support to a military intervention
Competence and resources	Moderate to high expertise and equipment required for production of *Bacillus anthracis* spores is provided by an international terrorist organization. Low level expertise and equipment is required for preparation of anthrax letters.
Threat compounds and their properties	
Threat compounds	Powder of *Bacillus anthracis* spores, not weapons-grade.
Properties of the agent	*Bacillus anthracis* is a Gram-positive, spore-forming, rod-shaped bacterium, with a width of 1-1.2µm and a length of 3-5µm. It can be grown in an ordinary nutrient medium. Special procedures are required to trigger the formation of spores from the vegetative bacteria.
Medical symptoms	Three forms of anthrax occur in humans: cutaneous, gastro-intestinal and inhalational. The most severe, inhalational anthrax, is observed in the current scenario. **Symptoms of inhalation anthrax** This form of anthrax results from inhaling *Bacillus anthracis* spores. The incubation period is 1-6 days depending on the number of inhaled spores. The disease onset is gradual and nonspecific. Fever, malaise, and fatigue may be present initially, sometimes in association with a nonproductive cough and mild chest discomfort. The initial symptoms are often followed by a short period of improvement (several hours to days), followed by the abrupt development of severe respiratory distress. Shock and death usually occur within 24-36 h after the onset of respiratory distress, and in later stages, mortality approaches 100% despite aggressive treatment. Physical findings are usually nonspecific. Confirmation of diagnosis is obtained by detection of the bacillus or the toxin in clinical specimen.

	Prophylaxis, treatment available: Most *B. anthracis* strains are sensitive to a broad range of antibiotics. To be effective, treatment should be initiated early. If left untreated, the disease is highly fatal. The fatality may, however, be reduced by complementing treatment with antiserum directed to the anthrax toxin. Effective vaccines are available mainly for risk groups.
Availability	Moderate to low depending on local application of bio-security guidelines and measures.
Amount	200 g 10^9 to 10^{10} spores/g
Dissemination	
Amount	2 g powder per letter
Release mechanism	Aerial dispersion at opening or accidental disruption of letters.
Equipment	Common protective clothes, gloves and mask required for preparation of the envelopes.
Physical state	Powder (spores).
Fate	Contagious. Persisting in the environment for decades.
Location	
Location description	Private house for preparation of anthrax letters. Postal distribution infrastructure. Administrative buildings with various levels of mail screening procedures are affected in all 27 EU capital cities.
Weather	Seasonal average weather conditions.
Population at risk	Intended recipients and other civil servants in close proximity at the time of release. Postal services employees.
Time	Days 3 and 4 are weekend.
Other	
Indication or alert	
Announcement (Yes/No)	Yes (a message is included in the anthrax letters).
Observations	Powder and threatening message in letters. Onset of symptoms in a postal service clerk.
Detection	Visual detection of powder. Unambiguous confirmation of anthrax spores after analyses of

	samples at reference laboratories.
Alert	At opening of letter by first recipient. Likely by Police service according to local procedures. Confirmation by reference laboratory is quenching full activation of governmental crisis management cell.
Local safety and security measures	Evacuation, closure and securing the crime scenes.
Possible consequences and development	
Reference time	Day 1 Simultaneous mailing of anthrax letters in public post boxes at different locations in Europe.
Minutes	
Hours	Letters are collected and enter the distribution processes. One letter is damaged and releases anthrax powder in a mail sorting machine. The incident is not detected at this point.
Days	Day 2 First letters are opened by several recipients across Europe. First buildings are evacuated according to local routines and prevention plans. First communication to the general public is performed at national levels. Day 2 First identification by a reference laboratory confirms the nature of the agent. More letters are opened across Europe. The damaged letter is detected. The postal distribution centers downstream are closed. The postal distribution system is affected locally. Day 3-4 More anthrax-letters are received. More facilities are evacuated. Medical countermeasures are scaled up accordingly. Numerous suspected letters are declared to local police stations, challenging the threat assessment capacity. Day 5-15 The contaminated sorting machine is identified. Cross contamination of other letters is demonstrated. Contaminated infrastructures are systematically investigated by bio- and forensics experts. Coordination at the European level is initiated. The postal distribution system is hampered globally.
Months	Decontamination and decontamination assessment are implemented. The public debate is complicated by different perceptions and is affecting re-occupancy decisions as well as reactivation of postal distribution systems. The issue of harmonization is addressed at the level of the European

