This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 662287.

EJP-CONCERT

European Joint Programme for the Integration of Radiation Protection Research

H2020 – 662287

D 9.28 Report on observational study of emergency exercises: List of uncertainties

Authors:

Tanja Perko (SCK•CEN); Vasiliki Tafili (EEAE); Roser Sala (CIEMAT); Tatiana Duranova (VUJE); Nadja Zeleznik (EIMV), Yevgeniya Tomkiv (NMBU); Ferdiana Hoti, Catrinel Turcanu (SCK•CEN)

Reviewer: Catrinel Turcanu (SCK•CEN, WP5 leader)

Work package / Task	**WP 5**	**5.2.3. Conceptualization and management of uncertainties in emergency exercises in EU countries**
Deliverable nature:	**D 5.4**	
Dissemination level: (Confidentiality)	Public	
Contractual delivery date:	**46**	
Actual delivery date:	**46**	
Version:		
Total number of pages:		
Keywords:	**Uncertainties, observation, nuclear emergency exercises, drill, social uncertainties**	

Disclaimer:

The information and views set out in these reports are those of the author(s). The European Commission may not be held responsible for the use that may be made of the information contained therein.

Abstract

In order to identify uncertainties that decision makers, affected population and emergency responders may face during a nuclear emergency, this research investigated the behavior of people involved in emergency exercises. It provides insights into the way uncertainties are addressed and handled during emergency exercises, by looking at the information flow and communication between actors, as well as the assumptions and decisions made under emergency exercise conditions. The methodological approach relies on nonparticipant observation as a technique for the systematic study of human behavior. The observers recorded actual behavior under almost completely natural conditions. In order to enhance and deepen the understanding of uncertainties in emergency management, a constructivist approach has been applied, with special attention to authenticity, trustworthiness, reflexivity, particularity and subjectivity (takes into account biases), and triangulation across data sources (capturing and respecting multiple perspectives). The objective was to maintain the integrity of unique cases/findings, to crystallise rather than generalize, and contribute to theory and dialogue about nuclear emergency management under uncertainties. 11 national exercises were observed in six countries, as well as one international exercise, with a total of 29 observation points. The observers recorded in conventional language the various behaviors and actions of emergency exercise participants and the conditions under which they occurred.

D9.28 Report on observational studies of emergency exercises may be updated based on feedback from participants to the observed exercises.

Executive summary

Results demonstrate a gap between the theory of uncertainty conceptualization and the results of the observations, as well as specifics related to a nuclear emergency management. In theoretical typologies, uncertainty is usually categorized as: aleatory (ontic/ stochastic) resulting from factors which are unpredictable, random or stochastic in nature; epistemic uncertainties, caused by limited or lack of knowledge and/or information; and uncertainties due to ambiguities. However, the non-participatory observation of exercises reveals uncertainties that cannot be readily placed in the above-mentioned categories.

The following dilemmas, causing uncertainties or being caused by uncertainties have been defined on the basis of observations: What is the origin of the first information? Is the information exchange sufficient? Which tools of information exchange are reliable? How to deal with time pressure? Which factors impact information exchange? How is information understood by different stakeholders? Is information consistent? Are all emergency actors informed timely? How to communicate negligible impacts? Is ICT reliable? Wich information is public and which information should be restricted to the emergency management teams? How will public communication/information needs be addressed effectively? Which areas will be affected? How serious is the accident? How to decide on protective actions? Which protective actions to apply? How to implement protective actions? Will people follow the instructions or recommendations given? How to deal with long-term consequences? When is the time of the beginning of the release? How to deal with technical aspects (e.g. source term) during the early phase of the

emergency? Is radiological assessment consistent? How to interpret dispersion models maps? How to coordinate cross-border aspects? How will coordination and collaboration among emergency response actors be achieved? Is there a gap between legislation (including plans) and reality? Are the preconditions of the functioning systems taken into account? Are all emergency response actors familiar with their roles, procedures and plans? Are the available resources adequate? Are the emergency actors familiar with and trained to use the equipment? Are social and ethical considerations taken into account? What comes first: safety or security?

Identification of uncertainties contributes to creating awareness about potential challenges and improving decision-making under uncertainty in nuclear emergencies.

Contents

1.Introduction

1.1 Project Context

In nuclear emergency management and post-accident recovery, addressing scientific and societal uncertainties is an intrinsic aspect of decision-making. The challenge lies within incomplete or lack of knowledge about the current situation or its predicted evolution, or the consequences of protective actions. The latter reflects uncertainties faced by the different actors (decision makers, experts, affected population, and other stakeholders) throughout their own decision-making processes.

To protect the population, conservative assumptions are often taken which may result in more overall harm than good due to secondary causalities, as observed following the Chernobyl and Fukushima accidents. Therefore, developing approaches to deal with uncertainty is crucial to improve protection, health and well-being of the affected population, and to minimise disruption of daily life.

Uncertainty is different at various stages of an emergency, which typically can be subdivided into the pre-release, release phase, post-release and the long-term recovery phases. The project CONFIDENCE (COping with uNcertainties For Improved modelling and DEcision making in Nuclear emergenCiEs) focuses on identifying and reducing uncertainties in the release and post-release phases of an emergency. The latter includes the transition between the short-term post-release and recovery phases (e.g. the first year(s)).

1.2 Task description

A dedicated work package of the CONFIDENCE project focuses on social, ethical and communication aspects of uncertainty management (WP5). The research objectives of this work package are: to identify societal uncertainties in emergency and post-accident situations, from the early phase to recovery; to highlight the ethical implications of uncertainty management; to investigate the understanding and processing of uncertain information by lay persons and emergency actors, and their subsequent decision-making behaviour in nuclear emergency situations; and to develop improved communication of uncertainties, specifically for low radiation doses.

The results of the work foreseen can be summarized as follows:

- Understanding stakeholders' response to uncertainty in past incidents and accidents (Chernobyl, Fukushima, Fleurus, Asco, Krsko);
- Identifying societal uncertainties, and clarifying the implications of the different types of uncertainty and the relationships to ethical issues;
- Gaining new insights into behavioural intentions and information needs in relation to protective actions in emergency situations;
- Assessing differences in mental models of uncertainty management for lay citizens and emergency actors in various national contexts;
- Elucidating the conceptualisation and management of uncertainties during emergency exercises in EU countries;
- Developing and testing improved communication tools through consideration of uncertainty;

- Eliciting stakeholders' preferences and priorities for uncertainty management;
- Establishing a dialogue between international experts related to coping with uncertainty in emergency and post-emergency situations.

CONFIDENCE address key uncertainties relevant for decision making, reduce them if possible and communicate them as such that decisions can be made in a more robust manner, reflecting the complexity of the real situation.

The Objective of subtask 5.2.3 (this document) is to identify uncertainties in emergency response by observation of nuclear emergency exercises in selected European countries. This document reports the results of this subtask. The non-participant observation study focused on the behaviour of people involved in emergency exercises (decision and opinion makers, first respondents and other participants in the exercises). The objective was to identify uncertainties, to gain insight in the way uncertainties are addressed and handled during emergency exercises by looking at the information flow and communication between actors, as well as the assumptions and decisions made under emergency exercises.

Ethical considerations for the subtask: All notes and material collected during observations is treated as confidential. Field notes were exchanged between task members, but not distributed outside the group. For the purpose of reporting, information on findings are generalized and presented in such a way that it isnot be possible to identify individuals participating in the exercises.

A draft of this report is made available to those responsible for the emergency exercise in each country. Participants were encouraged to provide feedback and comments on the report before its final publication.

2. Theoretical background

2.1 Definition of uncertainties

There are many definitions of uncertainty in scholarly literature, and a common definition of uncertainty related to risk doesn't exist (Aven and Renn, 2009). In fact, the risk literature often defines the risk concept with an expression of uncertainty (Hoffman et al., 2011; Rosa, 2003), a probability distribution (Graham and Weiner, 1995; Paté-Cornell, 1996) or as an event, e.g. (Abbott et al., 2006; Verhaegen and Bergmans, 2015). If risk is defined by risk probability or as an event, the understanding, interpretation and judgement of risk may also lead to uncertainties, since risk is usually expressed in numerical form as odds or subjective probabilities, which is difficult for many people to process, especially in stressful situations, e. g. (Schwartz et al., 1997; Sohn et al., 2001). Due to this, systematic error in making judgements under uncertainty often appears. This systematic error has been investigated extensively, mainly by information processing scholars. For instance, Tversky and Kahneman (1974) classified heuristics in the decision-making process related to uncertainties in three categories depending on the situation under which this systematic error can appear: 1.) representativeness, when people need to judge probability of instances or scenarios; 2.) availability of instances or scenarios, when people need to assess the frequency of the plausibility of a particular event; and 3.) adjustment from an anchor, which is employed in numerical prediction (Tversky and Kahneman, 1974).

There is little appreciation for the fact that there are many different dimensions of uncertainty, and there is a lack of understanding about their different characteristics, relative magnitudes, and available means of dealing with them. Even within the different fields of decision support (policy analysis, integrated assessment, environmental and human risk assessment, environmental impact assessment, engineering risk analysis, cost-benefit analysis, etc.), there is neither a commonly shared terminology nor agreement on a generic typology of uncertainties (Walker, Harremoes et al. 2003).

Different interpretations of uncertainties are acknowledged also in the CONFIDENCE project. The uncertainty as defined in the CONFIDENCE project "*can include stochastic uncertainties (i.e. physical randomness), epistemological uncertainties (lack of scientific knowledge), endpoint uncertainties (when the required endpoint is ill-defined), judgemental uncertainties (e.g. setting of parameter values in codes), computational uncertainties (i.e. inaccurate calculations), and modelling errors (i.e. however good the model is, it will not fit the real world perfectly). There are further uncertainties that relate to ambiguities (ill-defined meaning) and partially formed value judgements; and then there are social and ethical uncertainties (i.e. how expert recommendations are formulated and implemented in society, and what their ethical implications are)*" (French et al., 2018, c.f. French 2017). The following definition of uncertainty is used in the project:

"*Uncertainty is a situation which involves imperfect and/or unknown information related to the investigated nuclear emergency case. Uncertainty is the lack of certainty, a state of having limited knowledge or information where it is impossible to exactly describe the existing state related to the emergency, a future outcome, or more than one possible outcome including consequences. Due to a lack of knowledge, lack of information or lack of trust in information the emergency stakeholders have difficulties to make informed decisions what to do or not to do, how to react and what actions (advised or not advised) will they take. In such situation stakeholders need to make decisions under uncertainty*" (Perko and Abelshausen, 2017).

In theoretical typologies, uncertainty is categorized mainly as: *aleatory (ontic/ stochastic)* including uncertainties which are unpredictable, random or stochastic in nature and cannot be reduced; *epistemic uncertainties,* which are caused due to lack of knowledge and/or information and can be reduced with new research; and uncertainties due *to ambiguities,* which do not have a clear meaning (Walker, Harremoes et al. 2003, Walker, Kwakkel et al. 2010, Fox and Ulkumen 2011, Kunz, Grêt-Regamey et al. 2011, Knoblauch, Stauffacher et al. 2018).

The following pargraphs give an overview of societal and ethical uncertainties and definitions of uncertainties as defined by the CONFIDENCE Project (French et al., 2017, pp. 10-11).

Ethical uncertainties: Many uncertainties relate to value judgements. The emergency managers and those in charge of recovery need to consider how to balance different types of costs related to strategies and their impacts: health, social, environmental, economic, etc. For instance, managers may be charged with *minimising health effects* but may not know precisely what is meant by this. What is a health effect? The imperative to *minimise* implies that they must be quantified in some way. But in what way? By number, scale, some combination? Does it matter who suffers the health effect? Should they care more about

health effects in children than adults? If the risk is long term, is the focus on immediate or long term health effects in present populations or the health of future generations? Is a physical health detriment to a few more important than a mental health detriment to many? There are a host of uncertainties which need to be unpacked and defined before the imperative to 'minimise health effects' can be operationalised and followed. These uncertainties relating to values and ethics clearly have a different character compared to stochastic or epistemological uncertainties.

Moreover, in resolving such uncertainties, we should recognise that decision makers often aim at representing a wider group of stakeholders, maybe an organisation, a local community or the wider public. This brings to the fore the question of whose values and ethics should be drawn into the decision making. The decision makers need to understand and articulate the values and ethics of the people whom they represent. This can bring into the mix some epistemological uncertainty in which the decision makers seek to learn what their constituents want. Methods of opinion polling may be used which can result in formal probabilistic representations of public values in some sense. But in complex cases, stakeholder workshops and other interactive forms of engagement are to be used to provide the decision makers with a qualitative understanding of the values and ethics that should flow through their decisions.

Experience, notably from the Chernobyl and Fukushima accidents but also from non-nuclear accidents, shows that stakeholders' values, ethical considerations, requirements for public communication and the contrasting needs and concerns of people in different environments are key factors influencing the effectiveness of risk assessment and management. In particular, the inherent societal uncertainties, the different perceptions of risk, and the societal (dis)trust issues pose important challenges to radiological risk governance.

Societal and ethical uncertainties are most often used to describe the way recommendations and information is taken up by lay people and other publics (i.e., whether the advice given by modellers and/or authorities is acted upon). Models are always based on assumptions about the social context where decisions take place (e.g. that people will accept to live in contaminated territories). Therefore, the efficiency of protection strategies depends significantly on the way the social context is understood and accounted for in decision-making. Social and ethical uncertainties can also be attached to the decisions, choices and assumptions made by modellers, scientists and other experts during their 'scientific' assessment (i.e., the selection of data, coefficients, criteria, target populations or reference organisms, levels of significance for statistical testing, etc.).

Societal uncertainties can be found in how expert recommendations are implemented in society may refer to public acceptance and compliance with protective actions advice; the social and economic consequences of the recommendation and actions, and uncertainties in those consequences; and the level of stakeholder and public engagement used or planned.

Ethical uncertainties may refer to:

- Acceptance of risk (either "scientific - it is below the number"; or "other – I didn't give consent"
- Being sensitive to inequalities in the distribution of risk
- Any mention of the way in which autonomy, governance, responsibility, transparency might impact on public acceptance of risk

Societal and ethical uncertainties can also be recognized in expert recommendations. For instance, is there any discussion on possible societal or economic consequences? Are challenges of criteria selection (e.g. worst case? vs best possible estimate) discussed? And are any of the above taken up in the expert/authority recommendations or decisions?

Communication of uncertainties

To include communication about uncertainties in public communication strategies is highly advised by different EU projects, for instance PREPARE and EAGLE, ARGOS, as well as by risk communication researchers, since it helps people to make informed-decisions (Perko et al., 2015; Perko et al., 2017; Perko et al., 2016a; Perko et al., 2016b; Ropeik, 2011; Sandman, 1987; Shirabe et al., 2015). It is also advised that emergency actors admit uncertainties in their communication to public(s) (IAEA, 2012, 2014; OECD/NEA, 2015; Perko, 2016; Perko et al., 2016). However, systematic removal of uncertainty from public information is common in practice, especially related to emergency situation. Jensen et. al. (2017) found that although scientists often try to thread uncertainty into their discourse (e.g., a limitations section), it has been observed that this information is systematically removed as scientific discovery is prepared for public communication (Jensen, 2017). The FP7 project EAGLE found out in discussions with experts that this systematic removal of uncertainty from public information related to ionising radiation is often done due to lack of methods and tools to communicate uncertain information (http://eagle.sckcen.be/en/Deliverables).

2.2 Nuclear emergency exercises

Emergency response exercises are a key component of a good emergency preparedness program. They can provide unique insight in the state of preparedness of nuclear emergency response organizations. They can also be the basis for continued improvement programs for the over emergency response infrastructure. However, to be most useful, emergency response exercise need to be well organized, professionally conducted and their evaluation must focus on constructive improvement potential (IAEA, 2005). Under the term exercises we understand drills, table-top exercises, partial and full-scale, on- and off-site exercises, as well as field exercises.

As stated in in the Safety requirements for Preparedness and Response for a Nuclear or Radiological Emergency (Safety Standard Series No. GS-R-2), "…*The operator and the response organizations shall make arrangements for the selection of personnel and training to ensure that the personnel have the requisite knowledge, skills, abilities, equipment, procedures and other arrangements to perform their assigned response functions…*" "…Exercise programmes shall be conducted to ensure that all specified functions required to be performed for emergency response and all organizational interfaces of facilities.

Objectives of nuclear exercises: Exercises, trainings and drills are an important aspect of the preparedness phase. Exercises are conducted to ensure that all specified functions required to be performed for a

nuclear emergency response and all organizational interfaces for facilities are tested at suitable intervals. Exercises should include the participation of as many as possible of the organizations concerned (IAEA, 2002).

