[PRACTICE]

D2.3A CRITICAL EVENT PARAMETERS

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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 objective of the work package (WP) 2 on selection of scenarios and identification of critical event parameters is 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, prioritising and in a number of cases developing appropriate emergency preparedness and response measures.
- Identify a set of non-terrorist accident scenarios, 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.
- 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. Such a set of publicly available scenarios is not available today.

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

This report, "D2.3A Critical event parameters", constitutes the first part of the third deliverable of WP2 "Scenarios and critical event parameters" of the EU FP7 project PRACTICE. The second part "D2.3B Consequence assessments of the reference set of CBRN scenarios" is given in a separate report (Breivik *et al.*, 2012). This WP is led by the Norwegian Defence Research Establishment (FFI).

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Contents

1. Executive Summary

This report is part one of two of the final deliverable in PRACTICE WP2. The previous deliverables have established a template for scenarios (Endregard *et al.,* 2011) and developed a reference set of scenarios (Endregard *et al*., 2012). In this report we analyze the developed scenarios to find the parameters triggering specific responses in the handling of the incidents, *i.e.* the critical event parameters. Part B of the deliverable 2.3 undertakes both quantitative and qualitative consequence assessments of the PRACTICE reference set of scenarios (Breivik *et al.*, 2012).

The set of critical event parameters we have identified is not meant as an exhaustive list, but rather the specific parameters coming out of our limited set of CBRN scenarios. As the scenarios are chosen in order to span a wide range of incidents and challenges, however, we consider that the list is a representative subset of CBRN-relevant parameters. The work is 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
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The work of Task 2.1 is reported in "D2.1 Scenario template, existing CBRN scenarios and historical incidents" (Endregard *et al.*, 2011).

The work of Task 2.2 is reported in "D2.2 Reference set of CBRN scenarios" (Endregard *et al.*, 2012).

In this report we identify parameters from the scenarios developed in D2.2. We give a short description of each scenario here, for the full text we refer to (Endregard *et al.*, 2012).

3. Objectives

The primary objectives and subsequent application of the set of reference CBRN scenarios (Endregard *et al.,* 2011b) are their use within the PRATICE project:

- To identify critical event parameters for CBRN crises which either trigger or influences preventive or mitigating actions by emergency services (WP2)
- 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)

To facilitate all these different uses, the scenarios must be analyzed to identify the specific parameters in the chosen scenarios to help set up a more generic parameter list.

4. Critical event parameters

4.1 Parameters and operational functions

Critical event parameters are in this project defined as *the observables triggering or determining the performance of a function*. A general approach to parameter-function interactions can be:

1. You observe something (the parameter)
2. You analyze the observation
3. You perform an action (the function)
4. The action affects the observed system and your observation changes

The interaction is cyclic, and the value of the parameter may change for each repetition of the loop, even though the parameter itself is defined in the same way.

The parameters can be grouped in several ways. We have chosen to divide them in two main categories: *Key parameters triggering an operational function* and *parameters that influence the* *performance of the function*. Some occur only in one or a few of the phases of the security cycle[1], some are specific to the threat agent, and some are specific to the time or place of the incident.

The phases of the security cycle prior to an incident will not be analyzed in great detail. Much of the detailed information is based on intelligence sources and strategies, thus not available in the public domain. In addition, members of the WP2 are mainly familiar with emergency preparedness, response and recovery. Some general parameters can however be listed:

1. ***Threat assessment***

- Incidents in other countries
- Upcoming events
- Suspicious communication/contact
- Threats, specific or non-specific
- Trade with suspicious components or quantities
- Information from the public

2. ***Prevention***

- Quality of inventory of CBR threat compounds (industrial sites, storages, …)
- Quality of physical security measures, including containment and access control
- Quality of cyber security
- Quality of surveillance systems (cameras, patrols, …)
- Quality of detection systems
- Implementation of health surveillance
- Quality of vector control

3. ***Preparedness***

- Threat level based on agent characteristics
- Threat assessment, gap analysis, output and conclusions
- Measures implemented based on a threat assessment
- Level of awareness and knowledge of the general public
- Level of security of the site and physical protection of the threat agent
- Level of knowledge of general infrastructure, importance, vulnerability and conclusions on measures needed and implemented
- Availability of personnel, vaccines, equipment, …
- Equipment performance characteristics and number

Functions in the prevention or preparedness phases are also often triggered by legislation or built into normal operating procedures. This is, however, not regarded as critical event parameters, as this is part of the known framework.