	Council.
1st order challenges	
Directly affected population	A few thousand clerks and users of the contaminated public services including postal service are considered exposed to the anthrax letters.
First responders	Facilities security officers, the Police, national CBRN intervention teams.
Health services	Increased surveillance. Implement prophylactic measures (antibiotics).
Command and control centre	Direct and coordinate emergency management.
Site/building/infrastructure stakeholder(s)	Assist CBRN experts in risk assessment of individual facilities (*i.e.* providing technical building drawings and diagrams of the High Ventilation and Air Conditioning (HVAC) system).
Other authorities	Postal distribution services, home office.
Media	Promote and communicate recommended interventions. Inform public about evolution of the crises. Organize public controversial debates involving experts and non experts.
Infrastructure	Risk assessment of contaminated buildings with special attention to HVAC systems.
Environment	Decontamination of buildings where the anthrax envelopes have been opened. Destruction/inactivation of contaminated waste.
Authorities in other countries	Coordination at EU and WHO level
International organisations	WHO
References	
List of relevant literature	Department of Justice (2010), "Amerithrax investigative summary", Friday February 19, 2010. http://www.justice.gov/amerithrax/ WEB resources • FBI public information related to Amerithrax investigation http://www.fbi.gov/about-us/history/famous-cases/anthrax-amerithrax • General information about anthrax http://www.bt.cdc.gov/agent/anthrax/ • Biological/chemical threats by post

	http://www.hse.gov.uk/biosafety/diseases/anthrax.htm Free Full text articles on PubMed Central http://www.ncbi.nlm.nih.gov/pubmed • "A review of sentinel laboratory performance: identification and notification of bioterrorism agents". Wagar EA, Mitchell MJ, Carroll KC, Beavis KG, Petti CA, Schlaberg R, Yasin B. *Arch Pathol Lab Med*. 2010 Oct;134(10):1490-503. • "Public Response to an Anthrax Attack: Reactions to Mass Prophylaxis in a Scenario Involving Inhalation Anthrax from an Unidentified Source". Steelfisher G, Blendon R, Ross LJ, Collins BC, Ben-Porath EN, Bekheit MM, Mailhot JR. *Biosecur Bioterror*. 2011 Aug 5. • "Detection technologies for *Bacillus anthracis*: prospects and challenges". Rao SS, Mohan KV, Atreya CD. J *Microbiol Methods*. 2010 Jul;82(1):1-10. • "Addressing residual risk issues at anthrax cleanups: how clean is safe?" Canter DA. *J Toxicol Environ Health A*. 2005 Jun 11-25;68(11-12):1017-32. Review. • "Inhalation anthrax: dose response and risk analysis". Coleman ME, Thran B, Morse SS, Hugh-Jones M, Massulik S. *Biosecur Bioterror*. 2008 Jun;6(2):147-60

V Appendix R1

Scenario R1	
Radiological dispersal in city – Radioactive caesium spread in fire	
Scenario justification	
The starting point for this scenario is a real event; A major fire in a cancer treatment hospital in London in 2008. Several sources of radioactivity were on the premises, but no releases of radioactive material took place. However, what could the consequences have been if radioactive material had been released? The EU-projects MASH and CIE Toolkit have developed and used a scenario based on this incident assuming that radioactive particles were released. The MASH scenario 5: "Radiological dispersal in urban area" and CIE Toolkit scenario 5: "Release of radioactive material in urban area" are adapted and used here. This scenario illustrates that an accidental fire in special facilities may disperse dangerous substances, not normally associated with fires. The purpose of this scenario is to evaluate: • The effectiveness of emergency authorities to detect and identify radioactive release • The first responders' competence, training and equipment to deal with a radioactive release event • The evacuation of patients • The communication to the public regarding the nature of the threat and what to do • The management of possibly contaminated people • Collaboration between the Police, the radiation protection authorities and the hospital staff • Human and social impacts	
Scenario outline	
A hospital is hit by an accidental fire which starts in the radiological clinic and spreads quickly. The risk that gas tubes could explode prevents proper fire-fighting. An explosion occurs minutes later. A radioactive caesium-137 (Cs-137) source is blown up, and the powder is dispersed by the blast. Radioactive particles mix with combustion gasses and smoke, and are dispersed in the neighbourhood.	
Cause	
Intentional (Yes/No/Both)	No
Profile of actor (if intentional)	Not applicable.
Description of cause	Welding during maintenance work ignites flammable materials causing a big fire. Subsequently, gas containers near a radioactive source explode due to overheating. The radioactive source is damaged and radioactive powder released and dispersed.
Competence and resources	Not applicable