In the exercises one or more objectives of the emergency response can be trained and/or tested. The objectives are part of the exercise specifications, written in the exercise plan. In a nuclear or radiological emergency the practical goals of emergency response are (as defined in IAEA Safety Standards para. 2.3 (2002)):

(a) To regain control of the situation;
(b) To prevent or mitigate consequences at the scene;
(c) To prevent the occurrence of deterministic health effects in workers and the public;
(d) To render first aid and to manage the treatment of radiation injuries;
(e) To prevent, to the extent practicable, the occurrence of stochastic health effects in the population;
(f) To prevent, to the extent practicable, the occurrence of non-radiological effects on individuals and among the population;
(g) To protect, to the extent practicable, property and the environment;
(h) To prepare, to the extent practicable, for the resumption of normal social and economic activity.

The following specific aspects can be addressed during an emergency exercise; the establishment of agreements and protocols, function of authorities and technical organizations, their interaction, staffing and qualifications, test of the response plans, clearness of roles and procedures, as well as provisions for public information and logistical support needed. In addition, the stakeholder's engagement can be evaluated. The exercise objective is defined as the result that must be achieved when performing an action.

Frequency of the exercises: The staff responsible for critical response functions for a facility should participate in a training, exercise or drill at least once every year or on an appropriate schedule as defined by IAEA (2002). In addition, the officials off the site responsible for making decisions on protective actions for the population within the precautionary action zone and/or the urgent protective action planning zone should be trained in the strategy for protective action and should regularly participate in exercises. The performance of exercises at facilities should be evaluated against established response objectives that demonstrate that identification, notification, activation and other initial response actions can be performed in time to achieve the practical goals of an emergency response.

All European countries with nuclear power plants (NPP) carry out emergency exercises in order to test emergency preparedness and response for on-site and/or off-site emergencies at least once per year (see figure 1). This is in line with IAEA requirements (GS-R-2) (IAEA, 2002). The frequency of exercising broad national arrangements varies from several per year to about once every five years (ENCO, 2013). In addition, specific cross-border exercises are organized by several countries where NPP are sited in relatively close proximity to the border of a neighboring country (e.g. Belgium, France). At international level additional exercises are organized every few years e.g. CONVEX, INEX or ECURIE exercises.

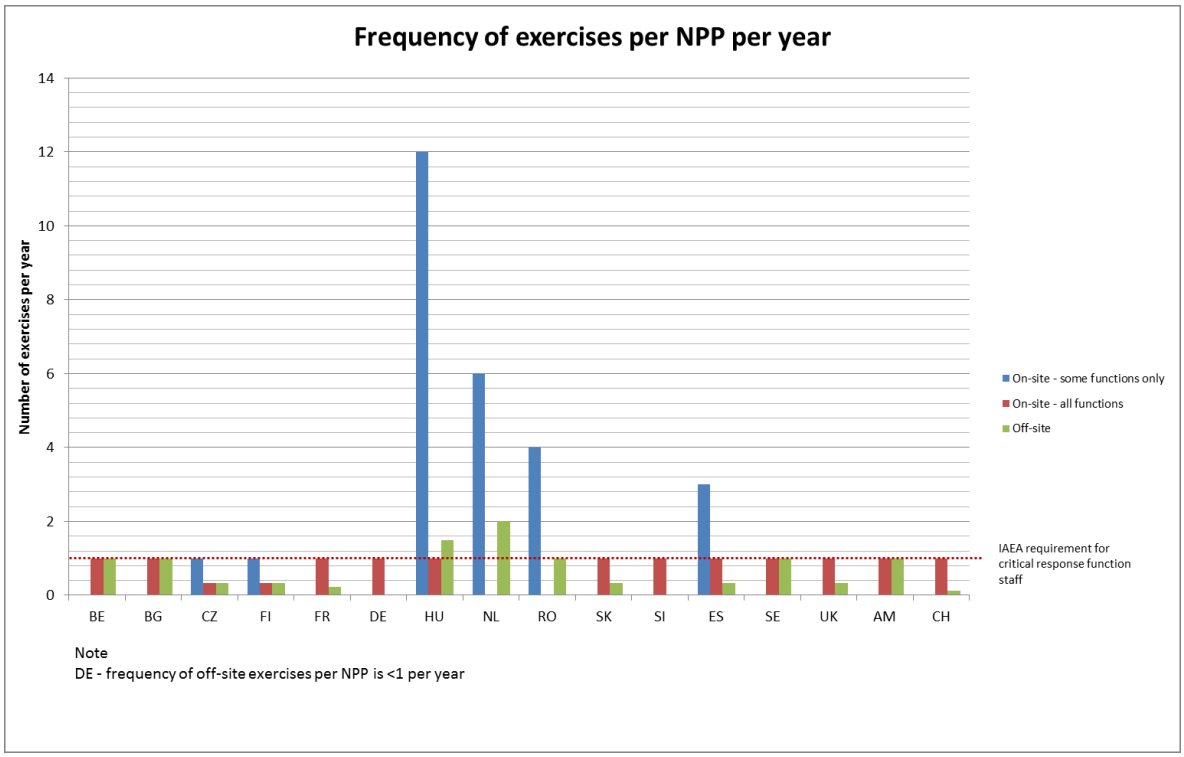


Figure 1: Frequency of exercises per NPP per year, (ENCO, 2013)

Management of the exercises: The exercise management committee consists of senior decision-makers and planners from key participating organizations as well as regulators. The chair of the exercise management committee is normally the exercise director. The following positions are involved in the management committee: an exercise director; a lead controller and lead evaluator; on-site/off-site representatives; and representatives of major stakeholders (Figure 2).

Figure 2: Organisation of the exercise management and roles

The exercise specifications consist of the objectives, scope and constraints related to the exercise. Exercise objectives are based on the response objectives relevant to the plans being exercised. A response objective is defined as the result that must be achieved when performing an action (IAEA, 2005).

The scope of the exercise includes: selecting the organizations that will participate and the extent of their participation; deciding on the time and duration of the exercise; and determining the extent of the actions that will be carried out during the exercise.

Exercise objectives are often subject to constraints imposed by practical considerations. For example, it may not always be possible to start the exercise in the middle of the night, even though this would allow a useful test of the functions at a time when people are least available. Financial resources may also be limited and prevent the conduct of an exercise lasting more than one day. There may also be other priorities, political or other, that restrict the time available for the exercise, or that limit the participation of important organizations. Constraints should be identified early in the process to avoid wasting efforts in designing an exercise that cannot be implemented (IAEA, 2005).

A general outline of the exercise scenario should include:
- start state;
- key events and critical timeline;
- technical scenario;
- detailed sequence of events;
- narrative;
- master events list; and
- exercise inputs and data.

The critical timeline is the time at which key events must occur in order to allow the participating organizations to take appropriate actions. These events are often developed in table format and contain the following information: input sequential number; time at which the input is to be provided; the message, data or action that is to be delivered; comments, if needed.

3. Method

3.1 Nonparticipant observation

Nonparticipant observation as a technique for the systematic study of human behaviour (Barner-Barry, 1986; Liu and Maitlis, 2010) was applied. The CONFIDENCE researchers recorded not only actual behaviour, but also recorded that behaviour under almost completely natural conditions. Measures were taken to minimise the disruptive effects of the presence of the observer. It has been agreed between observers that the disruptive effect of observers was minimal and diminshed very quickly over time, similar to other studies (Barner-Barry, 1986; Birdwhistell, 1972). In order to enhance and deepen understanding of uncertainties in emergency management a constructivist approach has been applied (Pattonn, 2002). Thus a special attention was given to authenticity, trustworthiness, reflexivity, particularity and subjectivity (takes into account biases), triangulation across data sources or theoretical perspectives (capturing and respecting multiple perspectives). The objective was to maintain integrity of unique cases/findings, to crystallise rather than generalise and contribute to theory and dialogue.

A "*Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers*" has been developed to insure the highest quality of the research ((Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H., 2017) .

3.2 Observations conducted

Eleven nuclear or radiological exercises were observed in 6 countries and one international exercise. Observers recorded in conventional language the various behaviours of the emergency exercise participants and the conditions under which they accrued were noted at 29 observation points. Six intermediate – observation case reports were finalised (supplementing and refining the field notes and the record was analysed in order to broke it up into behavioural situation unit) and uncertainties were preliminary identified and reprted in national reports (Annex). Field notes are stored by the 5.3 task memebers and indicated as confidential document to ensure anonymisation of the non-participatory observations.

Table 1: Observations conducted

Country	Exercise	Type/level	Players	Date	Observation points

Belgium	Site nuclear emergency	Limited nuclear emergency exercise	From installation: emergency headquarter, first responders, measurement team, employees (evacuation), From Federal Crisis Centre: evaluation cell	02/06/ 2017	A) Crisis centre: management of the emergency
					B) Site emergency center
					C) Evacuation room
Belgium	Non-nuclear emergency exercise at a nuclear installation	Confined to installation	From installation: Firefighters, medical team, employees and visitors, emergency headquarter	25/10/ 2018	A) Assembly point (where evacuated employees assembled)
					B) Emergency management headquarter at the installation
					C) First responders: medical team
					D) First responders: firefighters
Belgium	Nuclear emergency exercise	Federal level	From installation: all services and employees;	20/11/ 2018	A) Measurement team: Field work
					B) Federal cell: radiological evaluation cell

			From federal Crisis Centre: radiological evaluation cell, decision cell measurement cell, communication cell First responders: Civil protection, measurement team, police Local stakeholders: local community		C) Headquarter of the measurement team: Local coordination cell
					D) Local emergency centre
					E) Home of a first responder: member of measurement team during an activation
Greece	Nuclear accident abroad	National level	Regulatory authority	04/07/ 2018	A) Incident command centre: Decision-makers B) Communication cell: public information officer C) Experts- advisors: Supporting teams (e.g. models simulation)
OECD/NEA	Cross-border nuclear emergency (INEX5)	Internatio-nal level	Nuclear emergency authorities from EU countries	24 & 25/ 10/2017	A) Decision-makers: nuclear safety authorities (HERCA)

Norway	Nuclear submarine emergency	Internatio-nal waters	The entire emergency response organization-all players	11/12/ 2018	A) Emergency management centre
Slovak Republic	Site nuclear emergency exercise	On-site	The entire emergency response organisation - all players	26/10/ 2017	A) Emergency response centre: decision makers B) Assembly point - sheltering and follow-up evacuation
Slovak Republic	Site nuclear emergency exercise	On-site	The entire emergency response organisation - all players	09/11/ 2017	A) Medical centre: decontamination of injured person B) Evacuation route C) Assembly point - sheltering and follow-up evacuation D) Emergency response centre : meeting of group leaders E) Debriefing point
Slovak Republic	Nuclear emergency exercise	Full size on-site - off-site	Nuclear installation: the whole emergency response organisation, including employees Nuclear Regulatory Authority	25/10/ 2018	A) Regional Civil Protection and Crisis Management Office B) Check point: schoolchildren

					evacuation, decontamination
			Regional level: the whole Regional Crisis Staff, First responders School children		
Slovenia	Nuclear emergency exercise	National level	Institutions: NPP Krško, Information centre of RS, Regional information centre Brežice, Agency for Environment, Slovenian Nuclear Safety Authority	06/06/ 2018	A) Emergency command centre at a nuclear safety authority
Spain	Nuclear emergency exercise	National level	From installation: emergency headquarter, first responders, measurement team, employees (evacuation) From national crisis centre: emergency cell	22/03/ 2018	A) Crisis centre: management of the emergency B) Emergency room of the Nuclear Safety Council
Spain	Nuclear emergency exercise	Regional level	From regional crisis Centre: evaluation cell, emergency management, civil protection, police	12/04/ 2018	A) Operative Coordination Centre in the region

3.3 Research Procedure

In order to identify uncertainties related to the nuclear emergency situation addressed in the exercise, the following research procedure was applied (Figure 3):

1. Research protocol – methodological document was developed;

2. Training of observers was conducted;

3. Approval for the observations was issued;

4. Observation points were selected based on the objectives of the exercise and objectives of the CONFIDENCE study;

5. Non-participatory observations were done and detailed notes written (field notes are classified as confidential document);

6. Additional open interviews were conducted in order to clarify decisions taken during the exercise and the behavior of the exercise participants;

7. Preliminary analysis of the collected notes was conducted with national CONFIDENCE team of researchers;

8. Workshop of the subtask 5.3.2 and 5.3.1 was organized in order to define a conduct for the analysis;

9. The field notes have been analysed individualy by 4 independent reserchers and discussed on the consensus workshop. The uncertainties and exect wording of the uncertainty expression from field notes have been disscussed and agreed by the CONFIDENCE task 5.3 members.

10. A draft of the final project report was made available to those responsible for the emergency exercise in each country. Participants were encouraged to provide feedback and comment on the report before final publication.

11. Agreed and final fist of uncertainties was created and reported in the result section of this deliverable D5.4.

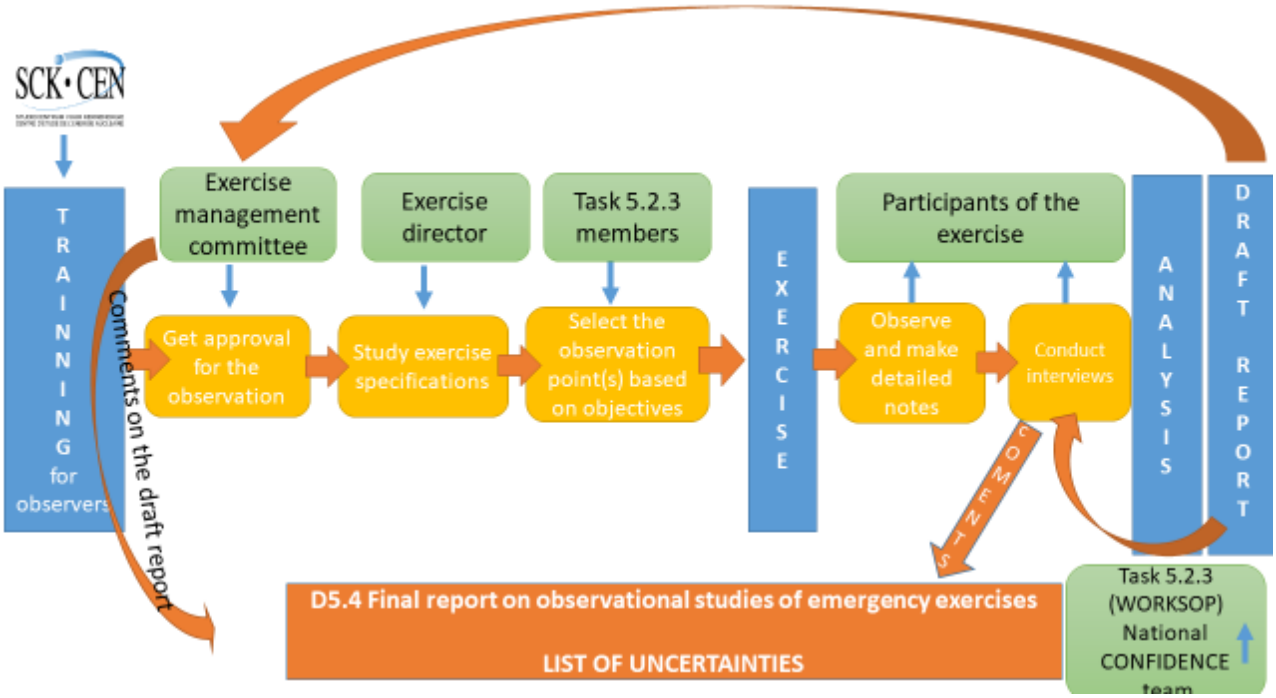


Figure 3: Research procedure

4. Results

4.1 List of uncertainties

Through the nonparticipatory observation of eleven nuclear or radiological exercises in six countries and one international exercise and at 29 observation points, this research identifies the following uncertainties that appeared to different participants of the observed emergency exercises:

- Uncertainty: What is the origin of the first information?
- Uncertainty: Is the information exchange sufficient?
- Uncertainty: Which tools of information exchange are reliable?
- Uncertainty: How to deal with time pressure?
- Uncertainty: Which factors impact information exchange?
- Uncertainty: How is information understood by different stakeholders?
- Uncertainty: Is information consistent?
- Uncertainty: Are all emergency actors informed timely?
- Uncertainty: How to communicate negligible impacts?
- Uncertainty: Is Information Communication Technology reliable?
- Uncertainty: Wich information is public and which information should be restricted to the emergency management?
- Uncertainty: How public communication/information needs will be addressed effectively?
- Uncertainty: Which areas will be affected?
- Uncertainty: How serious is the accident?
- Uncertainty: How to decide on protective actions?
- Uncertainties: Which protective actions to apply?
- Uncertainty: How to implement protective action?
- Uncertainty: Will people follow the instructions or recommendations given?
- Uncertainty: How to deal with long-term consequences?
- Uncertainty: When is the time of the beginning of the release?
- Uncertainty: How to deal with technical aspects (e.g. source term) during the early phase of the emergency?
- Uncertainty: Is radiological assessment consistent?
- Uncertainty: How to interpret dispersion models maps?
- Uncertainty: How to coordinate cross-border aspects?
- Uncertainty: How coordination and collaboration among emergency response actors will be achieved?
- Uncertainty: Is there a gap between legislation (including plans) and reality ?
- Uncertainty: Are the preconditions of the functioning systems taken into account?
- Uncertainty: Are all emergency response actors familiar with their roles, procedures and plans?