For the response and recovery phases we will go into more detail below. In sections 4.1.1 and 4.1.2 we give examples of types of parameters, and in section 4.2 we have analysed our set of scenarios to give examples of parameter values.

[1] In PRACTICE we use a security cycle with five phases: Threat assessment, prevention, preparedness, response and recovery. For more on the security cycle, see *Bastings 2012*.

4.1.1 Parameters influencing the performance of functions

There are some generic parameters that will influence the way in which a function will be carried out, and also the level of success in the performance. These are not necessarily CBRN specific. The same parameters will influence both the immediate response and the later recovery. We have identified some important examples below:

- Weather characteristics (temperature, wind, precipitation, …)
- Atmospheric pollution
- Level of training of the responders
- Level of public awareness
- Quality of the communication to the public
- Availability of equipment
- Capacity in the medical services
- Speed of reference laboratory results
- Capacities of laboratories and sampling team
- Human behaviour in the situation (Auto-evacuation, confusion, …)
- Location characteristics
- Timing of incident (time of day, season)
- Population at risk
- Population affected (fatalities, injured, contaminated)
- Accidental release or intentional attack

4.1.2 Key parameters triggering a response

The parameters specific to CBRN-incidents include both the observations leading to the conclusion that the incident might be CBRN related and the physical properties of the specific threat agent.

Some examples of triggering parameters:

- Announcement
- Warning and reporting
- Health and medical surveillance
- Detection, sampling and identification of a threat agent
- Threat agent properties
- Performance degradation
- Symptoms
- Time for onset of symptoms
- Path of intake
- Release method
- Mechanism of dispersal
- Fate of agent

Threat agent properties for C, B, R and N incidents are the parameters really setting CBRN incidents apart from the conventional types of incidents. C, B and R threat compound properties differ significantly from each other and must be considered separately. Because our main perspective is CBRN, we go into greater detail here. The threat agent properties given below were identified in the European Defence Agency project ATHENA (Endregard and Enger 2010):

Chemical threat compounds

- Physical state at ambient conditions
- Toxicity through various exposure routes (inhalation, ocular, gastrointestinal, dermal)
- Boiling point
- Purity
- Evaporation rate
- Vapour pressure
- Flammability
- Reactivity
- Stability
- Solubility
- Smell
- Visibility
- Type of exposure, i.e. inhalation, gastrointestinal or dermal
- Medical countermeasures and treatment

Radiological threat compounds

- Radiation type and level
- Dose and dose rate
- Physical state
- Physical half life
- Biological half life
- Type of exposure, i.e. external and/or internal (inhalation or gastrointestinal)
- Exposure time
- Chemical properties (e.g. solubility)
- Particle size distribution

Biological agents

- Type (bacteria, virus, toxin)
- Infectivity
- Infection dose
- Lethality
- Virulence
- Incubation period
- Transmissibility
- Route of exposure
- Stability
- Particle size distribution
- Treatment
- Vaccines

The health care system will look for other parameters than the first responders. Many of these parameters are the same for all CBRN agents, and some are B specific.