Threat compounds and their properties	
Threat compounds	Cs-137 as caesium chloride (CsCl)
Properties	Fine-grained, easily water soluble salt. Gamma emitter. Radioactive half-life 30 years
Medical symptoms	Blast injuries from the explosion. Burns and inhalation of toxic fire gasses due to fire. Increased cancer risk in the long term from gamma radiation exposure.
Availability	Common radioactive source in medical and industrial applications.
Dissemination	
Amount	2 TBq, less than 1 g caesium chloride powder.
Release mechanism	Explosion and fire/smoke.
Equipment	Not applicable.
Physical state	Particles in smoke.
Fate	Binds easily to concrete, stone and asphalt. Inhaled caesium binds in soft tissues
Location	
Location description	The hospital is situated near the city centre.
Weather	Temperature +12ºC, cloudy, wind speed 5 m/s
Population at risk	200 employees and 180 patients at the hospital. Several hundred people live and/or work in the neighbourhood.
Time	Daytime with many people in the streets.
Other	
Indication or alert	
Announcement	Not applicable.
Observations	Explosion and fire.
Detection	Fire alarms going off. Known presence of radiation sources in the building.

	Gamma detectors showing increased levels of radiation.
Alert	Called in as fire alarm, but quickly updated with information on the presence of radiation sources.
Local safety and security measures	Fire evacuation routines. Radiation protection official in the hospital.
Possible consequences and development	
Reference time	The registered time for the fire alarm.
Minutes	Evacuation of the burning building. Radioactive release. Radioactivity (radioactive particles) in the air until particles deposit on the ground. Re-suspension of particles may occur.
Hours	Fire is extinguished. Re-suspension of particles may still occur.
Days	A large area is contaminated and cordoned off.
Months	The normalization phase includes measures to reduce radiation levels by decontamination and if necessary demolishing buildings or infrastructure.
1st order challenges	
Directly affected population	400 in the hospital plus hundreds in the streets outside. 15 persons are wounded by the blast. 30 persons are severely contaminated. 60 persons are moderately contaminated. 250 are slightly contaminated.
First responders Are there plans, methods, equipment, procedures and training?	Technical measures • Rapid detection and alert of gas explosion and fire • Fire fighting training and equipment, also when the presence of radioactivity complicates the response • Gamma detection equipment. Awareness of radioactivity may minimize secondary contamination. • Individual protective equipment (IPE) • Perimeter for possible contaminated area must be established and closed off to the public (safety zone) • Forensic work Casualty care • Extract the victims from the hot zone

	• Triage and first aid • Registration • Decontamination, if necessary • Transport of casualties to hospitals for further treatment Organisation • Chain of command Communication • Emergency services communication • Crisis information • Media communication
Health services	Awareness of radioactivity. Gamma detection equipment. Decontamination. Capacity to distribute Preussian Blue. Mass casualty response plan.
Command and control centre	Emergency communication. Logistics and coordination of resources. Media communication.
Site/building/ infrastructure stakeholder(s)	Evacuation and warning of personnel and visitors. Alerting and supporting the first responders. Safety of personnel. Registration and relocation of patients and personnel. Subsistence.
Other authorities	The national radiation protection authority and other competence centres will provide expert advice, analyse samples, and provide guidance on protective and mitigating measures. The meteorological service will assist and perform dispersion modelling and prediction of hazard areas and countermeasures. Medical authorities will examine exposed persons.
Media	Media communication. Information to the public from authorities.
Infrastructure	Traffic and pedestrian management. Temporary food and accommodation for those evacuated from the area. Possible overload of the mobile phone system.