- Uncertainty: Are the available resources adequate?
- Uncertainty: Are the emergency actors familiar and trained to use equipment?
- Uncertainty: Are social and ethical considerations taken into account?
- Uncertainty: What comes first: Safety or security?

4.2 Uncertainty: What is the origin of the first information?

The uncertainty related to origin of the first infmation related to the emergeny appeared mainly in decision-making body of an emergency management and to the people responsible for public information and communication.

The following sentences taken from field notes illustrate this uncertainty: *"Several news sites report on possible nuclear accident in a neighboring country."; "There is not yet any official notification/information" (source of information: internet); "Probably it would be first information…" - "We received only this information". - Bilateral notification (agreements) is faster and more useful than standard report form of IAEA."; Why is there no alarm. - Yes, there is no alarm so we don't have to go outside"; "Won't we be warned via mobile phone?"*

4.3 Uncertainty: Is the information exchange sufficient?

The uncertainty related to sufficiency of the information exchange appeared often during the observed national emergency exercises in all countries (except in Norway), as well as during the international exercise. Decision-makers and emergency manangers as well as people in the assembly room have been faced with this uncertainty. This uncertainty is mainly caused by the lack of information, deficiency of communication or miscommunication.

The following sentences taken from field notes illustrate this uncertainty: *"There is no official confirmation yet about the accident." ; "The situation and the conditions in the plant are not known."; "Information about the situation and conditions in the plant which is needed to assess the hazard for the country is limited." ; "It seems that a release is possible"; "No definite conclusion could be reached based on the available information." ; "PR asked if the internet dark site will be activated - Response: not yet"; "Some members have information not available to others."; "Even though the person in charge of receiving the USIE and ECURIE messages was in the room, the experts' teams were not informed on time about new information available through these mechanisms."; "Discussion among the members of all teams regarding the more effective way of being notified and informed about the messages sent through ECURIE and USIE."; "The level of expectations related to information is different at different countries."; "Maybe we forgot some information. Maybe some other would like to have more.- one is saying yes, the other is saying no." "Important information is missing: intervention doses (it is not clear from the picture whether is this a real release or prognoses), is it controlled release, duration of release."; "If the forms are completed correctly there is enough information."; "Source term estimation at Unit X NoY - what was the basis for that estimation? - Without answer."; "The communication with bus driver has to be improved, there was not contact and evacuees were waiting without information."; "Fire brigade - they received command on intervention and response, whom from?"; "There is currently no information from the Main Control Room*

because they have been evacuated, a warning before evacuation from the command room. The ID level is not yet known."; "Is evacuation in control room X finished? Have they managed to get to emergency panel"; "They wonder if the reactor of unit X has been stopped.- Some confusion exists regarding the unit in which the emergency alert has been declared."; "Complex information flow. They use verbal statements and also documents to share information, they are 14 people."; "Someone asked: do they have reported anything else regarding the fire?"; "They want more information about the injured. They are not clear about the notification number of the declaration of ending of the event."; "They realized they have no information about the situation of the fire in unit X, they assume that it is not under control."; "They do not know what compressor is damaged ""the alpha?"" Communication about the damages is not clear."; "We need data! Is it possible to obtain sample somehow?"; "No data about radiological levels."; "They realized they have no information about the fire."; "They don't have information about radiological values."; "XY asks for the wind direction: S – S/W (the opposite of earlier)."; "They say that they have no information about the other measurement teams and what they have measured, unless you overhear them via radio."; "XY says yes, basically you simply get in the car and follow assignments. That's it. Content-wise you know almost nothing. XY says in fact the information about the discharge is something the measurement teams should get, then they would know e.g. whether or not to take Iodine tablets. XY says communication is never easy."; "Several people make phone calls and ask to stand-by. Somebody (who was called) asks what this means, what do they have to do; The answer is "I cannot tell you what to do, I just have to let you know to be on standby"; "Did the firemen intervene? - - Probably yes."; "We do not know exactly the origin of the release of iodine".; "Where did the firemen go? - Don't know exactly"; ""We don't know what is going on. No info about meteorological data, technical data, no information from basis coordinator, no contact with the authorities."; "Discussion on where is the person from the methorological institute. In the place of the accident? It is not clear."; "Did you contact Nucear safety authority? Do you have more information? - "No, I don't have any new information"; "You have to take contact with basecamp coordinator"; "We cannot decide on the measurement strategy since we don't have information from the facility."; "They tell that they still have no contact with the liaison from the facility."; "We still have no contact with the faciity, is he still not present? - But he should already be here? -- yes, but we still have nothing like contact"; "Is the decontamination unit informed ? Have they arrived ?- - I do not know".; "The problem for them came from the fact that the 112 did not mention that the intervention was specific. They came without their material. When they arrived on the site, they first received inappropriate masks because the facility personnel was not aware of what they needed."; "Finally, they were not aware that there was a fire, no communication with fire services".

4.3 Uncertainty: Which tools of information exchange are reliable?

Decision-makers in Incident Command Centres have been often uncertain whether the tools for information exchange were reliable. The communication channels were often broken or pertubed by a lot of noise, overloading of lines, bed signal or inoperative information exchange tools, leading to uncertainties for emergency mananagement actors. This was common uncertainty in all countries and in international exercise. Emergency measurement teams also had to deal with the same uncertainty.

The following sentences taken from field notes illustrate this uncertainty: *"Main communication channel is private phone.- Technical problems with communication technology."; "It was difficult to understand the*

message of the colleagues through the radio"; "Message through radio, very hard to understand."; "XY tries to reach physical control with the radio because they rang on the Nokia, but they don't answer. He tries with his own mobile phone but also no answer."; "All telephone numbers from ministry of defense don't work. They don't know how to establish a contact with military. - They told us that these numbers have been checked one week ago and everything was ok. Now, we cannot reach anyone."; "I checked: telephone numbers are not valid since months ago. However, military doesn't play the exercise anymore due to real protests on the streets."; "The person in charge asked if we can have access to specific folder in the internal network – access was not possible through the laptop of the room."; "IT department informs about blackout in telephone lines and internet access."; "Phone calls for establishing reliable info. according to the need to know. - this would be too many phone calls and would cause a delay in decisions. - Telephone calls are useful, but should be limited. - Videoconference is ok, however you have to prepare it well in advance. You can lose too much of time. Telephone call is better. - It is not useful to have videoconferences – too many experts, too much of time."; "Is communication with the police out of scope for this exercise? What about SMS warnings or information?"; "The first call was unsuccessful; X is repeating information to Y, because the first info was inaudible; Z is trying to inform HQ via landline - not successful, next via mobile – successful."; "The radio is not working very well there. Did not hear well."; "The problems with mobile operators: even there are information what to do, even so there will be a lot of different calls and network will be overloaded."; "Calling to responsible person with request to switch on sirens. Number is occupied. Curier is sent to fulfil the command."; "The emergency plan establishes that citizens have to be informed by megaphone from the town hall. Would this help to the emergency management?".

4.4 Uncertainty: How to deal with time pressure?

Time preasure during an ongoing emergency causes a lot of uncertainties, especially for decision-makers. Most often decisions have to be taken without all necessary data. The procedures, e.g. validation of results or inserting data in templates, are time consuming.

The following sentences taken from field notes illustrate this uncertainty or causes for this uncertainty: *"We have to make an advice based on the information that we have, although it is not updated."; "No data yet from measurement teams"; "Expert for other emergency cell comes and asks whether there is any result from the radiological evaluation already: because we sit there with people waiting"; "The fire service was really quick, but the time from the extraction of the victim until its medical treatment lasted far too long. Around 55min. They do not understand why it was so slow!"; "The validation is needed and this takes time. Summary: bilateral agreements are faster than IAEA report."; "We would not wait for a heavy accident. In our country we don't have iodine pre-distributed to houses. We would immediately start preparing."; "In one case - release of command on activation of notification and warning system for the degree of emergency 2 "Emergency on-site" it took one minute more (6 instead of 5minutes) because of getting more information and data during communication, not only that under the procedure."; "Time limits were not fulfilled for two criteria related to preparation and sending of reports to NRA with deviation 1 and 6 minutes caused by transfer of information into the written form of reports - templates."; "While finishing one report, other data came. Too quick change of the situation under the scenario. Complex scenario brought*

complications, but work was very flexible."; "Output of information centre is demanding. If the routine announcements are not recorded in advance it will take more time."

4.5 Uncertainty: Which factors impact information exchange?

This uncertainty deals with factors influencing information exchange. A multilingual environment, noise, communicating too fast, overload of correspondence, low trust, new templates, (not)updated point of contact, radio channels, missing factual data and the speed of new media information may impact the information exchange.

The following sentences taken from field notes illustrate this uncertainty or causes of this uncertainty: *"Different languages used in an emergency cell. Experts are addressing experts in wrong languages. Some experts don't speak some languages and can't follow all the discussion."; "One expert tries to translate to other expert in English (not enough time to translate everything)"; "Expert is using google translate to understand Logbook of the emergency centre."; "All information, radiological information is given vocally, really fast and experts are trying to write down."; "We can't hear you – It is a lot of noise"; "One expert can't give an advice related to vegetable since she did not understand the language used. They explain it in another language."; "They are trying to find the correct e-mail."; "We need to make sure they don't send us in the wrong direction."; "The communication through the radio is difficult to understand. It is like the persons speaking are holding it upside down. Some people also talk very fast in mother tong not taking into account that this is a second language for the recipient of the information."; "New form comes in with technical information; form not clear."; "XY tried several times to contact the facility expert but also got the wrong person."; "Sometimes forms from the facility are not very clear or info not readable -> clarified via web conference."; "Dissemination of printed information: at some point not printed anymore because displayed on screen: however, this is important for people coming in; oral info can be misinterpreted; after the crisis the basis is the written info."; "Trying to find the correct radio channel to reach Civil protection (there are some changes related to use of chat groups that not everybody is informed : know) they are using different channels."; ""Bad radio-communication because of the siren overall in the town."; "Problem of information between cc-prov and cp-ops: they did not get good information from them."; "Discussion about the distance of the accident power plant in order to include this information in the press release - They are not sure what the exact distance is."; "Speed of news and information transfer-social media – how will that impact sharing of information?"; "Someone else pick-up the phone at emergency service (not one expected to pick-up)."; "Not all hear well as there are a lot of people around and voice coming through mask is not so loud."; "Some did not hear well and went to the area where none contaminated are gathered. "*

4.6 Uncertainty: How is information understood by different stakeholders?

This uncertainty deals with how information is understood by different stakeholders. This uncertainty appeared for different decision-makers, experts, affected population as well as general public. Examples are how will media report about the emergency, will foreigners at the location of an emergency understand instructions, how will the use of jargon and scientific language affect lay people's behaviour, will all affected communities understand and interpret the information the same way, will decision-makers

understand the tasks the same way, or will the affected populations interpret the instructions the same way.

The following sentences taken from field notes illustrate this uncertainty or causes of this uncertainty: *"After a while, a notification in one of a national language came on the television screen, even though there were a lot of English-speaking people at the gathering place. Durong the final minutes of the exercise, an English notification came on as well."; "Public relations dept. monitors the media about news stories regarding the accident." ; "Our experts were talking to local authorities in such a language that they could not understand anything. "; "How the public and technical experts interface should be discussed and improved."; "Possibility for miscommunication in similar but different languages e.g. Slovak-Czech; Croatian-Slovenian)."; "Are the 3 municipalities the only ones with problems?"; "Are we handling the more acute phase or are we also planning for the handling the next months – this is unclear to me."; "Some of employees are putting on the coat immediately, even the staff is informing loudly that that situation could last some time, may be about half an hour and there will be hot in here. They should be only prepared now, not to start evacuation."; "Will we be surely evacuated"; "There was a question in a foreign language (not English) - they were translated it with a Google translator, they will answer in a national language."; "Regulators' inspector speaks with regulatory body by phone. She explains the state of the emergency; she has doubts about the declared events. She consults her notes, but it seems it is not clear for her."*

4.7 Uncertainty: Is information consistent?

This concerns for instance the time between the moment in which the emergency occurred and the moment in which emergency is declared; inconsistency in dates on templates, units, comas in numbers, inconsistent instructions for iodine tablets, inconsistent public information about the release, inconsistent information about victims.

The following sentences taken from field notes illustrate this uncertainty: *"The information about base camp is not correct. Something is wrong."; "Team 2 also didn't come to the building. Coordinator is looking for them."; "A secretary comes in and asks for guidance regarding what should be said to the public that calls for information about the accident and required actions."; Date on the template (communication to NRA) is wrong."; "Inconsistent information that the different members of decision makers have has been identified."; The head of experts group said that the meteorological data are not ok. - There are doubts about how reliable the meteorological data could be."; "09.42: the "Follow-up written information No. 1"; 10.02: person X is receiving info from person Y about escalating situation to 3rd degree which is General Emergency, recommends the preparation of evacuation; 10.16; "Follow-up written information No.1"; 10.19: "Follow-up written information No. 1"; 10:28: "Follow-up written information No. 1"; 10.29: Follow-up written information No.1"; 10.37: "Follow-up written information No.1"; 11.16: person Y is asking to prepare "Follow-up written information No. 2"; "The last exchange of KI in 2017 was done in other way as usual. The KI pills were ordered in other country (X) and did not fit to the country (Y) legislation in leaflet given with pills and number of pills in a single box was not the same as usual. For decades the countrie's Y supplier delivered KI pills in a box with 4 pills - first two has to be taken immediately after emergency announcement and recommendation and other two pills has to be taken later on when recommended. All are recommended to take pills with instructions how much to take for children written in the leaflet. So each from population living in the emergency planning zone received each 5 years new personal box of KI*

pills and returned the old ones. The different packing and instructions caused a lot of additional work and confusion in comparison to previous decades of pills exchange campaigns."; "The level of water was wrongly given in the report (1.031 instead of 10.31). Checking once more already sent report, the mistake has been recognized and had telephone call with NRA Emergency staff member correcting the number." ; "Noticed that the fax includes wrong risk level, it must be corrected by the national authority."; "Evacuation of control room of unit no.X starts: - in 10 minutes we have to get hold of the remote control panel, if not we will have to change to category 3, - we have 15 minutes to restore control- Exact minutes of the emergency protocols are not clear."; "They have doubts about the exact moment of the declaration of the event."; "They change the time of the event declaration.- Some doubts appear regarding the exact time of the event. They are really worried about this. Confusion between the moment in which it occurs and the moment in which it is declared."; "Doubts about the declaration of the injured person: Emergency Director says: The injured has not been notified, right?"; "Some doubts appear about the location of one of the injured."; "They realized about a communication mistake: there are 2 injured, not 3."; "The regulator's inspector realized that the location of the contamination of the second injured is not written correctly on the whiteboard."; "The contamination of the injured is not written down properly and people can not read it."; "The regulator calls the inspector asking something, she insists "they have not said it, I tell you everything they have said verbatim". "The technicians doubt about the exact time of activation of the evacuation (5 minutes). The experts say this cannot happen, but also that it happens very often."; Computers in helicopter crash. They needed to land and restart all equipment once more.".

4.8 Uncertainty: Are all emergency actors informed timely?

This uncertainty deals with the timeliness of information, i.e. are all emergency actors informed timely? This uncertainty has been observed by the following actors: military, radiological evaluation cell, first responders, decisionmakers, local politicians. The uncertainty relates, among others, to delays in information transmition, start time of procedures, information about the situation, broken communication, information to local decision makers (e.g. mayor), forgetting to inform first responders, forgetting to activate a member of a team.