- Clinical manifestations of the infection

  - Signs and symptoms
  - Clinical course, outcome
  - Number of hospitalized cases
  - Proportion of cases in ICU
  - Proportion of cases requiring "limited resources" (e.g. mechanical ventilation)
  - Proportion of cases with subclinical infection
  - Proportion of cases with typical disease
  - Proportion of cases with severe illness
- Epidemiological manifestations of the infection
  - Total number of suspected cases
  - Total number of confirmed cases
  - Total number of deaths
  - Distribution of cases and deaths per age and sex
  - Distribution of cases per health status
  - Clinical attack rate[2]
  - Case fatality rate[3]
  - Transmission characteristics (estimated incubation period, reproduction number, …)
- Characteristics of the agent (B specific)
  - Sensitivity to antimicrobial drugs
  - Molecular markers of virulence
  - Molecular markers of biodiversity
  - Antigenicity
- Vulnerability of the population
  - Pre-existing immunity to the agent in the population:
    - Age
    - serological data
    - history of exposition to similar agents e.g. seasonal flu
  - Proportion of people having medical or other conditions increasing the risk
    - Pyramid of age
    - Pregnancy rate
    - People with chronical underlying diseases
    - Data on age specific attack, hospitalization and mortality rates
    - Malnutrition
    - Infection with other infectious diseases
- Capacity for response
  - Access to health care
    - Capacity to treat severe cases
    - Capacity to identify and treat people at increased risk
    - Capacity for adequate triage
    - Capacity to implement infection control measures
    - Capacity to provide at the same time care and treatment for other medical conditions

[2] The proportion of persons who are exposed to the disease during the outbreak who do become ill.

[3] The number of deaths due to a specific disease as compared to the total number of cases of the disease.

- Communication and social mobilization
  - Capacity to provide updated information to healthcare and other responders
  - Capacity to provide updated information to the public[4]
  - Capacity to provide updated information to stakeholders
- Advance preparedness and planning
  - Capacity to deliver healthcare to large population (e.g. vaccination campaigns)
  - Capacity to do it in chaotic circumstances
  - Capacity to assess preparedness
  - Capacity to mobilize support from other countries and international organization

4.2 Parameters identified in the reference set of CBRN scenarios

Below we have identified parameters from each of the scenarios. We find that many parameters are present in all or most of the scenarios, but with different values. This gives a basis for evaluating the possible span in the parameter. The parameters below are of course examples of possible parameters and not an exhaustive listing, but as the scenario set is chosen to span a wide variety of CBRN incidents the examples likely cover most important aspects.

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

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 posed.

[4] Information should include what is known on et agent and the disease; home-based care; where and when to seek help; who may be at increased risk; preventive measures accessible to the general population

Parameter	**Value**
Key parameters triggering response	
Threat agent • Physical properties • Toxicity	Sarin • Liquid • Boiling point 147 ºC • Colourless • Odourless • High toxicity (see estimates in scenario)
Symptoms	• Impaired vision (miosis) • Dizziness • Headache • Increased salivation • Vomiting • Runny eyes and nose • Difficulty in breathing • Bloody secretion from mouth • Diarrhoea • Fasciculation • Loss of Bodily Functions • Convulsions • Respiratory arrest • Death
Time for onset of symptoms	Rapid, seconds or minutes depending on concentration and exposure time
Amount detected or observed	Unknown
Release mechanism	Liquid spill in ventilation shaft
Path of intake	Inhalation
Observations/alert/announcement	People showing symptoms No announcement from perpetrator
Casualties	300-600 within 10-15 minutes
Detection/identification	Hand-held detector on-site Identification in specialized laboratory
Fate of agent	Self-purges
Influencing parameters	
Weather • Temperature • Wind speed and direction • Precipitation	• Cold autumn outside • Inside temperature 20 ºC • Inlet air in the ventilation system is heated (16 ºC)
Population at risk	1200 persons inside building Mostly adults, some children
Timing of incident	Day time, during trade fair
Location	Indoor Large hall Urban
Intentional	Yes
Environmental	N/A
Early phases general parameters	
Availability	Not commercially available

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

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 fifty 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 deposit 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 rash 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.