Environment	Assessing contamination levels in soil and water (including sewage).
Authorities in other countries	Not applicable.
International organisations	Reports to the International Atomic Energy Agency (IAEA).
References	
Relevant literature	Cassel G., Eriksson H., Sandström B. (2008), "Mass-casualties and health care following the release of toxic chemicals or radioactive materials (MASH)", Work Package (WP) 4 deliverable, "Scenarios", Swedish Defence Research Agency (FOI). Cassel G., Sandström B., Norlander L., Thorstensson M., and Eriksson H. (2011), "Exercise Card Concept. Exercise Director Instructions and Scenarios", Chemical Incidents Emergencies Toolkit, Work Package 6 deliverable, Swedish Defence Research Agency (FOI). IAEA (1998), STI/PUB/815, "The radiological accident in Goiânia", ISBN 92-0-129088-8.

VI Appendix N1

Scenario N1	
Nuclear power plant accident – Release of fission products	
Scenario justification	
The nuclear accident known as the Three Mile Island accident in 1979 occurred in a pressurized water reactor (PWR) (3000 MWt (1000 MWe)). The reactor was fairly new and had only been operating for about three months. Due to a failure in the cooling system, the fuel elements started to melt, allowing radioactive gases and water soluble materials to be released into the cooling system. Overheating and production of hydrogen gas could have caused explosions in the reactor. However, the reactor containment vessel did not breach, and only relatively small amounts of radioactivity were released into the environment. The accident put auxiliary systems and crisis management plans on the test. Evacuation and remediation was necessary. The accident is described in more detail in Collins *et al*,(1982) and US NRC Backgrounder (2009). A nuclear accident and subsequent release of radioactive material from a nuclear plant could affect more than one country directly, as was demonstrated in the Chernobyl accident in 1986. This scenario is inspired by the Three Mile Island accident and will give an opportunity to test and train international cooperation, alert-routines, effectiveness of international agreements, etc. for cross-border releases of radioactive material. The purpose of the scenario is to evaluate: • Alert-routines, both at a national and an international level • The effectiveness of detection and identification systems • Transnational response coordination, communication and responsibilities • Communication and recommendations to the authorities and to the public • The effectiveness of the crisis management (the management of the contaminated people, the mobilization of resources and policies for medical treatment, the decontamination of the infrastructure) • The human and social impact	
Scenario outline	
A commercial nuclear power plant (3 GW_t/900 MW_e pressurised water reactor (PWR)) experiences loss of coolant, with fuel melt-down as result. The reactor is situated in a populated area and close to two cities. The event starts in the early morning before normal work hours, and most people are in their homes. A feed-water pump fails and steam builds up in the reactor. A relief valve opens, but does not close again, leading to loss of coolant. The operators misinterpret the instrument signals and reduce coolant flow rather than increasing it. The fuel overheats and the encapsulation bursts, releasing volatile fission products to the reactor building. Because of the reactor containment, only gases vent to outside environment.	
Cause	
Intentional (Yes/No/Both)	No

<table>
<tr><td>Profile of actor (if intentional)</td><td>Not applicable.</td></tr>
<tr><td>Description of cause</td><td>A combination of technical failure and operator error.</td></tr>
<tr><td>Competence and resources</td><td>Not applicable.</td></tr>
<tr><td colspan="2">Threat compounds and their properties</td></tr>
<tr><td>Threat compounds</td><td>Reactor fuel and fission products inside the reactor. Directly outside the reactor there will be an external gamma radiation hazard. Outside the reactor there will be radioactive noble gases (xenon and krypton), iodine and caesium.</td></tr>
<tr><td>Properties</td><td>Fission products in the form of noble gases are not reactive. Iodine is easily taken up in the thyroid gland if inhaled. All these radionuclides have relatively short half lives (minutes to days) and are gamma emitters. Iodine and caesium (30 year half life) are water soluble and will dissolve in the primary coolant water.</td></tr>
<tr><td>Medical symptoms</td><td>Acute radiation syndrome has nausea and vomiting as first symptoms, later potentially diarrhoea, loss of hair and inner bleeds. The immune system collapses which leads to a higher risk of infections. Onset of symptoms occurs within hours to days depending on the exposure levels. Some treatment is available, but above certain radiation exposure levels there is no effective treatment.