The following sentences taken from field notes illustrate this uncertainty: *"There is a big delay in information transmission using different communication channels to inform first responders (in this case a firefighter)"; "Results not yet at emergency response centre."; "One fireman then highlighted the fact that they did not receive SMS signals to inform them of the incident. According to them, this was a problem and it might impede their intervention. They were happy that under those conditions they still could come fast on the site."; "One fireman told that he talked to reactor building employees that did not know what happened and did not know how to react in case of a fire alarm. According to him, this is a big problem because they have all information even on a dynamic screen. According to him, even when everything is well written, they did not know what to do."; "I hope they received information that radiological evaluation cell operational" (before Logbook failed)"; "Is military informed about the drone? It is not allowed to use drone in the domain?"; "Discussion about time, when the information must be send; person X hasn't info about preparation of iodine prophylaxis: Was instruction send? This information is not provided, he is revising report for Head Quater."; "Hope they arrived. The didn't report the arrival time"; "The announcement by shift supervisor on who is staying at their working place has to be first to that announcing*

the sheltering."; "It took 50 minutes to summon 27 members of the radiation evaluation cell. Up to now the crisis staff did not receive any real info on further situation development from NPP."; "Waiting for the information from Central Monitoring and Management Centre who has to receive information from the NPP and immediately send this information further."; "Do they exercise today?"; "There is no clear information about the situation, the signed will be called to find out what is true. - They are asking what is happening. - NPP reports that they do not receive e-mails from the national authorities."; "Discussion about the action that are taken by the regional crisis management staff."; "Discussion about the need to start using roadblocks in the 10km radius. - The subdelegate asks if he should communicate with the local mayors. - Should local mayors be informed?"; "They realized firefighters have been informed later than expected. - The regulator is in charge of all group activation (e.g. firefighters) but it seems it does not work properly. Is it because of information flow?".

4.9 Uncertainty: How to communicate negligible impacts?

The uncertainty related to communication about negligible impacts was pointed out only in one country. The public relations cell and the lead of the emergency were faced with it.

The following sentences taken from field notes ilustrate this uncertainty: *"How to report environmental impacts in case of negligible impacts?"; "Review of the press release from NPP: now there are discharges, noble gases."; "The national authority organization will correct their statement - The environmental impacts are negligible and without consequences for the inhabitants (but they are)."; "Preparation of press statement No 4: is the dose due to noble gases an increased environmental impact?"*

4.10 Uncertainty: Is Information Communiction Technology reliable?

Uncertainties related to reliability of information communication technology may be caused by broken telecommuncation, software systems, automatic warning systems, phone centres, printers, mistakes at connection between a simulator and a decision support system, malfunctions of an automatic activation system for members of an emergency team, among others. All countries observed were faced with this type of uncertainty.

The following sentences taken from field notes illustrate this uncertainty: *"Problem with internet connection continues. The ICT is not available."; "No connections with the emergency site? No video, no phone."; "Is there anybody who could contact somebody there to get more information" asks head of the emergency response centre."; "No video conference established – problem to accept a video call."; "Problems with telecommunications."; "When I interviewed one of the women who was using a cell phone with this, she explained to me that the automatic emergency number kept calling her (she lived in the "danger" area from the exercise) and that an automatic computer voice kept asking her for her ID-number. When she entered it, it did not do anything and said the number was wrong, even though it was not. It kept calling her, without ever giving the emergency message she was supposed to get."; "A software keeps breaking down. Maybe it's not connected properly? It asks quite some attention."; "The person responsible with Wapiti (WP) comes; after some troubles with starting the system, he starts filling in the information."; "Logbook software crashes"; "Information Technology department reports about the problem with the telephone lines."; "The telephone center is out of order." ; "Experts' teams were informed that the telephone center is out of order due to increased number of phone calls."; " There is a malfunctioning of*

microphone caused by network failure.; it is not possible to print documents."; "The reason of mistake was small font on the screen."; "There was mistake at simulator but they have reacted well and in time."; "There was problem in interface between simulator and decision support system."; "The display went out when prepared evaluation sheet, has to be checked."; "The regional crisis management staff lost communication with the technical support center in the NPP."; "Someone realized that the SMS send early in the morning to convene all the members in the regional crisis management staff has not reach everybody."; "But X replies I cannot enter that in the system. I can also not enter the value 0 – it automatically turns it into 1."

4.11 Uncertainty: Wich information is public and which information should be restricted to the emergency management?

Wich information is public and which information should be restricted to the emergency management team was an uncertainty with which high level decision makers, as well as first responders and members of measurement teams, were faced with in many observed countries. Often, restricted information has been made public to the affected population through radio communication used by first responders.

The following sentences taken from field notes ilustrate this uncertainty: "*How to explain to my family that I have to leave and not to disclose too much of information or increase concerns?"; "Are we ready to answer all questions?"; "We need to include facts and not assumptions in the press release."; "There is still open loud communication sound which goes from the radio transmitter and everybody could hear what is going on at the site. - There is injury during the electrical cable placement".*

4.12 Uncertainty: How public communication/information needs will be addressed effectively?

How public communication and information needs will be addressed effectively is an uncertainty faced mainly by public information officers and high level emergency management actors. A great need for information by affected population in shelters and assembly points, not updated list of contact points, no direct communation, and long waiting time for the information indicated this uncertainty.

The following sentences taken from field notes illustrate this uncertainty: *"The people in the shelters and assembly points would like to know what is going on outside."; "It is demanding to synchronize information. Information for the spokesperson is coming with delay."; "Contacted spokesperson of the enterprise - was not in agreement with decision support system, information was supported by fax. - Had no information. - The change of person at the enterprise was not announced."; "Communication is the biggest uncertainty. One of them says: the population would be really alarmed! Another responds: and we do not have anybody there informing and trying to calm the population!, - One of them clarifies "we are not evacuating, we are moving them as a preventive measure".*

4.13 Uncertainty: Which areas will be affected?

Members of evaluation cells are often uncertain about which areas will be affected not only due to the scientific uncertainties related to the source term, the meteorological conditions and the model calculations, but also due to different protective actions in different (neigbouring) countries.

The following sentences taken from field notes ilustrate this uncertainty: "At 3 km more iodine than at 2 km. Did the wind change?"; "When will the plume arrive – possibly after the midnight - Release time is needed for the assessment of the impact, yet we cannot estimate it."; "Discussion on the regions affected by the plume."; "The person in charge says that we do not know when the plume will arrive in the country"; "Plume trajectories available – discussion on specific regions."; "I would not give the information about the arrival time."; "We would wait for a map to be precise, - to check weather forecasts for identifying immediate threat. - I am not sure whether our institution would be able to issue such kind of map in 2 hours." ; "Each country calculated the area with their own model based on the same source term. - Here are discrepancies with different approaches. - The problem is that every country will calculate own protective actions."

4.14 Uncertainty: How serious is the accident?

One of the most significant observed uncertainties related to how serious the accident is, leading to further uncertainties in extent of contamination of people and environment, the level of contamination. Experts need to estimate consequences and make assumptions, and are uncertain which scenario should they base their decision on (the worst-or- the most-likely scenario) for their assumptions. Sometimes they express uncertainty in ranking the level of emergency and often they do not have insight in the number of people injured or contaminated.

"Are there people contaminated or irradiated?"; "What was exactly the accident?"; "Were the victims contaminated?"; "Release probably stabilized at around 100 GBq (twice more than before) : the origin of previous underestimation is identified."; "The staff responsible for receiving ECURIE and USIE messages was asked to clarify the type of message received e.g. alert?" ; "The amount of release and the timing cannot be specified at the moment? Assumptions have to be made?" ; "This is the outcome based on the 'good' scenario, not the worst-case scenario."; "The results show that the country could be affected, with a low, yet of the level of the international criteria impact in some areas, even in the good scenario. The areas cannot be specified!"; "The members of the Radiation Protection team discuss possible consequences of the accident."; "Instructions have to be started with "Attention, exercise". In the text for sheltered it was not the case during current exercise. It was announced for real. Templates have to be changed accordingly."; "Evaluatin cell foresees, according to known information about the situation at the NPP, that ID is ranked as risk level 1 or 2. - Increased radiation in the room, it has not been yet explained why the radiation is increased in the charging station 2"; "Doubts remain about the declaration of category 3. They wonder if it makes sense to declare category 3 to clear it in a few minutes."; "More doubts about the event declaration. Emergency protocols are consulted. - Is it possible to return to category 2 once you have declared category 3?"; "They start to discuss two options: stay in category 3 or return to category 2."; "Emergency director stated that perhaps they should keep at category 3 trying to be as conservative as possible. Others stated that it seems not logic to stay in category 3 once the control from remote control panel has been established. They finally decided to return to category 2, using the analogy of what is established in the case of fire."; "It seems that there is no forecast of radiological emission outside."; "New doubts about the real number of injured."; "Which is the category of the incident? Doubts about if its category 3. Category 3 is determined by the abandon of the control room for more than 15 minutes."; "They consult emergency protocols - Doubts regarding the numbering the level of the emergency. - 1.1.3 is clear,

but I do not see 1.2.3 as clear. Finally, they agree not to declare the event 1.2.3."; "New doubts about the declassification of the event 3.2.7".

4.15 Uncertainty: How to decide on protective actions?

Uncertainty on how to decide on protective actions is the most oftenly ecountered uncertainty in all observed countries. Experts and decision makers are faced with this decision which is not purely scientific and based on calculations. They deal with strong societal and political pressure, they are faced with uncertainties on what and whom to protect first, how to balance the different impacts and decide on protective actions, taking all societal effects into account, or what should be the extent of zones with protective actions.

The following sentences taken from field notes illustrate this uncertainty: *"President asks: do we have to shelter or not? What do we advise the emergency decision-making body?"; "Radiological evaluation cell considered sheltering unnecessary, but decision-making decided reflex actions; this info didn't come back to the radiological evaluation cell (also because Logbook crashed)."; "The civil protection has still no information about potential contamination due to the wind!"; "What do police agents have to do if they have to build a perimeter that is in the scope of the irradiated winds?"; "Discussion on what is recommendation and what is a measure?"; "Discussion about the measurements methods. Iodine tablets distribution is excluded. Sheltering is considered. A dose over the 100mSv is possible. - They do not know what to propose for pregnant women and children."; "Decision makers are expecting the results of the models. The experts choose to give them the JRODOS results. - The decision is political: we have different levels of protection in different regions. It is a political decision. - This is not the HERCA approach."; "In decision making it should be also a criteria to consult a neighboring country. - Differences in different levels in different countries are the main obstacle for coordinated approach to emergency management. - Protective measures are not based only on technical aspects but also societal aspects to take into account. You should justify why different things (e.g. small village evacuated, city not)."; "Decision makers are more-or-less independent from (your) recommendations. - If needed sheltering longer than 2 days, psychological aspects to be considered". "You need to have a political level to take decision, without it you cannot decide anything"; "Various groups mentioned uncertainties, and then we go to decision-makers with them and this is the biggest uncertainty."; "The problem is not the scientific community, the problem is somewhere else."; " Measurements: prioritize mapping areas with public; - Life and health first – fisheries later; - I strongly disagree – the Crisis Cell is able to decide whether fish or people should be measured first. Then people need to come first – no doubt; - Of course that comes first, but in the gray areas, which we will encounter this will be things that are not thoroughly discussed. Many things we need to do – difficult to prioritize for us.; Which actions can be taken at sea?; What are we talking about – considering measurements, are we sure this should be done, have to be sure, and all or none to evacuate – no two sides over the street"; "Fukushima shows that this is a very complicated mitigating action – so we must proceed with care, and have to be 100% sure. So wants more indoor stay – until we have more information from measurements."; "How to prioritize – clean up, waste, economic cost and the handling of this must be discussed."; "Very sharp lines here, what if I lived on the other side of the street?"; "They say: "There isn't external radiation but conservatively evacuation would be done towards location. - This would be in case of contamination, but there is not"; "Discussion about the prophylactic measures needed to be taken.- Are*

prophylactic measures needed?"; "Do we need to evacuate the students in the area? - Some of the members of the regulator have doubts about the adequacy of this measure arguing that it was not technically necessary (it can create social alarm and unintended effects such as accidents and it was taken by the regional crisis management staff unilaterally). Some of the members at regulator consider it adequate given the situation"; "Are some of the measures by the regional crisis management staff just a reaction to the potential social pressure?"; "Internal discussion about the reaction or overreaction by the subdelegation of government. What is the role of the regulator? Should the regulator just provide information about the scenarios? Who is responsible for the actions?"; " Are preventive measures really needed?"; "From the radiological point of view, there is no forecast of external leakage (decision about evacuation needs to be taken). - Is it really necessary to evacuate if there has not been any leakage? Even if there is no external leakage forecast? Perhaps we can send them home?". "Regional crisis management staff asks the emergency director if the measure was adequate. Some of the members of the regulator have doubts about the adequacy of this measure arguing that it was not technically necessary (it can create social alarm and unintended effects such as accidents and it was taken by the regional crisis management staff unilaterally). "Are some of the measures by the regional crisis management staff just a reaction to the potential social pressure?"; "Internal discussion about the reaction or overreaction by the subdelegation of government.

4.16 Uncertainties: Which protective actions to apply?

Decision makers are often uncertain whether the protective actions are feasible for the diferent stakeholders involved. There is also uncertainty related to cross-bordereaffects and different protective actions in neighboring countries.

The following sentences taken from field notes illustrate this uncertainty: "*Cows inside, no consumption of vegetables, don't give animals to drink open water - It takes time to get them in, it is a hot day. After the exercise, leader and one another expert expressed that "this advice is not applicable and is not the optimal."; "They are not sure about which measures to propose and where." ; "Discussion about food consumption restrictions"; "Discussions about iodine tablets – Disagreement. - We will not have any other choice than shelter 20km area. - It would be that we would do the same. - If you consider giving stable iodine you would shelter up to 30-35 km. As a neighboring country we would give iodine to more than 120km." - "What would you do if I give iodine also to this part (If is green in B they would take iodine, they have them home.) - Iodine and sheltering is always combined. You can shelter without iodine, but never iodine without shelter"; "The need to evacuate schoolchildren is discussed. Police of the affected towns is informed. They have to decide where to move the children."*

4.17 Uncertainty: Will people follow the instructions or recommendations given?

Uncertainty whether people will follow the instructions or reccomendations given has been found in all exercises where stakeholders other then decision makers have been involved. The observation results show that there are always some obstacles to following the reccomendations and that uncertainty related to following the instructions is rather large.

The following sentences taken from field notes illustrate this uncertainty: *"Will we face mass evacuation, self-evacuation, and voluntary evacuation?"; "Due to the fact that no one was really rushed and not everyone heard the alarm, the evacuation to the gathering point went rather slow."; "It was also remarked that the use of mobile phones and consuming food and drinks was not permitted during this stage of the exercise. This remark was not followed up however, because before and after this remark, a lot of people were still using their mobile phones."; "After four groups it looked like she decided to try a different approach because off the time-consuming manner of doing it like this and she started to try to get everyone quiet and to call out names."; "Some people did not come to the assembly room but remained instead at their desk or still outside, working."; "How to force people to understand how we do this and to follow our instructions?"; "Public survey on would you follow central advice or decisions? Yes they would. There is a large difference between being clear or giving wish-wash advice."; "Assembly point/sheltering team member remark to employees: Take a coat, possibly evacuation will take place. - An answer: I will take it later"; "Employees are grouping. Some remarks: "I will do it after the alert…"; "One of the employees is coming out of the assembly point without mask to his office just across the corridor. The shelter team member is holding doors open and pays attention what employee is doing, pointing out to employee that everything needed should be taken with him, he was noticed on this by instructions, and the procedure should be kept. Additional interview: He is diabetic; he had something sweet and wanted to have it with him as he did not know how long they will be sheltered."; "The list of all taking the iodine prophylaxis is circulating for signature by everybody. Nobody cares. -We will count them to know who was here instead-noticed sheltering team member"; "If it is real accident I will surely call home. I am not informed I should not do it in case of accident";"Fireman is near and intervenes. Woman shouting: Call ambulance, I do not want you, no fireman, call ambulance, I have a pain in abdomen"; "The woman hysterically calling from the beginning ambulance is among last injured in the assembly area marked with yellow strip - light injury. - Take me to the hospital - she adjures."; "Please, attention. 4 people did not sign the list. Please, come on here and sign"; "Some employees did not use protective measures passing to shelters/assembly points"; "Question from NPP representative: - What happen in case of self-evacuation?"; "The whole region is taking part in the drills and exercises. All are involved in the evacuation. 75% of population is supposed to be self-evacuated in the plans. The railways in any case are prepared to perform 100% population evacuation. Municipality is prepared to organize this under their responsibility. Each 19 minutes there will be prepared train with 14 carriages each for 80 people + 2 carriages with necessary material for evacuees."; "Children coming out first are staying in a group. Do not hear the instructions; do not pay attention and listen."*

4.18 Uncertainty: How to deal with long-term consequences?

Uncertainty related to long term consequences of an emergency have been identified only in one country.

The following sentence taken from field notes illustrate this uncertainty: *"Problem is that all acute decisions have long term consequences which makes this all the more challenging."*

4.19 Uncertainty: When is the time of the beginning of the release?

Radiological assessment teams and decision makers in some exercises had to face uncertainties about the start time of the release.