Parameter	**Value**
Key parameters triggering response	
Threat agent • Physical properties • Toxicity	Sulphur Mustard • Colourless • Odourless, garlic if impure • Melting point 14 ºC • Boiling point 227 ºC • Low volatility • High stability • Soluble in organic solvents • Non-soluble in water • High toxicity (see estimates in scenario)
Symptoms	• Eye pain, tear flow, loss of sight • Respiration difficulties • Coughing, sneezing • Chemical pneumonia • Inflammation of skin • Fluid filled blisters • Wounds resembling thermal burns • Nausea • Vomiting • Diarrhoea
Time for onset of symptoms	4-18 hours depending on exposure
Amount detected or observed	Unknown
Release mechanism	Small droplets from explosion
Path of intake	Through skin contamination
Observations/alert	Explosion
Casualties	10 dead from explosion 100 trauma injuries from explosion The same 100 develop sulphur mustard symptoms 200-300 develop sulphur mustard symptoms
Detection/identification	Hand-held detector on-site Identification in specialized laboratory
Fate of agent	Persistent

Influencing parameters	
Weather • Temperature • Wind speed and direction • Precipitation	• Temperature 15 ºC • Wind speed 2 m/s • Clear sky, no precipitation
Population at risk	1000, mostly healthy young people
Timing of incident	18:00 Saturday night in summer, start of concert
Location	
Intentional	
Environmental	N/A
Early phases general parameters	
Availability	Not commercially available

4.2.3 C3 Chemical transport accident – Train derailment causing chlorine dispersal

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 contents are released during 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.

Parameter	**Value**
Key parameters triggering response	
Threat agent • Physical properties • Toxicity	Chlorine • Pressurized gas • Yellow-green colour • Pungent, characteristic odour • Boiling point – 34 ºC • Medium toxicity (see estimates in scenario)
Symptoms	• Irritation of eyes • Lung oedema • Suffocation • Chemical pneumonia • Coughing • Irritation of skin
Time for onset of symptoms	Minutes to 48 hours
Amount released	45 metric tonnes
Release mechanism	Leakage caused by rupture
Path of intake	Inhalation
Observations/alert	Collision Yellow cloud ADR marking on railcar Pungent smell
Detection/identification	Identification by smell
Casualties	1 dead from collision 20 dead from chlorine exposure 350 severely injured

	1500 village people and 20 first responders lightly injured
Fate of agent	Will disperse within hours
Influencing parameters	
Weather • Temperature • Wind speed and direction • Precipitation	• Temperature 17 ºC • Wind speed 5 m/s • Clear sky, no precipitation
Population at risk	2000 village residents
Timing of incident	19:00, Friday, spring
Location	Open air train station Inside village
Intentional	No
Environmental	Corrosive and oxidising. Affecting wildlife, vegetation and metal surfaces.
Early phases general parameters	
Availability	Extensively used in industrial applications Commonly transported on road or rail

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

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 gushes over nearby houses and buildings, sweeping away people, livestock 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 will cross several national borders.

Parameter	**Value**
Key parameters triggering response	
Threat agent • Physical properties • Toxicity	Mixture of organic mercury, agricultural chemicals, traces of cyanide • Coloured waste water • Bad smell • No toxicity data, but causing symptoms
Symptoms	• Eye damage • Skin burns • Vomiting • Headache • Dizziness
Time for onset of symptoms	Hours
Amount detected or observed	"Huge amounts"
Release mechanism	Breach in dam wall
Path of intake	Skin contact Possibly oral intake of contaminated water
Observations/alert	Flood from dam breach Smell

	Colour
Detection/identification	Identification in chemical laboratories
Casualties	12 dead 46 severely injured 4 missing
Fate of agent	Persistent in river water and sediments
Influencing parameters	
Weather • Temperature • Precipitation	• Temperature 17 ºC • Cloudy, no precipitation
Population at risk	Workers at the site 50 000 in nearest city
Timing of incident	06:30 normal work day
Location	Dam close to river
Intentional	No
Environmental	Dead wildlife Dead livestock Contamination
Early phases general parameters	
Availability	Many sites storing toxic liquid waste

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

After being informed of the rejection of an EU grant application, a junior scientist training in the Americas steals a vial of H1N1 suspension from an animal source kept at a Faculty biosafety level 3 facility. Using his own private illegal "garage biology laboratory" he prepares after propagation of the virus in embryonated chicken eggs 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 5 days later and to provoke a pandemic flu across Europe.