Even in the absence of any symptoms, radiation exposure can lead to elevated cancer risk in the long term. This is the most likely outcome here.</td></tr>
<tr><td>Availability</td><td>There are 128 pressurized water reactors (PWR) operating in Europe today. 8 additional ones are planned.</td></tr>
<tr><td colspan="2">Dissemination</td></tr>
<tr><td>Amount</td><td>Total amount released:
<table>
<tr><th>Nuclide</th><th>Bq</th><th>Pathway</th></tr>
<tr><td>Kr-88</td><td>1.4E16</td><td>Air</td></tr>
<tr><td>Xe-133</td><td>5.8E16</td><td>Air</td></tr>
<tr><td>Xe-133m</td><td>8.3E15</td><td>Air</td></tr>
<tr><td>Xe-135</td><td>1.1E16</td><td>Air</td></tr>
<tr><td>Xe-135m</td><td>9.25E14</td><td>Air</td></tr>
<tr><td>I-131</td><td>5.6E11</td><td>Air</td></tr>
<tr><td>I-131</td><td>8.5E9</td><td>Water</td></tr>
<tr><td>Cs-137</td><td>8.9E9</td><td>Water</td></tr>
</table></td></tr>
</table>

Release mechanism	Rupture of fuel encapsulation, venting of gases. Release of liquid effluents through the normal spill water system.
Equipment	Not applicable.
Physical state	Noble gases, volatile substance dissolved in water and non-volatile substance in water.
Fate	Short half-life, non-reactive substances will be dispersed and diluted in air. Some contamination of the close environment, and possible transfer to milk and farm products.
Location	
Location description	Inside the reactor building and in the open air outside. The site is situated on a small island in a river, 2 km from the west bank and 275 m from the east bank of the river. The island is connected to the east bank by two bridges. A few hundred private residences and summer cottages are located on the banks and islands around one km from the site. A community of 900 is 1.9 km to the west. A town of 10,000 lies 4 km to the north. A city of 70,000 is 14 km north-west and another of 50,000 is 21 km to the south. Inside a radius of 80 km there are 2 million people.
Weather	North-westerly wind, no precipitation.
Population at risk	2 million people in local area.
Time	4 a.m.
Other	
Indication or alert	
Announcement	Not applicable.
Observations	Alarms indicating non-specific problems in the cooling system and automatic reactor shut-down.
Detection	Elevated radiation levels outside the reactor building are detected with dedicated equipment.
Alert	Malfunction of the reactor is reported to the plant owner, state authorities and the national radiation regulatory body by phone.
Local safety and security measures	The plant has procedures for abnormal situations, including also automatic and hand-held detection equipment.

Possible consequences and development	
Reference time	Time zero is when the first automatic alarm is triggered
Minutes	Loss of coolant water. Automatic shut-down of reactor by successful insertion of control rods. Venting of coolant. Many different alarms go off.
Hours	Partial melt-down of the reactor core due to residual heat. Venting of released radioactive gases. Build-up of a large hydrogen bubble in reactor vessel. Elevated radiation levels outside reactor building. Slightly elevated radiation levels further from reactor site. Forced cooling is restored.
Days	Second emission of noble gases. Hydrogen bubble is diminished. 70 % of release has occurred. Contaminated coolant water leaks into the reactor building.
Months	Contaminated coolant water still leaks into the reactor building. Natural cooling is restored and reactor is in “cold shutdown”. Radioiodine is released through degradation of charcoal filters and evaporation of liquids in reactor building. Low levels of radionuclides can be found in the surrounding environment and in milk and farm products.
1st order challenges	
Directly affected population	2 million people within a radius of 80 km are in potential danger of inhaling radioactive particulate matter. The site personnel is at risk of direct radiation.
First responders Are there plans, methods, equipment, procedures and training?	Is there a need for external first responders, or is the crisis handled adequately by site personnel? Technical measures • Re-establish sufficient cooling • Prevent radioactive releases • Perform risk assessments (current radiation levels and prognosis) • Evacuation from affected areas