The following sentences taken from field notes illustrate this uncertainty: *"The amount of release and the timing cannot be specified at the moment? Assumptions have to be made?"; "We do not know the exact*

release time."; "Misunderstanding regarding the beginning of the release. - How to understand (less than) 6 hours?"

4.20 Uncertainty: How to deal with technical aspects (e.g. source term) during the early phase of the emergency?

Radiation dispersion modellers were uncertain related to source term during the early phase of the emergency.

The following sentences taken from field notes illustrate this uncertainty: *"Do measurements correspond to estimations?"; "Discordance between model and measurements: model calculations used source term without Pu. - New updated source term provided by operators (they know how much material is in the building)."; "*Source term: there are 2 available source terms – they were asked both to use both of them Depressurization in unit X. A safety valve has been opened. The head ask is there is any indication of radiological leak."; "They are not sure if they will be able to close the valve. - They ask maintenance. They say no."

4.21 Uncertainty: Is radiological assessment consistent?

Consistency of radiological assessment is uncertain for experts as well as decision makers due to on-going changes in assesments, rapid changes in the situation, changing information about victims, lack of information about the presence of radionuclides, differences in measurement units used by different measurement teams, discrepancy between simulated and pre-prepared parameters.

The following sentences taken from field notes illustrate this uncertainty: *"Your models are not coherent. - The doses impact is now higher that we were calculating before. This is the attention point that we have to improve - Something wrong with models, they are wrong. Doses are higher than calculated."; "Do measurements correspond to estimations? - Suppose so."; "Time 13:24: "No one is left in the zone" - Time 13:32: 2 people are missing and they are not sure in which site they were.- They get informed that one of them did not come today at work and the other one is "maybe" missing. - The operator says he still doesn't know who is missing."; "Nurse briefs: It's about a fire in the reactor building but the security people think it's real"; "Time 13.43 the third victim is brought outside, laid down on the floor by the fire fighters with the message the he is contaminated. –Time 13.45 Another fire fighter comes and says he is not contaminated; he was not in the hot zone"; "During the debriefing, it was stated that the information about the contamination of the 3rd victim was wrong. - The lack of clarity about the contamination was also mentioned again."; "The error in the HOTSPOT calculation is explained. One expert cautions that uncertainty is high in such estimates. Somebody remarks that measures are less conservative than in 2008 - better to take the same for coherence?"; "Discussion about why one of the firemans has a higher iodine dose? - Expert asks to check if he was being treated for thyroid problems? He was not treated for thyroid."; "Which radionuclide is out-there? Only iodine or Cz?- We don't have this information, we have only in mSV"; "Different measurements units from different teams. (civil protection in points, other measurement team in Bq…); "How to coordinate cross-border aspects?"; "More clarifications are asked on the way we measure radioactivity in these cases. The grid is not defined."; "JRODOS and HYSPLIT results depict the plume initial entry position differently."; "In 6 countries we had factor of 20 differences in dose calculations. -Even if some countries would run the models, the results would be different and uncertainties would be different.";*

"The biggest uncertainty is the source term and the weather prediction. This would motivate us even more to be in aliment with the neighboring countries." ; "It is great if neighboring country does own calculations taking the weather forecast into account. It is uncertain."; "Fallout and doses have not been monitored much so far because of the indoor ask"; "Will send it, situation changes quite quickly"; "Stable status, in my opinion improving, temperature going down."; "Radiation situation - I would not suppose quick change. Stable status."; "There was problem in interface between simulator and decision support system. Therefore, the source term was estimated based on the available information."; "Discrepancy between simulator and pre-prepared parameters"; "There isn't external radiation but conservatively evacuation would be done towards location. This would be in case of contamination, but there is not."; "Discussion about the prophylactic measures needed to be taken.- Are prophylactic measures needed?"; "Do we need to evacuate the students in the area?".

4.22 Uncertainty: How to interpret dispersion models maps?

How to interpred dispersion models maps has been recognised as an uncertainty by public relation officers and well as by decision makers. Maps often caused an uncertainty during the observed emergencies due to lack of information and legend on the maps.

The following sentences taken from field notes illustrate this uncertainty: *"Public relation officer (PR) asked for a copy of the maps and the measurements. A decision has been made to publish maps showing the plume. PR asked who is going to prepare explanatory notes about the maps and what extent of uncertainty we have regarding the data." ; "Problem identified in reading and understanding the maps by the decision makers provided by the experts group preparing the maps"; "The person in charge discusses with the coordinator of experts group on what info is needed to be included in the maps"; "The experts group sends by email to decision makers the maps and doses – a lot of questions by decision makers – more clarity in the maps is asked."; "Maps are discussed, however it is not easy to understand what they depict."; "Coloured maps produced by JRODOS and HYSPLIT - Format of the results have not been pre-defined (explanatory legends were missing)."; "Misunderstanding regarding the release and the map. How to understand the (below) 6 km? - The figures that look the same, can be understand completely different."; "Misunderstand regarding the significance of the map. Ensure that information sent is understandable, especially maps and charts."; "The picture (plume) used for the exercise has been misunderstood by some members. Although we use this type of maps, this is not OK. There is a need to use better maps that is guarantee that this maps are correctly understood."; "Our decisionmakers don't understand such scientific maps. - Decision makers need other maps."; "Important information missing: intervention doses (it is not clear from the picture whether is this a real release or prognoses), is it controlled release, duration of release."*

4.23 Uncertainty: How to coordinate cross-border aspects?

Cross-border emergencies caused a lot of uncertainties due to different protective actions, trying to achive coordinated approach to the emergency management as well as due to political and diplomatic issues.

The following sentences taken from field notes illustrate this uncertainty: *"Protective measures are not harmonized. - One country has different values for children (10mSv) than for adults (50 mSv), the other not, they have only 50mSv"; "How to implement 360 radius if it includes neighboring country with other intervention levels?"; "You are not able to provide iodine tablets to your neighbors. You would give tablets to your children but what about our children. Where would you provide tablets. - At your embassy?"; "Accident countries are not notifying in an equal manner. - Intervention levels are different in countries."; "Countries have different levels and this is why should be also informed"; "Public would need to get a feeling that they are equally well protected. - There are differences in countries response, some would start with evacuation and iodine tablets, others with sheltering and iodine tablets"; "Coordination of protective measures for populations are limited by major obstacles such as intervention levels"; "Will Neighboring Country be informed before starting sirens in Emergency Planning Zone?"; "I would suggest to have emergency plan for the border and not national emergency plan"; "Understanding of what coordination means is an issue"; "Territorial discussions – there is a foreign ship in the country proximity. Your attention to the location of the ship – who does what"; "But the decision for this is probably too complicated to be taken around this table – decisions belong to nation – ministry and prime minister"; "Discussions on how to mitigate releases from boat ensue – sink it (which channels, what regulations, diplomacy etc) foaming."; "Accident state may want to fix this themselves, how does the country judicially plan for handling this type of situation. And this type of competencies are only a few persons. These questions will occur and dialogues must be held with dialogue country."*

4.24 Uncertainty: How coordination and collaboration among emergency response actors will be achieved?

There is a huge uncertainty identified in all the observed countries where many disciplines and emergency actors have been involved. The uncertainty relates with not knowing the rules, roles and competences of other ators and stakholders involved in the emergency, use of different communication and frequencies, limited communication or miscomunication.

The following sentences taken from field notes illustrate this uncertainty: *"There should be contact people to give information"; "The medical service observer says that the medical team waited long after its arrival before contacting the fire fighters"; "It's mentioned that it was unclear for quite a while whether there was water to cool the burns of the first victim. The nurses then asked the fire brigade observer about the water for cooling the burns. Can we use your hoses? Yes, it's clean water and you can use it"; "Can we then ask fire fighters for help? – Yes, and you arrange the pressure of such a hose? - Yes."; "A medical staff member that had remained there said that they asked for a doctor in the emergency room, but that the radios had been turned off so he couldn't reach a doctor. The doctor responded that they had called for the end of the exercise, so she turned off her radio.", "Measurement team member 1 finds where the tasks would be displayed. – Ok, there is no instruction yet. – Measurement team member 2 says: But the local coordinators aid to leave"; "Still no confirmation who is ready for the measurement team? No connection established by radio or phone."; "Why don't you come here? - Why don't you listen to the radio? (For this communication private phone is used)"; "First fireman arrives: Damn it's a mess to get in and out of the site, there's nobody from the installation."; "Other disciplines are not present. It is a problem, whe had*

some communication problems."; "Lack of coordination between plans. The Police and discipline five (communication) plans say specific things that do not match. There is no integrated plan that is followed by everyone!"; "The communication of the decision makers' cell with other cells/roles is problematic."; "One member of the team was not notified."; "They have no information regarding the discussions and the decisions made by the decision makers in Room A. Also, they do not know if anyone monitors the data from the radiological monitoring network"; "There is no communication among the members of radiation protection team."; "The common understanding of the text of the law is not there."; "Roles and sectors are engaged at different times during such an emergency – and this may give challenges in the discussion around this table of the < "; "Regional plans and capacities may vary very much."; "Press releases – must be coordinated."; "What about those who stay, what and where do they evacuate etc"; "Ambulance team decide to re-examine the woman as she was already shouting that she has pain in the abdomen."; "They decided to put her into the red - seriously injured. The yellow strip given by other first responder remained on the wrinkle. - When getting her to the assembly area the chief of ambulance team saying:To yellow, seeing yellow strip at the wrist. - No, to red. She is seriously injured" fireman said and the ambulance team chief gave instruction to treatment, recording and prepare to the ambulance car as first priority"; "Nowadays people are better informed, but we are here to deal with possible chaos. It is important to avoid chaos or deal with it."

4.25 Uncertainty: Is there a gap between legislation (including plans) and reality?

The gap between legislation, plans and reality is an uncertainty as much as it is also cause of uncertainties. It may relate to new laws, feasibilitiy of protective actions, among others.

The following sentences taken from field notes illustrate this uncertainty: *"This is a boat, but very complicated international laws and rules apply – many uncertainties"; "But the decisions for the radiological consequences are ours – and we will make those no matter what the diplomacy of this is."; "Measurement team member 1 says if something real ever happens, you have to trust people your own judgement. If you have to wait for Charlie 1…"; "People don't communicate according to procedure (radio communication)"; "There is another traffic accident on the way that measurement team is using. More delay.- NO PLAY information (other crisis appears)- A real crisis: protests, blockage of streets in vicinity, governor is there to negotiate with protesters, police is activated…"; "Like for the police, we see that emergency plans do not match, they have different procedures that do not match."; "This is legislation versus reality."; "Mandate is wide – perhaps it should be corrected or revised; We have regulations that go far in protection – but given these kinds of decisions – where we need to go back home to check out how far legislation goes"; "Evacuation is easier on paper than in reality, just moving that many people would be a huge operation. Plans should be in place."; "Iodine tablets have been delivered on 81% - more than 47500 of population did not take over the KI pills within the new campaign."; "The press release was sent without waiting for the response of the nuclear safety authority. - NPP sends data to other e-contacts, not to the contacts requested in EPR procedures."; "Some part of the information is planned in the emergency response plan but it is not really clear what is said."; "They realized that in the case of an earthquake, most of them cannot be in the regional crisis management staff so far (due to other commitments in the emergency systems)*

Discussion about iodine tablets starts - Someone says, - yes, we should, it is established in the emergency plan. - Other says, -no-, we do not have time for this! We will distribute iodine tablets once in the gathering points/areas hosting people".

4.26 Uncertainty: Are the preconditions of the functioning systems taken into account?

Uncertainty related to systems and their preconditions for functioning has been found in a few countries. It is mainly related to the communication network and internet access.

The following sentences taken from field notes illustrate this uncertainty: *"There is a vehicle from civil protection with a satellite which is supposed to foresee everybody with Wifi, but it doesn't work."; "Everybody seems to think it is ok, but they wonder what if there is no network?"; "communication responsible still no wi-fi access. Trouble to make it work."; "There are 4 phone numbers at the IRS, is it enough?".*

4.27 Uncertainty: Are all emergency response actors familiar with their roles, procedures and plans?

Unertainties related to rules, roles and responsibilities, in a real situation and in the case of an exercise, were very frequent across all exercises observed, and among all actors involved. They were connected to the use of new tools, unclear roles in the emergency management process, EPR plans not known or not used, new people filling in various roles .

The following sentences taken from field notes illustrate this uncertainty: *"The access to internet (they are searching for a new code that has been used since one week, but they don't know it)."; "Who communicates about protective actions?"; "The person responsible for security is not sure through which gate these 2 missing employees checked in for the last time."; "One firefighter asks which company was working in the machine hall but he says he doesn't know.; "Can't find notification forms"; "Who contacts the families of the injured?"; "Is there an emergency number where the family members can call?"; "I wasn't sure what to do first. Go to the place of the accident or to the emergency room. So I went there first, and then came to the emergency room".; "Normally there is a consultation team composed of the person in charge of security , person for radiological control, fire brigade, and the operator in the place of accident. Some of them were not there so I was not sure what to do."; ""Who's going?" "Shall I take the car?"; "Not sure who to talk to. "Should we ask X for an update?" "Should we announce we are here?"; "Medical people respond "ok we don't touch then". Both ask questions "should we take the mask?" "What type of contamination?" "Can we touch the victim?" "What is the state of the victim? What is the scenario"?; "Another person arrives at the scene. He was instructed that he should come, but knows nothing. "; "Only one person from the fire brigade was meant to brief. Now it was very unclear. It should have been the commander, but different firefighters came and delivered different information."; "Was waiting right thing to do? The doctor said she would not have waited. She said we were wearing gloves, had the ambulance with us. Life-threatening conditions go above contamination. The nurse said she disagreed with the doctor on this. As first aiders the first lesson is "own protection first."; "They find the third victim but are not sure if he is*

contaminated and how to react."; "During the debriefing, the captain said that there was not enough hierarchy. To explain it, he drew a pyramid on a board with the different level and role of people. Through *this chart he would like to explain that the higher in hierarchy has to delegate and not do everything. In contrary, during the exercise, there was little delegation and information."; "X asks Y: "Do you know where radio lies in building A?. Y isn't sure, X then says no they are in the building B. X explains that actually all measurement teams should go to base camp first for a briefing and then to be dispatched from there. But it has never been like this in an exercise, they say. In fact both have never been at a base camp."; "Should we wear PBM"?; "X makes a call. It is explained that normally they would have to wear overshoes, gloves and overall, and a P3 for internal contamination. But now it's an exercise so they don't have to."; "X asks "but which measuring unit?" Y answers Bq/cm2. Y says "Ok then take counts/second"; "Disscussion about helicopter: who has to approve?"; "Do you have any idea who from civil protection will make a base camp? We don't know whom to contact?"; "There is a problem with use of channels – civil protection uses the old channel that should not be used any more (information received by cell phone)";"What should be communicated by us and what by communication department?"; "What personal protection equipment we have to wear?"; "No food, everybody hungry… secretaries are discussing who is responsible to logistically support people that are in emergency room more than 6 hours without any support. They then got information by SMS from a colleague."; "The policeman at the CP-ops is now the police director because according to the D3 emergency, the police director has to be on the site .. Problem: divergences between the different plans"; "Policeman: « where are the Iodine pills ? » do police have iodine pills ? »We learn the victim has been contaminated.. - One fireman: "does she need to be transported? -"first responders coordinator: Yes of course; - Where?; - To the decontaminating cell of the nuclear installation! Secretary of the first responders coordinator:: "not at the IRE, it is an irradiated area. The victim has to go to a hospital!!"; "no, the installation has a special cell dedicated to this. It will go far quicker to go there rather than to send him to a hospital; - Secretary: "but it is irradiated: who will accept to deal with him inside of an irradiated area?" He has to go to a hospital!"; "first responders coordinator: mmmh… You may be right; transfer him to him to hospital"; "Again discussion whether they have to go to the decontamination cell of the installation or to hospital, they do not agree but finally decide to go to hospital"; "He also asks to get a full protection equipment. The personnel from the IRE, who gave them an outfit, without a second pair of gloves, without specific shoes and without dosimeters. According to the medical service responsible at the installation they did not know anything about CBRN risks. Therefore, the time they took to put the correct outfit last really long!"; "they did not use dosimeters because they were not informed by the 112 that dosimeters were needed and they did not get dosimeters from the personnel of the nuclear installation."; "they do not know well how to transfer a contaminated person: Ambulance? Helicopter? How to make sure that the victim won't contaminate the vehicles and rescuers!"; "It is not pre-defined who gets the calls and answers information requests by the public; One of the decision makers asked who is in charge of responding the telephone calls; One of the decision makers said that only the safety authority knows Annex x - Problems in roles/coordination/cooperation?; PR asks when/under which conditions the public information is not only a task for the competent authority and other bodies are also involved"; "They discuss their roles and the roles allocation; The person in charge wonders if he should go to room B to check the experts group-Confusion/doubts about the roles"; "Need to refresh the plans for the CC – so all know what their role is.; This might be more political, and we might need advice from ministries.; Are we advisors, or do we actually handle this? Does the CC for example have the mandate to discuss something like this*

with the accident country?; Major railway goes right through this area – has not been any train since accident – decided by transport sector itself to avoid problems for transport sector and their goods.; "Who coordinates and handles this now, where do reports from this go?; Military: are we advisors, or do we actually handle this?; Ministries have to be informed so they also are a part of decisions.; You would think people knew how the CC works by now!; Need to refresh the plans for the CC – so all know what their role is.; Marine Research Insitute must be consulted to check on pollution etc. But the decision for this is probably too complicated to be taken around this table – decisions belong to nation – ministry and prime minister."; "Who is responsible to classify degree of emergency situation "; "We suppose that injured people will be carry out by this exit. Man measuring injured has no gloves. Nurse is dressing on the injured to the same clothes. She has gloves. Leave it on. "; ""What for we were registered electronically at the entrance to the shelter/assembly point/room?"; "Took wrong box during the exercise, with pills after expiration."; "The instruction to wear Tyveks is given with warning do not put employee card under the Tyvek."; "What with the coat? It will be cold outside without it"; "Call emergency channel. - Which number? -Emergency channel is not at that number. Switch on and it goes"; "For future improvement: articulate clearly taking leadership for the severe accident. Who is superior to the EROD? Nobody? Do we need some?"; "There was technical problem with opening at one shelter which was solved very quickly."; "A discrepancy occurs when they are giving information and reporting messages which they are not authors, were not working on their preparation. Routine training needed and development of their own reports. "; "Telephones, mobile phones - have to be switched off? Is it the culture? It is not restricted and phone ban is not in procedures."; "After the elections there are new representatives and employees at municipalities, will not know anything. The quality of management members (mayors, city managers, crisis staff members) will be different."; "It is not enough to have knowledge; they have to have skills, form a habit and not to study during the emergency."; "They have doubts about the emergency protocol (specific event category). Who is responsible for decisions on evacuation? Approach: Internal discussion about the role of the regulator in providing information on the recommended actions/taking the actions. "; "Emergency military unit has been activated, but they are not clear about what use they are going to make of this unit, they need authorization from the regulator."