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 of face mask commonly used by tourists.

Parameter	**Value**
Key parameters triggering response	
Threat agent • Physical properties	Influenza A virus (H1N1) • Particle 80-120 nm diameter • Can survive and be infectious outside body for 2 to 8 hours • Destroyed by heat 75-100 ºC • Destroyed by several chemical germicides • Suspension
Symptoms	• Fever (38-39 ºC) and chills • Aches and pains throughout body • Normally healthy people recover within 3-7 days

	• Complications like pneumonia or co-infections possible
Time for onset of symptoms	1-4 days
Release mechanism	Infected person, spray in air and surfaces
Path of intake	Inhalation
Observations/alert	Unseasonal accumulation of flu symptoms
Detection/identification	Identification in microbiology laboratories
Casualties	None acute, 125 000 cases reported in total
Fate of agent	Contagious Not persisting more than 8 hours in environment
Influencing parameters	
Population at risk	First passengers and crew, then general population
Timing of incident	July
Location	Aircraft and airport General society
Intentional	Yes
Environmental	N/A
Early phases general parameters	
Availability	Virus is stored in many bio-labs with varying security

4.2.6 B2 Biological attack in buildings – Anthrax letters

In a context of increasing international tension, the support of several EU MS to a global military intervention against a third country is extensively debated at national and European council level. The “Defenders of Truth”, a radical group decides to influence EU governments by launching a campaign of mail-borne anthrax attacks against governmental buildings in Europe.

With the support of an international terrorist’s organisation, the terrorists mail 54 letters containing anthrax spores to intermediate level civil servants at the Ministry of Defence and the main municipal buildings in the 27 EU capital cities.

Following the international postal distribution lines, the letters are reaching their targets in the next days (day 1 to 5). Each anthrax letter includes a short message announcing mass release of aerosolized anthrax in EU urban areas if any EU MS join the global military intervention. Official buildings where envelopes were detected are partly or completely evacuated. Samples were collected and send for identification/confirmation of anthrax.

One envelope arrived damaged with only residual traces of anthrax powder, suggesting that contaminations events occurred along the distribution line. The public postal services are paralyzed. 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.

Parameter	Value
Key parameters triggering response	
Threat agent • Physical properties	Anthrax • Spores in powder • Gram-positive • Rod-shaped, size 1 micron by 3-5 micron
Symptoms	• Fever • Malaise • Fatigue • Severe respiratory distress • Shock and death
Time for onset of symptoms	1-6 days from inhalation
Amount detected or observed	N/A
Release mechanism	Mail, aerosolization from opening of letters
Path of intake	Inhalation
Observations/alert	Powder and message in letters Symptoms in postal clerk Identification in laboratories
Detection/identification	Identification in microbiology laboratories
Casualties	A few
Fate of agent	Contagious. Persisting in environment for decades.
Influencing parameters	
Weather • Temperature • Precipitation	N/A
Population at risk	Intended recipients, others in same room/building, postal employees
Timing of incident	N/A
Location	Postal distribution infrastructure. Administrative buildings
Intentional	Yes
Environmental	May persist in environment for decades
Early phases general parameters	
Availability	Spores are stored in many bio-labs with varying security

4.2.7 B3 Biological attack on food supply – Bacterial contamination

A small group of ultra-nationalist European natives aiming at reinforcement of the national barriers to the mobility of persons and goods is contaminating massively fruits and vegetables 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”) in two Northern European plants working with products from Southern Europe. The terrorists do not claim the first series of attacks. They intend to repeat the attacks on a regular basis and hope that the geographical origin of the contaminated products will affect significantly the relationship between Northern and Southern Europe.