	• Stop people from entering affected areas Casualty care • Are there any casualties? Organisation • Chain-of-command Communication • Information flow between different levels of authorities • Crisis information • Media communication
Health services	Psychosomatic symptoms may be wide-spread. Providing sufficient dosimetry for external responders and other potentially affected. Providing health advice to the public about health impacts (short and long term health impacts. Treatment, mitigating measures, etc.).
Command and control centre	Coordination between many authorities with different responsibilities.
Site/building/infrastructure stakeholder(s)	The site owner and the operator: main responsibility. Few others are in a technical position to help.
Other authorities	Licensing authority National competent authority (IAEA term) National warning point (IAEA term) Local government National government
Media	Extensive local and world press coverage.
Infrastructure	Areas with restricted access?
Environment	Possible contamination of environment. Need for monitoring (short and long term) and possibly remediation.
Authorities in other countries	Neighbouring countries. Countries with bilateral notification agreements.
International organisations	International Atomic Energy Agency (IAEA) World Health Organisation (WHO) Food and Agriculture Organisation (FAO) World Meteorological Organisation (WMO)

References	
Relevant literature	US NRC Backgrounder (2009), "Three Mile Island accident". Battist,L. Peterson Jr., H.T. (1980), "Radiological consequences of the Three Mile Island accident", US National Research Council (NRC). Collins E.D. (1982), Oak Ridge National laboratory, "The Three Mile Island accident and post-accident recovery – what did we learn?" , Presentation at *Meeting of the American Society of Certified Engineering Technicians*. PRIS database, IAEA, updated Sept. 2011 Rogers M. B., Amlot R., Rubin G. J., Wesseley S., Krieger K. (2007), "Mediating the social and psychological impacts of terrorist attacks: The role of risk perception and risk communication", *International Review of Psychiatry*, **19**, (3, June 2007), 279-288.

VII Appendix H1

Scenario H1
Hoax – Unknown powder in congress centre
Scenario justification
The threat or suspicion of dissemination of a hazardous CBRN material can be enough to inflict fear and call for emergency response actions. After the 2001 anthrax letters in the United States, numerous hoax “anthrax” letters were distributed in Europe. These letters had to be analyzed, and people were put on prophylactic antibiotic medication awaiting analyses results. Fortunately, all letters in Europe proved to be hoaxes. The incidents, however, caused huge costs and psychological effects. Also, they demonstrated the need for procedures and capacities to deal with contaminated mail, secure possibly contaminated areas and a capacity to quickly identify unknown samples. This scenario is based on the hoax letter cases and other incidents were the police or other emergency services encounter unidentified suspicious material which must be dealt with. The scenario takes place in a major congress centre during a large political meeting. An activist group calls in a threat and also disseminates an unknown suspicious material in the centre. The purpose of the scenario is to address: • Preparation of the local facility manager and security officers for a high-profile event • Collaboration between private and public services • Ability to manage large cohorts of potential victims • Decisions and communication about the risk and countermeasures including quarantine, decontamination, prophylaxis or simply registration of potentially exposed to an unknown threat compound (C, B and/or R) • Procedures, organization and capacities for rapid analysis and identification of unknown samples (C, B and/or R) • Ability to quickly distinct hoaxes from real threats
Scenario outline
Two months before the elections for a European Parliament, a political party is organizing a meeting at a congress centre in the middle of a large city. The congress centre has a local facility manager and security staff with instructions to alert the emergency services in case of any suspicious incidents. The night before the meeting a group of activists places yellow powder inside three mobile air condition units inside the conference rooms. In the middle of the congress day, the facility manager receives a phone call claiming that a number of disseminating devices have released toxic and infectious agents in different locations in the congress center. In parallel, security staff accidently finds yellow powder in a mobile air condition unit. The facility manager immediately informs the emergency services.