4.28 Uncertainty: Are the available resources adequate?

Emergency actors may have to deal with insufficient resources, both technical as well as human, which may cause uncertainties on how to adapt to such situations. At the same time, some resources may prove inadequate.

The following sentences taken from field notes illustrate related uncertainties: *Difficult to see (with cameras?) details from the accident place"; ""Should we go somewhere else to cool? We don't have anything here"; "We also only have 1 oxygen cylinder. What if the 2nd victim also needs oxygen?"; "They ask whether there is a tent to remove the body from sight. There is not."; "X commented on the lack of staff and the difficulties in the case of a real emergency; Discussion on possible ways of implementing a radiation measurements campaign (since there are limited resources); Doubts whether we can exclusively be supported by the network of collaborating laboratories for the dose rate measurements."; "Lack of*

resources / who is going to deal with the dark site content?;""Well with measurements to be done, how would this be done with limited resources?; What capacity does the nuclear safety authority have to go 24/7 and handle reports from all the branches who need to be/are mobilized in this scenario?"; "Problems with dosimeters in shelter "; "Not many people are presented today, it was 30-50 last time, will be more fresh air, it is big advantage"; "Driver: "Well, only glasses are steamed-up". Me: "How will you drive?" Driver: "Somehow will do it, I have to". His mask was not as good as those we received at NPP. It did not fit well and it was the reason of glasses become steamed-up."; "We have only one ambulance car, it takes time to return…"; "They wonder if the actual areas designated to host the people will have the capacity to absorb all the affected population. "Critical actions: ask for help from outside, we have limited resources, this is critical point."; "The doctor asks "Is there anything foreseen for posttraumatic stress? Not by us, but this is important!"; ""We have been better prepared before, there were much more people involved in".

4.29 Uncertainty: Are the emergency actors familiar with and trained to use the equipment?

These uncertainties are faced mainly by experts, first responders and decision makers. They may occur due to insufficient or irregular training, participation of new personnel, use of new tools or new procedures, or lack of knowledge about protective equipment, among others.

The following sentences taken from field notes illustrate this uncertainty: *"ICT expert explains that here is everything settled, but not in the emergency location, thus videoconference can't be established."; éDosimeter gives radiation level in numbers and one of the firefighters says "I don't know how to interpret this". "X returns with 2 tablets. He says "I don't know which one we will take so I brought them both - "Did you follow the training (to work with the tablets)? Because I didn't. - yes."; "I can't find the roadbooks - "That's because we don't have them"; "They check the tablets. They can't seem to find what they are looking for". "My God there's so much stuff on these things! - Clear, isn't it!"; "The mobile phone in the measurement vehicle rings. X tries to pick up but says "I can't work with such a Nokia brick anymore!"; "X explains that tasks will be received via this tablet, but he can't find where. Y repeats he didn't get the training to work with this new system. Z needs to figure this out while driving because he is in the car alone for now".; "how do we know where this measuring point is based on coordinates?! They want to make sure it is not on the wrong side according to the wind direction"; "Person responsible with the logbook comes and X informs how to fill it in" ; "Call them via cell phone – obviously they don't use XY communication channel which they should. Please use XY channel – you are using the wrong one." ; "All results (history) of GPS are erased, thus team 1 doesn't know where is the Base camp."; "could get bigger masks which they received. However, many people did not know how to wear them."; "It is confirmed that the dark site can be activated by PR, without the involvement of the IT -PR seems not to know the activation procedure"; "Are here also masks available?" - discussing with colleagues."; "Driver: "Oh my God!". The driver nearly missed the turn right to the NPP entrance looking around on observers staying near the road and turned right in a hurry with discomfort for all."; "Some employees putting away the masks."; "I have recognized that I had wrongly worn the mask (not trained) what was the reason of glasses being steamed-*

up. I was instructed by employee sitting nearby. Driver had another type of mask and had it worn correctly."; ""Request power supply from outside. I do not know if we solve it. We have to re-evaluate it".; intervention at the engine room was good, knew their roles. The problem occurred with opening one storage locker as they have wrong key."; "X has a problem with starting the computer, since he does not remember the password. - Password problems still exist –"; "system 1 not running yet, perhaps because somebody else into it in his office (another computer)."; "Problems are with registration in system 1. The problem is in a laptop that is not properly configured to be able to connect."

4.30 Uncertainty: Are social and ethical considerations taken into account?

In the case of an emergency, from decision-makers to intervention teams and first respondents will be faced with social and ethical considerations. Such uncertainties may originate from dealing with or communicating about severe casualties, including deaths; decisions on whether safety measures (e.g. wearing a dosemetre) should override helping a colleague in need; attending to the needs of the emergency team (e.g. availability of food and drink; specific family arrangements for emergency situations or exercises); concerns of people requiring evacuation about how to inform their families; problems with stayng in a confined space for a long time; doubts about how much onformation can be disclosed; potential side effects of evacuating hospitals, nursing homes; informing parents and/or getting consent for measures taken for school children; separating families due to the need for rapid evacuation; perception of protective actions by the publics; psychological impacts such as stress or panic.

The following sentences taken from field notes illustrate this uncertainty: *"The medical team is not sure whether someone should stay with the body."; "It was mentioned that the radio communication can be heard by everybody. Colleagues may thus hear "person X is dead", or questions like "is he dead / not dead", that is very awkward. Everybody can hear everything that is being said on these radios."; "During the interview, one firefighter says she forgot her dosimeter so she could not go downstairs where the accident happened. However, she was seeing her colleague struggling for help and being slower because it was too heavy for him. She was not sure if she should go and help him so they can be faster or follow the instructions and not go downstairs without the dosimeter."X calls his son to check whether he's ok and ready to go to school."; "the measurement team is composed of a group of volunteers. They all received trainings. But with exercises, it is always the same people that volunteer."; "2 people called 112 and 101; they were anxious about the sirens "; "People get tired and hungry. No food available. "Where can we get something to eat and drink?""; "Is ICT reliable?; … then the contact disappears."; "What shall I do with my child: he needs to go to school only at 8.00 and I have to leave at 6:00? - Will I be back in time? -How long will it take? - What to say to my partner what is going on; How much of information can I disclose? -How can I explain that is not too much of information or concern?"; "Police are mandated to do it (i.e. evacuation), but it has a lot of problems associated with it, social uncertainties – so we have to be very sure that we need to do this; we evacuated hospitals with great human cost – that must be considered"; "Evacuated employee received mobile call from the wife: "… who knows as we have alert… otherwise computers… we have an exercise… no, do not be afraid, you should hear it immediately if something happen… do not go*

with him…"; "Waiting in the bus. Some are checking messages on mobile phone. "I have no idea how to get home"."; "The man from the first car is shouting, asking for the cigarette, asking where his hysterical wife is. "; "Have been inside for the long time, would like to feel free"; "separate in two rows - boys and girls"; "in a real emergency it would be difficult to stay there without knowing anything about their family. The regulator's inspector stated: "this is a lesson learned in real emergencies"."; "will these actions generate social alarm? Approach: Internal discussion about the unintended consequences of overly conservative measures. "If we evacuate the children from school also parents will evacuate spontaneously."; "Uncertainty: What will be the reaction of the parents? Some of the participants argue that parents will go for the children. It is considered that there could be an avalanche. The basic assumption is that, since the local population has already been warned, the parents of the perimeter should already have gone to pick up the children."; "One of them says: I think that people would get into the car and go on their own... Where will the people go?"; "They wonder if it is necessary to take the children out of the perimeter. If they do so, parents could panic too much."; "it was driver's first exercise on evacuation of employees from NPP. He was in a hurry in the moment in front of entrance, but then noticed that need to turn right. He knew the way, he was transporting inspectors before. But now under the stress and in a hurry noticed turn right in last moment, pushed the brake, may be too rapid and turned right. "Who knows how it would be in case of real accident".

4.31 Uncertainty: What comes first: Safety or security?

Uncertainities originating from inherent tensions between safety and security were experienced mainly by first responders, as it is not clear whether in an emergency situation security procedures can be overridden.

The following sentences taken from field notes illustrate this uncertainty: *"We need to pass the speed gate and the gate at the main entrance and need to badge. At the main gate the driver badges with all our badges. The speed gate at the road and the gate are open already", "The doctor says "we should not have badged at the speed gate and the main entrance". "I get asked to pull over for a security check. I explained I have to hurry because I take part in an emergency exercise and they let me pass." "X says this time permission was asked to enter before 7 am. But what would happen in a real situation?"; "Problem of rescuer identification at entrance in installation: they all had to show they clearance which delayed it a lot!";* "*Normally a badge is obligatory, but…"*

Annex: Exercise reports

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 662287.

EJP-CONCERT

European Joint Programme for the Integration of Radiation Protection Research

H2020 – 662287

Internal report

Uncertainties during and after a non- nuclear emergency exercise at a nuclear installation (25/10/2018): Results from a non-participant observation study in Belgium

Authors:

Hoti Ferdiana, Perko Tanja, Schröder Jantine, Glesner Colin

Reviewers: Turcanu Catrinel

Work package / Task	**WP5**	**5.2.3. Conceptualization and management of uncertainties in emergency exercises in EU countries**
Deliverable nature:	**Intermediate document**	
Dissemination level: (Confidentiality)		
Contractual delivery date:	**N/A**	
Actual delivery date:		
Version:	**V1**	
Total number of pages:		
Keywords:	**Observation, nuclear emergency exercise, uncertainties, decision making**	

Disclaimer:

The information and views set out in this report are those of the author(s). The European Commission may not be held responsible for the use that may be made of the information contained therein.

Introduction

This report presents the results of the observation of a non-nuclear emergency exercise conducted at SCK-CEN in Mol, Belgium, on 25th October 2018 within the CONFIDENCE Project, Task 5.2.3. **The objective of this observation was to understand what kind of uncertainties exist in a non-nuclear emergency situation at a nuclear installation; to gain insight into the way these uncertainties are addressed and handled during the emergency exercise by looking at the information flow and communication between actors; as well as the assumptions and decisions made during the emergency exercise.** The goal of this report is to describe the uncertainties encountered during the exercise, to group them in different types and to briefly discuss potential consequences that they are accompanied with. This will then help the CONFIDENCE project to find solutions in how to communicate about uncertainties, how to deal with uncertainties and how to reduce them if possible in order to support stakeholders' informed decision-making in emergency situations.

Description of the observed exercise: Scenario

The fictive non-nuclear emergency happened at the Belgian Reactor 3 (BR3) at the Belgian Nuclear Research Center (SCK-CEN) which is in the process of being decommissioned. As a prototype pressurized water reactor, BR3 was operational from 1962 to 1987. Around the world, pressurized water reactors are mostly found in nuclear power plants. BR3 was the first of its kind in Europe and in the next few years it will be the first one worldwide to be fully decommissioned. Nowadays, there are few tens of employees present at the installation during the working hours.

Figure 1: Belgian Reactor 3.

An external maintenance company (2 technicians) carried out checks on the BR3 boilers. However, something went wrong during the maintenance work and a fire developed on the burner (poorly adjusted combustion with 'flopping' of boiler) resulting in a deflagration (slowly advancing flame front). This flopping of the boiler caused a slight muffled bang, audible in the machine hall. Both technicians were injured. The first victim bumped his head and became unconscious, while the second victim got burns on forearms and hands. Victim 1 no longer reacted and victim 2 tried to get help. Then, the smoke continued to develop in the basement with a limited fire on the boiler and fuel pipes.

Due to the muffled bang, a third person went downstairs to check what was going on and sprained her/his ankle on the stairs. Hence, there were three victims: 1 in life danger, and 2 not in danger of life.

The main actors that participated in the emergency exercise were the monitoring service, the fire brigade, the medical service, a person for radiological control, and the emergency room members (limited

composition). The fire brigade, medical service, evacuation of the building and the emergency room were observed by the CONFIDENCE observers.

Country	Date	Brief description of the exercise scenario
Belgium	25th October 2018	Non-nuclear emergency exercise at a nuclear facility Accident in a boiler room at a nuclear reactor in decommissioning involving 3 victims and all internal first respondents services. The accident happened out of the rooms that are under a restricted access and not in in the reactor part containg radioactive material.

Table 1. Brief description of the observed exercise

Brief description of the emergency plans at the nuclear installation

SCK•CEN has a robust internal emergency plan, which is at place, with preventive measures, to limit the consequences of a crisis situation and to normalize the situation as quickly as possible in an acceptable manner. The internal emergency plan describes the organizational measures that are taken in an emergency situation. These emergency situations are inherent to the specific risks associated with the business activities of SCK • CEN. The internal emergency plan aims to:

• Prevent, contain and control incidents so that the potential effects and damage to people, the environment and goods are minimal;
• The warning and protection of employees, external employees and visitors present within the Technical Domain of SCK • CEN and VITO;
• Strengthening the deployment, coordination and coordination of the intervention teams and means of action with the intention of limiting the consequences for the site itself and for the environment as much as possible;
• Notification and passing on all necessary information to, among others, the Coordination and Crisis Center of the Government (CGCCR) and the responsible authorities;
• The efficient start-up of assistance to the government and the population, if the services of SCK • CEN are used in the event of a nuclear accident outside the SCK • CEN site.

Nuclear emergency

In case of a nuclear emergency two alarm types can be distinguished: Site Emergency and General Emergency. The phase 'Site Emergency' is declared when an incident occurs that has caused or may cause an important contamination inside a building. 'General Emergency' is declared when an incident occurs that has caused or will inevitably cause a contamination outside the concerned building. 'Site Emergency' could be scaled up, to 'General Emergency' which in this phase of operation, the persons who have a task in the framework of the emergency plan, are already warned and could carry out specific tasks. 'Site

Emergency' is communicated by phone via secretary's office and also via an emergency call system called ALERT. 'General Emergency' is announced by siren-signals: a succession of long modulated tones of about 15 seconds.