Parameter	Value
Key parameters triggering response	
Threat agent • Physical properties	Entero-Hemorrhagic *Escherichia coli* • Gram-negative • Rod-shaped • Freeze dried powder
Symptoms	• Severe, acute hemorrhagic diarrhoea • Abdominal cramps • Possible complication; haemolytic uremic syndrome (HUS), red blood cells are destroyed and kidneys fail
Time for onset of symptoms	1-2 days
Amount detected or observed	N/A
Release mechanism	Spread on salad
Path of intake	Ingestion
Observations/alert	Accumulation of patients with symptoms
Detection/identification	Identification in microbiology laboratories
Casualties	Several thousand develop symptoms 100 deaths
Fate of agent	Contagious Viable on surfaces if wet
Influencing parameters	
Weather • Temperature • Wind speed and direction	N/A
Population at risk	Customers, in particular children and elderly
Timing of incident	N/A
Location	N/A
Intentional	Yes
Environmental	N/A
Early phases general parameters	
Availability	Bacteria are stored in many low security labs

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

A hospital is hit by an accidental fire starting in the radiological clinic and spreading quickly. The risk of exploding gas tubes prevents proper fire-fighting, and an explosion occurs minutes later. A Caesium-137 (Cs-137) source is blown up, and the caesium chloride (CsCl) powder is transported by the blast and the smoke and dispersed in the neighbourhood.

Parameter	**Value**
Key parameters triggering response	
Threat agent • Physical properties	Cs-137 as CsCl • Fine-grained powder • Water soluble • Beta/gamma-emitter • Radioactive half-life 30 years • Particles in smoke
Symptoms	• No acute symptoms • Increased cancer risk in the long term
Time for onset of symptoms	Cancer can develop after 5-30 years
Amount detected or observed	Source is known to be 2 TBq
Release mechanism	Explosion and fire/smoke
Path of intake	Inhalation and ingestion, skin deposition
Observations/alert	Explosion in visible fire
Detection/identification	Gamma detectors showing increased levels of radiation Identification with hand-held spectrometer and in laboratory
Casualties	15 wounded by blast 30 severely contaminated 60 moderately contaminated 250 slightly contaminated
Fate of agent	Binds easily to concrete and asphalt Inhaled caesium binds in soft tissue
Influencing parameters	
Weather • Temperature • Wind speed and direction • Precipitation	• Temperature 12 ºC • Wind 5 m/s • Cloudy, no precipitation
Population at risk	200 employees and 180 patients at hospital Several hundred people close by
Timing of incident	Daytime normal workday
Location	Urban
Intentional	No
Environmental	Surroundings will be contaminated for a long time
Early phases general parameters	
Availability	Used in many medical and industrial applications

4.2.9 R2 Radiological attack on public transportation – Hidden radioactive source

The scenario sets the challenge of a hidden device, 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, the origin of the source is important.

A strong gamma emitting source is stolen from a shipyard by an employee, and subsequently 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 hand and seeks medical attention. The injuries, in conjunction with his report of handling a small metal object, trigger the suspicion of radiation damage. A team of radiation experts is sent to the trash collection area and easily localizes the source and removes it safely. The next day, the perpetrator anonymously claims responsibility for the event.

Parameter	**Value**
Key parameters triggering response	
Threat agent • Physical properties	Iridium-192 (Ir-192) as solid metal • Sealed source • Radioactive half-life 74 days • Gamma/Beta emitter
Symptoms	Local radiation damage • Burns and blisters on skin Acute radiation syndrome • Nausea and vomiting • Diarrhoea • Loss of hair • Inner bleeds • Collapse of immune system Long term • Increased cancer risk
Time for onset of symptoms	Hours to days for acute symptoms Cancer can develop after 5-30 years
Amount detected or observed	Measured to be 5.5 TBq, contact dose of ~100 Sv/min
Release mechanism	Physical placement of unshielded source
Path of intake	External exposure
Observations/alert	Symptoms eventually triggers alarm Perpetrator calling in
Detection/identification	Easily detected with dose rate meter Identification with hand-held spectrometer
Casualties	5-10 local radiation burns
Fate of agent	No traces once removed
Influencing parameters	
Weather • Temperature • Wind speed and direction	N/A
Population at risk	Tens sitting in the closest seats Hundreds in the carriage
Timing of incident	Whole work day
Location	Public transport
Intentional	Yes
Environmental	N/A
Early phases general parameters	
Availability	Used in many industrial applications

4.2.10 N1 Nuclear power plant accident – Release of fission products

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.