Cause	
Intentional (Yes/No/Both)	Yes.
Profile of actor (if intentional)	A group of activists which seeks to influence the electoral campaign. The group has no prior record for acquiring, threatening or using C, B or R material, nor other violent means (explosives etc.).
Description of cause	The aim is to influence the electoral campaign.
Competence and resources (I)	No specific expertise required.
Threat compounds and their properties	
Threat compounds	Odorless, yellow pigment and wheat flour-like consistency.
Properties of the agent	No pathogenic properties.
Medical symptoms	The powder causes no medical symptoms if inhaled in low dosages, except couching.
Availability	Not relevant.
Amount	100 g in each of the three mobile air conditioning units. Total amount 300 g.
Dissemination	
Amount	Not disseminated.
Release mechanism	Placed in air conditioning unit.
Equipment	Air conditioning unit.
Physical state	Yellow pigmented solid powder.
Fate	Not relevant.
Location	
Location description	Congress Centre with several large auditoria, a large hall with shops. The Congress Centre is located in the centre of a busy city.
Weather	Not relevant.
Population at risk	Political party members, press representatives, local facility staff, first responders.
Time	Weekday, during normal working hours

Other	
Indication or alert	
Announcement (Yes/No)	Yes
Observations	Suspected improvised dissemination devices (air conditioning units) containing yellow powder potentially containing a C, B and/or R threat compound. No real medical symptoms. However, the security personnel and other persons who saw the powder are feeling dizzy and nauseous. They have headaches and heart palpitations (rapid beating).
Detection	First: visual detection of the powder, then measurements with hand-held detectors (C and R). Later: sampling and identification by CBRN experts in designated laboratories.
Alert	From the facility manager to the emergency services about the call from the activist group. From the security staff to the facility manager about the discovery of unknown powder.
Local safety and security measures	Access in and out the Congress Centre is controlled by facility staff and later by police forces.
Possible consequences and development	
Reference time	Telephone call from the terrorist to the facility manager.
Minutes	Security staff discovers the yellow powder and confirm plausibility. The facility manager alerts emergency services and organizes the response according to Police recommendations. Police forces and first responders arrive on site.
Hours	CBRN experts provide a preliminary assessment based on negative detector readings. Samples are collected for analysis and laboratory identification initiated.
Days	The next two days, reference laboratories confirm that the powder is harmless. It does not contain any radioactive material, toxic chemical agent nor bacteria or viruses. A potential perpetrator is arrested.
Months	The response is analyzed and an improved preparedness plan is adapted.

1st order challenges	
Directly affected population	All the 2000 people staying in the congress centre are affected. 1 security personnel and 14 persons are feeling dizzy and nauseous, have headaches and heart palpitations.
First responders Are there plans, methods, equipment, procedures and training?	Technical measures • Individual protective equipment (IPE) • Detection equipment • Sampling equipment and procedures • Laboratories for identification (C, B and/or R hazardous substances) • Evacuation plans • Forensic work Casualty care • Decision on possible prophylactic antibiotic medication • Psycho-social care for the affected Organisation • Division of responsibilities Communication • Crisis information to the affected • Information and updates to the general public
Health services	Sufficient medical stocks of antibiotics.
Command and control centre	Direct and coordinate the emergency management.
Site/building/infrastructure stakeholder(s)	Key role in coordinating facility security measures (cordons), possible evacuation etc. with emergency services and CBRN experts.
Other authorities	
Media	The incident happens in a congress centre in a populous city. There will be rumors of a terror attack. The public should be provided with guidelines and general information about the incident via media at an early stage.
Infrastructure	No physical damage.
Environment	Not affected
Authorities in other countries	Not affected
International organisations	International organizations will not be involved.

References	
List of relevant literature	Hagenbourger M., Lagadec P., Pouw M. (2003), "Postal security, anthrax and beyond Europe's Posts and the critical network challenge: Lessons from the anthrax case to meet future challenges", *J. Contingensies and Crisis Management* **11**, 105-107. Leask A,, Delpech V. and McAnulty J. (2003), "Anthrax and other suspect powders: Initial responses to an outbreak of hoaxes and scares". *New South Wales Public Health Bulletin* Vol. **14** No.11-12, 218-221. Mason B.W., Lyons R.A. (2003), Acute psychological effects of suspected bioterrorism", *J Epidemiol Community Health* **57**, 353-354. Page, L. A., Petrie, K. J., and Wessely, S. C. (2006). Psychosocial Response to Environmental Incidents: A Review and Proposed Typology. Journal of Psychosomatic Research, 60, 413-422. Rogers, M. B., Amlôt, R., Rubin, G. J., Wessely, S. and Krieger, K. (2007). Mediating the Social and Psychological Impacts of Terrorist Attacks: The Role of Risk Perception and Risk Communication. International Review of Psychiatry, 19(3), 279-288.