Procedure in case of 'Site Emergency': 'Site Emergency' is communicated by phone via the secretaries'offices and also by the emergency call system 'ALERT to the members of the personnel having a function in the framework of the Emergency Plan. The other members of the personnel are not involved in case of 'Site Emergency'. No specific action is expected from these persons in this case. The secretaries' offices will warn the persons having a function to fulfil in the framework of the Emergency Plan. In addition, they will also inform their hierarchy, should they not have any function in the framework of the Emergency Plan, about the emergency situation. When no building coordinator emergency plan is present in the building at that moment, it's necessary that the person with the highest rank takes this function. In case where the official Building Coordinator in case of Emergency should not be present, each member of the management can be brought to assume this function. In this case, the person with the highest rank, present in the building, and not have a specific function within the framework of the Emergency Plan, will become directly responsible for the building in question. This person will contact the cell 'Interior communication/Binnenverbindingen' inside the Emergency Room/Noodplankamer of the SCK•CEN. He/she will be then supported by a member of this cell to carry out the different instructions.

Procedure in case of 'General Emergency': employees and other people **outside the building** at the time of the alarm are instructed to do the following:

• Go as soon as possible to the nearest SCK•CEN building (return to the SCK•CEN site in case you were at this moment on the VITO-site). Go to the 'Reception room/ Ontvangstzaal - Salle de Réception'. This room is indicated in brown on the poster 'Evacuatie - Noodplan' at the main entrance of each building.

• Wait for the instructions of the Building Coordinator Emergency Plan in case of Emergency or of his deputies. All orders, as prescribed in the above mentioned section, are applicable.

Employees and other people **inside the building** at the time of the alarm 'General Emergency' are instructed to do the following:

• Close the doors and windows and switch off the window/toilet fans. Close also the windows of the toilets.

•Do not drink or eat. Smoking is in any case not permitted in the buildings.

• The persons, who have no function in the framework of the emergency plan, may not use the fixed phones of the SCK•CEN during the 'General Emergency', this to limit the saturation of the phone network.

• Go as fast as possible to the 'Waiting room/Wachtzaal - Salle d'attente': this room is indicated in green on the poster 'Evacuation and Emergency Plan/Evacuatie- en Noodplan' at the main entrance of each building.

• Follow the instructions given by the Building Coordinator Emergency Plan in case of Emergency or by its appointed deputies. These lasts are recognizable by wearing a yellow jacket. The Building Coordinator

Emergency Plan can be found in the 'Permanence room/Permanentielokaal - Local de Permanence', indicated in purple on the ground plan 'Evacuatie- en Noodplan'' at the main entrance of each building.

• The General Management has transferred their authority to the Building Coordinator Emergency Plan in case of Emergency; therefore, everybody must follow his/her instructions accurately.

• Follow the rules that may be applicable in a particular building in case of contamination. These instructions will be given by the Building Coordinator Emergency plan, his/her appointed deputies or by a representative of the 'Radiation control' (HPH).

• You are only allowed to leave the building with a permit given by the Building Coordinator Emergency Plan.

In case where the official Building Coordinator in case of Emergency should not be present, each member of the management can be brought to assume this function. In this case, the person with the highest rank, present in the building, and not have a specific function within the framework of the Emergency Plan, will become directly responsible for the building in question. This person will take contact with the cell 'Interior communication/Binnenverbindingen' inside the Emergency Room/Noodplankamer of the SCK•CEN. He/She will be then supported by a member of this cell to carry out the different instructions.

If employees and other people **outside working hours are present on the technical site** they have to follow the following instructions:

• Make sure somebody stays with the telephone in the 'Permanentielokaal - Local de Permanence (Permanence room)', indicated in purple on the poster 'Evacuatie- en Noodplan' at the main entrance of each building.

• If this is not the case, stay there yourself and announce your presence to the people in the Emergency Room or to the Surveillance Room - Main Entrance by means of the telephone. The cell 'Internal connections' (in case where the Emergency Room should be operational) can guide you in the execution of these tasks.

• In the Permanentielokaal - Local de Permanence (Permanence room), a file with the print-outs of all procedures that are applicable by the Building Coordinator Emergency Plan.

• Write down all the measures you have taken, and all the instructions you have received.

Non-nuclear emergency (i.e. fire)

At SCK•CEN the instructions are issued via the internal fire alarm bell, also referred to as the evacuation signal. It is recognizable by a modulating sound. If the situation necessitates the evacuation of the building, the instruction to evacuate can be issued via the yellow push buttons in different rooms of buildings, the so-called evacuation alarm. When the employees hear the internal fire alarm bell (also referred to as the evacuation signal), they are expected to evacuate calmly, but as quickly as possible, via the nearest escape route and proceed to/gather at the relevant assembly point.

The alarm can be issued via automatic fire detection, a manual report via the company fire emergency number or by pressing a red manual fire alarm button present. All these alerts are sent to the internal security department, which initiates the necessary emergency procedures. In each case the internal fire service is also notified. Also medical service is notified in the case that person or people are injured or if fire service activates emergency medical service in order to support the emergency management at the emergency scene.

The figures below present schematically the way how non-nuclear accidents like fire, explosions, etc. are handled at SCK•CEN and also interactions with different internal services involved in emergency management.

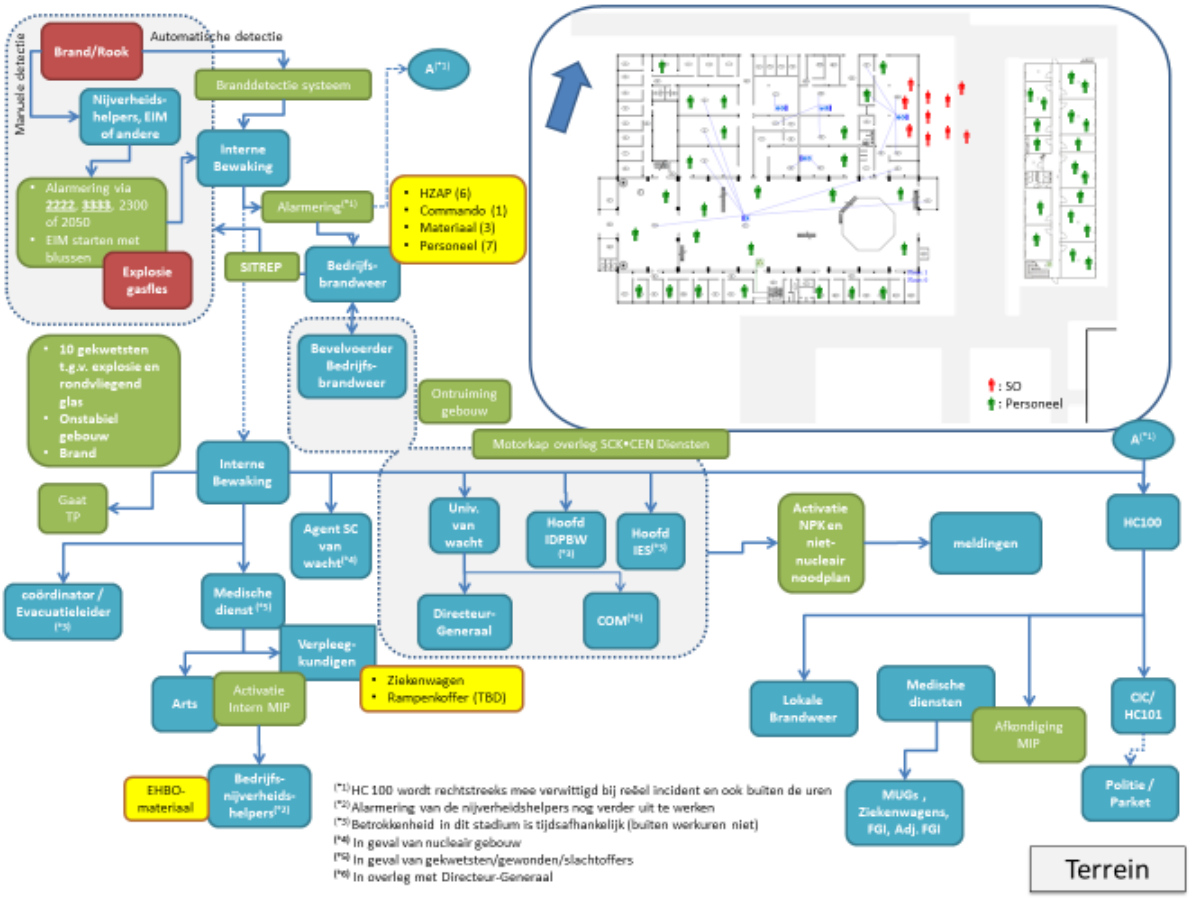


Figure 2. Strategical plan to cope with emergencies related to fires and explosions.

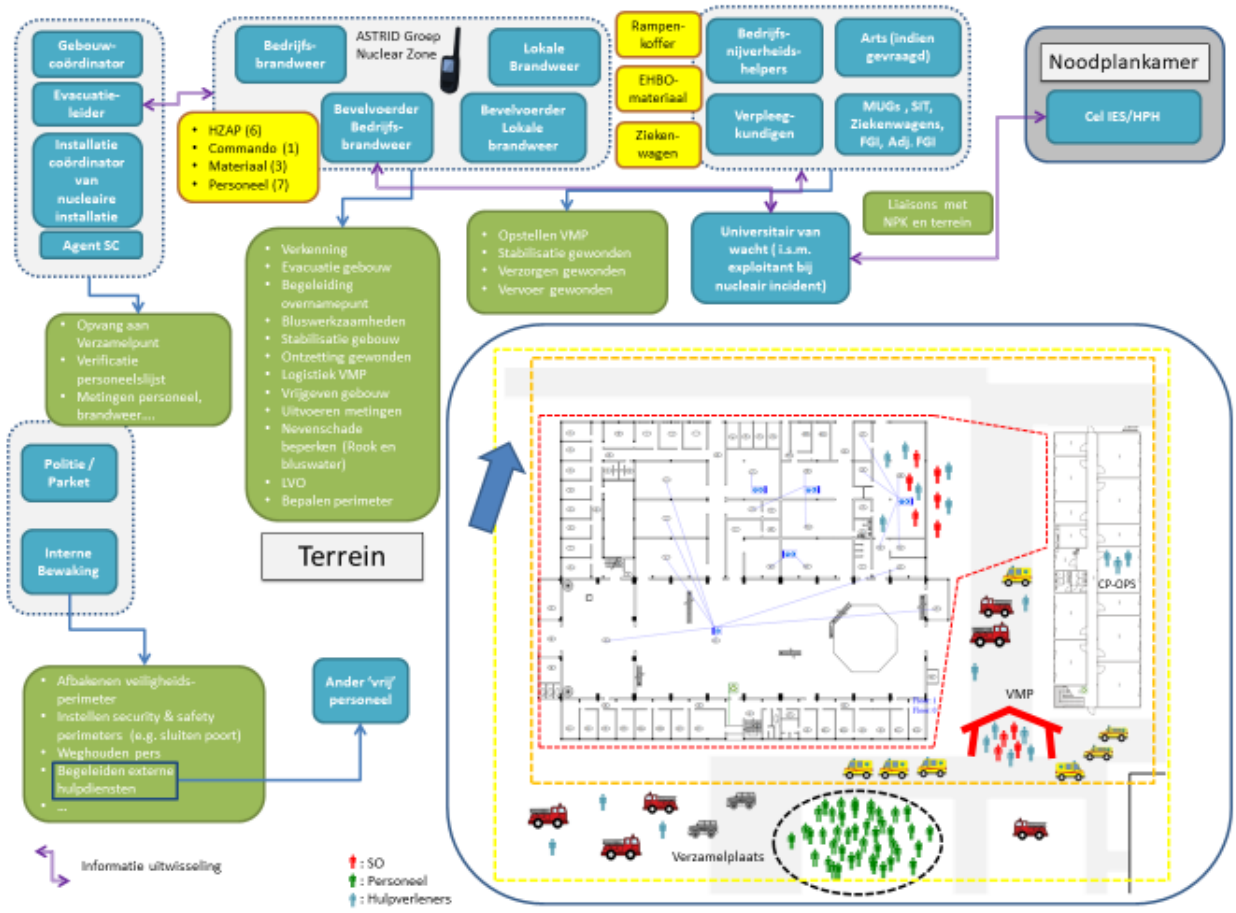


Figure 3. The plan related to dealing with the accident in terrain.

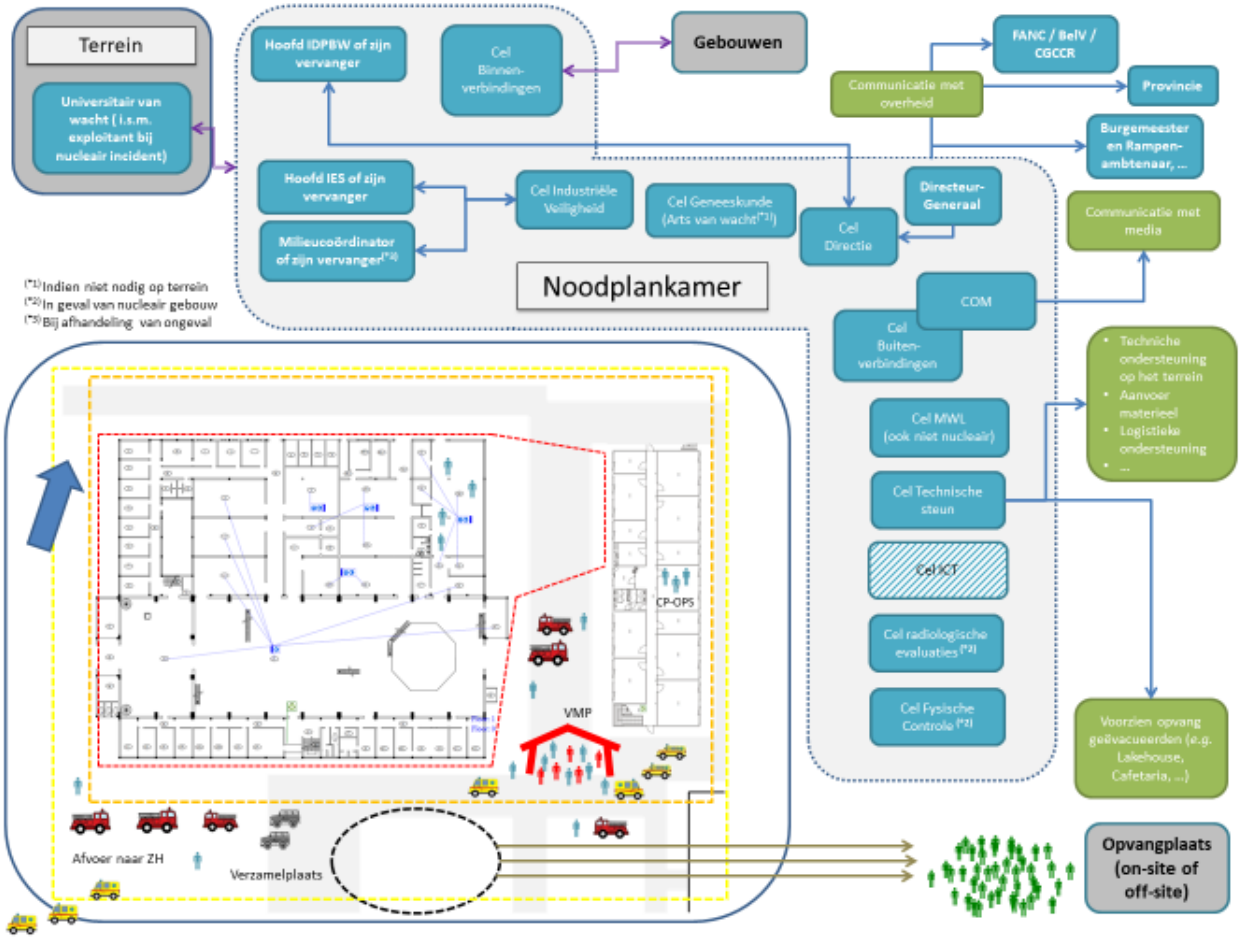


Figure 4. Interactions between crisis management cells

Description of main actors involved in emergency preparedness and response

Employees: SCK•CEN is one of the largest research institutions in Belgium. Every day, more than 800 employees dedicate themselves to developing peaceful applications of radioactivity: applications for the medical world, industry and the energy sector. The SCK•CEN is a multicultural environment (researchers from more than 40 nationalities), multilingual environment (Dutch, French and English are working languages) and multidisciplinary environment (nuclear and non-nuclear related disciplines, natural science and social science), different levels of educations (from technicians, administrative employees to high and university degrees researchers).

Contractors, visitors, and other personnel at the domain: SCK•CEN collaborates with numerous technical and research partners both from Belgium and abroad. The research center also organizes training courses and offer specialist services including consultancy and has an academy with more than 80 PhD and Postdoctoral students.

The company fire service i.e. qualified fire fighters: the SCK•CEN fire service, which consist of more than 25 semi-professional firefighters is activated after warning i.e., the notification of specific people about the start of a fire or hazard. This can be via automatic fire detection, a manual report via a special fire emergency number or by pressing a red manual fire alarm. All the above alarms are sent to the internal security department, which initiates the necessary emergency procedures. In each case the internal fire service is also notified. The internal fire service has equipment and members trained according to the highest standards in Europe.