Parameter	**Value**
Key parameters triggering response	
Threat agent • Physical properties	Commercial power plant (3 GW_t/900 MW_e PWR) • Noble gases • Volatile substance dissolved in water • Non-volatile substance in water
Symptoms	Acute radiation syndrome • Nausea and vomiting • Diarrhoea • Loss of hair • Inner bleeds • Collapse of immune system Long term • Increased cancer risk
Time for onset of symptoms	Hours to days for acute symptoms Cancer can develop after 5-30 years
Amount detected or observed	Low levels of radioactive noble gases Low levels of external gamma radiation
Release mechanism	Rupture of fuel encapsulation, venting of gases Release of liquid effluents through normal spill water system
Path of intake	External exposure Inhalation Ingestion of farm produce
Detection/identification	Elevated radiation levels outside the reactor building is detected with dedicated equipment
Observations/alert	Alarms indicating non-specific problems in the cooling system and automatic reactor shut-down Abnormal situation reported to plant owner and authorities by phone
Casualties	None
Fate of agent	Short half-life, non-reactive substances will be diluted in air Some ground deposition transferring to farm produce and milk
Influencing parameters	
Weather • Temperature • Wind speed and direction • Precipitation	• North-westerly wind • No precipitation
Population at risk	2 million people
Timing of incident	04:00
Location	Island in river, connected by two bridges 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.
Intentional	No
Environmental	Low levels of radionuclides in surrounding environment
Early phases general parameters	
Availability	128 PWRs operating in Europe

4.2.11 H1 Hoax – Unknown powder in congress centre

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.

Parameter	**Value**
Key parameters triggering response	
'Threat agent • Physical properties	Odourless, yellow pigmented powder • No pathogenic properties
Symptoms	No real medical symptoms Experienced symptoms: • Nausea • Dizziness • Heart palpitation
Time for onset of symptoms	Directly when observing powder
Amount detected or observed	Gram quantities of powder
Release mechanism	Placement
Path of intake	N/A
Observations/alert/announcement	Call from terrorist Powder found Symptoms experienced Call to police
Detection/identification	Reference laboratory
Casualties	None real
Fate of agent	N/A
Influencing parameters	
Weather • Temperature • Wind speed and direction • Precipitation	N/A
Population at risk	None in reality People in building
Timing of incident	Daytime during congress

Location	Indoor, congress centre
Intentional	Yes
Early phases general parameters	
Availability	N/A

5. Conclusions

We see that numerous parameters can be identified from the reference set of scenarios. In order to structure them, we have assigned them to the security phases, the nature of the threat agent and to the level of response (first responders/hospital). We see that the level of detail will vary, with more specific parameters in the measurable domain. Some parameters will directly trigger a response, while others will influence the way a certain response action is performed.

6. List of abbreviations

Bq	Becquerel, (event) per second, the SI unit for radioactivity
CBRN	Chemical (C), Biological (B), Radiological (R), Nuclear (N)
Cs-137	Caesium-137, a radioactive isotope
EHEC	Entero-Hemorrhagic *Escherichia coli*
EU	European Union
FBI	Federal Bureau of Investigation (USA)
FFI	Forsvarets forskningsinstitutt (*Eng.* Norwegian Defence Research Establishment)
FOI	Totalförsvarets forskningsinstitut (*Eng*. Swedish Defence Research Agency)
GW_t	Gigawatt thermal
IAEA	International Atomic Energy Agency
Ir-192	Iridium-192, a radioactive isotope
MW_e	Megawatt electric
PRACTICE	Preparedness and Resilience Against CBRN Terrorism using Integrated Concepts and Equipment
PWR	Pressurized water reactor
SGSP	Main School of Fire Service
TBq	Terabecquerel, 10^{12} Bq
TNO	The Netherlands Organisation for Applied Research
WHO	World Health Organization
WP	Work Package

7. Literature

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