SCK•CEN medical service: The medical service conducts medical examinations of the SCK-CEN employees and, among others, assists the firefighters in emergencies at the nuclear domain. They are trained and equipped to give first aid.

SCK•CEN emergency room: During emergency situations, representatives from different crisis management cells gather in the emergency planning room. These include representatives of: Bel-V, internal and external relations, managing board, physical control, medical service, radiological evaluation, communication, technical support, ICT and VITO.

Method

Non-participatory observation

Non-participatory observation was chosen as the method to be used for identifying different aspects of uncertainty impact on different actors involved in emergency management. In non-participant observation a researcher *"watches the subjects of his or her study, with their knowledge, but without taking an active part in the situation under scrutiny"* (Perko, Abelshausen et al. 2017). The observational study is based on the description of behaviors and the identification of patterns. The observation process was conducted while following the protocol described in the document "Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers" (Perko, Abelshausen et al. 2017). During the emergency situation, the observers were not allowed to intervene or participate with questions. They used a specific form to keep notes of the exercise developments (see Annex) and took photos of the situations. After the debriefing, they were allowed to conduct interviews with participating actors, if deemed necessary.

After the exercise, the observers participated in a meeting to discuss their notes and the uncertainties that were present during the emergency. The goal was to identify uncertainties, gain insight into the way they were addressed and handled during the emergency exercise, as well as the assumptions and decisions made by the involved actors.

Observation points

The non-participatory observation focused on identifying uncertainties that were present during the communication and decision-making processes of the involved actors in four settings (see table 2). It is of crucial importance to understand the way these actors assess the situation and how they decide to react. Therefore their actions and decisions were observed by one observer for each of the involved setting.

In the Belgian reactor 3, the evacuation process was observed by focusing on the actions and uncertainties of the evacuated employees as well as those of employees that are responsible for evacuation. The same applied for the other services as well. The observer of the medical service observed every word, action and decision of the doctors, nurses, interns and the ambulance driver; the firefighters together with the information they offered and decisions made were observed by another observer; and lastly, the actions and uncertainties in the emergency planning room were observed as well.

Setting	Location	Number of observers	Date	Tool
BR3 Evacuation	SCK•CEN	1	25 October 2018	Notes
Medical Service	SCK•CEN	1	25 October 2018	Notes
Fire Brigade	SCK•CEN	1	25 October 2018	Notes
Emergency Room	SCK•CEN	1	25 October 2018	Notes

Table 2. Observation settings during the exercise

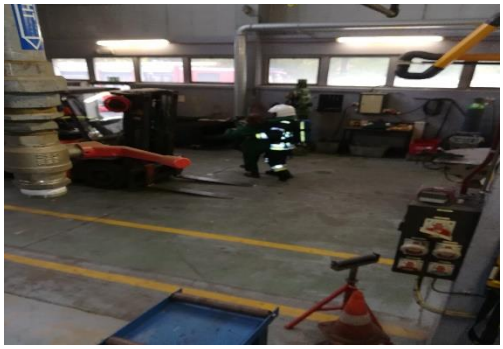


Figure 5. Place where the accident happened.

Figure 6. Evacuated employees at the gathering point.

Figure 7. Medical Service taking care of the first victim.

Figure 8. The fire brigade.

Figure 9. Emergency room.

Analysis and reporting

Throughout the discussion of the emergency exercise observation, the notes of observers were analysed from which uncertainties were then deducted and categorized as described below.

The analysis is included in the report which amongst others, will serve to identify some points where observers can focus more in future observations.

Results

In the following section we summarize the main actions or decisions that took place during the observed exercise that lead to different aspects of uncertainties. The focus is to see what kind of uncertainties exist and how do the actors act under or respond to these uncertainties. We then group them according to different aspects these uncertainties are related (see figure 3).

- ***Evacuation of the building where the accident happened***

The first step in the evacuation of BR3 resulted to a first uncertainty. Employees were informed by the evacuation responsible employee that there will be an emergency exercise so they started going downstairs where they all gathered in the ground floor (but not at the gathering point).

- *"Why are we being informed in person and not by an alarm?"*

They didn't hear an alarm so they were not sure if they should go outside to the gathering point. They were thus uncertain how to react. *Go outside or wait for the alarm?* (In a nuclear emergency employees are asked to stay in the building, while during a fire alarm, employees are asked to go out of the building).

After the alarm started, the evacuation responsible employees started calling names in order to check if everyone was there. They noticed 2 people were missing and they had no information about their location. They were *uncertain if they were in the building during the accident or not* so they called to ICT by phone to see from which door they badged for the last time. They understood that one of them did not come to work that day but they have no information about the location of the second person.

Figure 10. Evacuated employees at the gathering point.

That employee that did not come that day at work, came later and tried to go inside the building while not knowing that everybody is outside due to evacuation. He was then told by his colleagues that he is not allowed to enter the building.

After around one hour, they were allowed to go in the building. After they did so, the firefighters told the evacuation responsible employee that he should have waited for their permission before allowing employees to go inside. So, it led to another confusion: *who gives orders and whom should we listen to?*

Still, nothing was known about the identity of the victims and the employee responsible for evacuation was *not sure if any of the victims was an employee of the BR3.* He was not informed about *which company was working on the machine hall* either.

- ***Medical Service***

The medical service employees were already aware of the exercise but when they got the call, they were told the accident is real and then this generated a state of uncertainty. Normally if the accident would be real they would be informed by mobile phone and not by radio, so *is the accident real or not?*
After they get the second call they were informed better about the exercise-accident and they had to be present there but remain "stand-by" in case there are victims. After leaving to the place of the accident, they had to stop at the speed gate and the main entrance in order for all of them to badge (see figure 11). In normal circumstances these security measures apply, but in emergency situations they take vulnerable time. They also were not sure whether everybody in the car should badge (which is the standard security procedure) or only the driver (which would save time). So there were *uncertainties in how to deal with standard security features in emergency situations? What comes first, security of a nuclear installation or an emergency (safety)?*

Figure 11. Medical service cars stopping at the gates for badging.

After arriving at the place of the accident, the doctors were not sure whom to address *to inform that they were there and ask information.* They fact that they were asked to be "stand-by" also caused uncertainty in this regard. *What does being "stand-by" mean? Wait and see, or go and ask?*
Right after, the first victim arrived in need of oxygen and with burning wounds. The wounds had to be cooled. The medical team did not know where to get running water. *Could they ask the firefighters to help them to use their water? Does the water that is used by the firefighters fit for such a medical purpose?*
During the debriefing after the exercise, they mentioned that they were uncertain *about the collaboration between different disciplines (in this case doctors and firefighters). They were not sure if they could ask for help from fire brigade and use their equipment.*
After a while, the second victim arrived and the medical service was *uncertain what to do in case this victim needs oxygen as well because they had only one bottle.* This victim was worrying and uncertain about the fate of the colleague that is still inside the room where the explosion happened. *Where is my colleague, did you find him, what is going on?*

A third, unconscious victim is brought outside by the fire fighters, with the message "is contaminated". The victim needs to be reanimated, but the medical service first wants to have information about whether the victim really is contaminated and what kind of contamination. They were *uncertain about the contamination; what kind of personal protective measures they should take and which treatment is appropriate in this situation?*
Shortly after, another firefighter informs the medical service that the victim is in fact not contaminated and did not come out of the 'hot zone'. Now there are contradictory pieces of information. *Is the victim contaminated or not? Can we touch him (reanimate) or not* (see figure 12)?

Figure 12. Medical service not sure how to react with the potentially contaminated victim and waiting for information.

Regarding the treatment of the possibly contaminated victim, there appeared to be disagreement within the medical service during the debriefing. One actor said that they have personal protective equipment, so they should help the victim immediately, because life-threatening issues come first. Another actor said that "own protection comes first". *What is more important? Protecting yourself or saving the victim's life?* During the debriefing, another issue mentioned, was that everyone (including the victims) could hear the messages through the radio (e.g. about their meanwhile deceased colleague). *How to balance radio information knowing that bystanders can also hear what is being said? How to give clear and straightforward information, but at the same time be careful in case someone else will hear?*

The need for aftercare not only for victims but also for first aiders for post-traumatic stress was also brought forward by the medical team during the debriefing. They were *uncertain about who could provide such psychological help.*

- ***Fire Brigade***

The firefighters did not get informed by SMS about the accident so this raised *uncertainties related to technical reliability of alerting systems.* They were only informed through a pager.
During the interview after the exercise, one firefighter says that she forgot her dosimeter so she was not allowed go downstairs in the place where the accident happened. However, as she was supporting the team downstairs with water, positioning on the stairs, she was seeing her colleague caring and struggling with a victim. This was slowing the procedure and obviously he needed some help. Hence, she was *uncertain how to react. To follow the instructions of not going downstairs or to help her colleague and bring the victim faster to the medical service?*

Figure 13. The firefighters and one of the observers.

- ***Emergency Room***

In the emergency room, the main questions raised are *who contacts the family of the injured? Who gets information about their health status in the hospital?* In addition to that, *they did not know about any emergency number where the family members of the victims could call to get information*. They were not sure where the notification formularies are either and it took some minutes until they found them.
During the debriefing, they pointed out that no one in that room except the security responsible employee knew exactly *what the accident was about*. They said that *it was difficult to understand the message transmitted through radio. It was not very clear. Hence, another uncertainty related to technical reliability*.
In the interview after the exercise, the security responsible employee said that *he was not sure where he should be. In the emergency room or in the place of accident?* He said that there should be contact people to give information about this. "*Normally there is a consultation team composed of the SRE, person for radiological control, fire brigade, and the operator of BR3 in the place of accident. Some of them were not there so I was not sure what to do*".

Figure 14. The security responsible employee calling for someone from medical service to come at the emergency room.

Uncertainties grouped based on different aspects

Aspects	Uncertainty
Technical Reliability	• Why is there no alarm since there is an emergency? • The voice quality in the radio is very low which makes the message unclear. How to react when you don't clearly understand the message? • When to switch off the radios? When does an emergency really end? • Why is there no SMS received to inform about the incident?
Decision-making	• To go outside at the gathering point or wait for the alarm? • When to let people go back to their work and who decides about this? • Where should I stay? At the emergency room or at the place of the accident? Where am I more needed? • What to do when some members of the team (together with their information regarding the accident) are not present? • How to act when there is no sufficient equipment (oxygen bottles, and water for cooling the wounds)? • How to react when there is contradictory information related to the possibly contaminated victim? • How to balance the noises (radio from inside; firefighters and other services from outside) so we can hear the screaming victims? • What to use? Spray gun? Dosimeter? • How to proceed when we are not sure if the victim is contaminated or not?
Lack of information	• Don't know about the location of missing employees. Not clear if they were in the building during the accident or not. • The evacuation responsible employee had no information about the identity of the victims so he was uncertain if they were part of BR3 or not. • Not clear which company was working in the machine hall. • Can't find notification formularies in the emergency room. • Emergency room members didn't know what exactly the accident was. • Unclear whether one of the victims is contaminated and no information about the type of contamination. • The trainee had no information about the situation of one victim. He was just told "keep cooling". • Who is the main source of information? • Can we collaborate or ask for help from other disciplines (e.g. firefighters and medical service)?
Communication & task delegation	• Who communicates about the situation and when to tell people to go back to work? • Where can family members of the victims call for information when there is no emergency number?

	• Whom to ask about information related to where to be and what to do when there is no contact person to give information? • Misinterpretation by the medical service: is the accident real or not? • Contradictory communication related to the contamination of the victim. Whom to believe? • One employee was told that he should go at the place of the accident but was uncertain of what he should do there. • Who is responsible for briefing? Who is the main source of information and whom to believe? • How to balance radio information? How to give straightforward message but at the same time be careful knowing that everyone (including victims) can hear that message?
Security	• How to deal with standard security features in emergency situations? Badging at the gate takes time. What comes first, security or emergency (safety)?
Socio-ethical	• How to react in cases of forgetting the dosimeter? Follow the instructions and not go in the dangerous area or help my colleague and save time while working faster together? • What to do with the possibly contaminated victim? What comes first? Own protection or saving victim's life? • Should someone stay with the dead person?
Psychological	• Worrying and uncertain about the fate of the colleagues that were involved in the accident. • How to deal with post-traumatic stress of the intervention people? Who is responsible for that?

Table 3. Classification of uncertainties that arose during the exercise.

Summary of findings

Uncertainties may emerge in different stages of a radiological situation and they relate to different aspects such as legal, technological, financial, political, socio-ethical aspects, communication and stakeholder engagement in these situations (Perko, Abelshausen et al.).

During this emergency exercise, the goal was to identify what kind of uncertainties arose during the emergency situation and how did the involved stakeholders respond and react in this situation. This was made through observation of the exercise, discussion of the observation notes and this report. We found that the main aspects of social uncertainties that the involved actors were faced with, were decision-making, lack of information, communication and task delegation, technical reliability, security, socio-ethical, as well as the psychological aspects.

Being that these uncertainties have their consequences when decisions are made under them, it is of crucial importance to discuss the causes of their existence, to talk and communicate freely about them so that we can find solutions and reduce them in further exercises and real emergency situations.

References

Perko, T., et al. Decision Processes Related to Norm Contamination and Remediation: Focus on Uncertainties**:** 1-31.

Perko, T., et al. (2017). Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers**:** 6-40.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 662287.

EJP-CONCERT

European Joint Programme for the Integration of Radiation Protection Research

H2020 – 662287

Internal report

Uncertainties during and after a nuclear emergency exercise (20/11/2018): Results from a non-participant observation study in Belgium

Authors:

Hoti Ferdiana, Perko Tanja, Schröder Jantine, Glesner Colin, Catrinel Turcanu

Reviewers: Turcanu Catrinel

Work package / Task	**WP5**	**5.2.3. Conceptualization and management of uncertainties in emergency exercises in EU countries**
Deliverable nature:	**Intermediate document**	
Dissemination level: (Confidentiality)		
Contractual delivery date:	**N/A**	
Actual delivery date:		
Version:	**V1**	
Total number of pages:		
Keywords:	**Observation, nuclear emergency exercise, uncertainties, decision making**	

Introduction

This report summarises the results of non-participant observations carried out in the context of the nuclear emergency exercise conducted at the Institute of Radioelements (I.R.E) in Fleurus, Belgium on 20th November 2018 within the CONFIDENCE Project, Task 5.2.3. This exercise called IREX 2018 was coordinated by the Federal Crisis Center. The objective of this observation was to understand what kind of uncertainties arise in nuclear emergency situations at the national level; to attain a clearer perception of the way these uncertainties are addressed and handled during the emergency exercise; as well as the assumptions and decisions made during the emergency exercise under uncertain conditions. Based on the observations, this report aims at identifying what kind of uncertainties arise during these situations, group them in different aspects of uncertainties and present a brief summary. This will then support the CONFIDENCE project to find solutions to communicate about uncertainties, manage uncertainties and reduce them - if possible- in order to empower stakeholders for informed decision-making in emergency situations.

Description of the observed exercise

The Institute of Radioelements (IRE) produces radioisotopes for medical use. On Tuesday, November 20th 2018, an exercise took place in which a radiological incident on the site of the IRE in Fleurus, Belgium was simulated. This exercise, called IREX 2018, was coordinated by the Federal Crisis Center (FPS Home Affairs) during which the nuclear emergency plans and procedures of the national, provincial and municipal authorities, as well as the operator of the site, were tested. Members of the emergency services were deployed on the site. No action was expected from the population. Every two years an exercise is performed on the site of the IRE Fleurus with the aim to test and to reinforce contingency plans and procedures. The exercise IREX 2018 was methodologically supervised and the nuclear emergency plans and procedures of all actors involved were tested.

The scenario considers the presence of a truck trailer with tank containing 700 Litres of radioactive effluents in the hall B6D. This hall is heated via industrial electric heating system. During the night, there is no activity in the controlled area located next to this hall and no IRE staff is on the site. At 04:00 am, a fire started in the heating system, detected by the automatic detection system. The tires of the trailer catch fire. The fire-extinguishing system by water fog is triggered, slowing but not stopping the development of the fire. At 04:20 am, a flash-over spreads the fire to the B6 building (hot cells) and causes a general fire. The fire brigades arrive and open the door of the hall B6D (truck location). Opening the door allows the release of 64 GBq of Cs-137 from liquid evaporated from the tank. The humidity present in the B6 (hot-cells lab) provokes the desorption of I-131 accumulated in the active cool filters (a fraction of the 130GBq inventory, depending on the activation of supplementary filters).

This exercise lasted approximately 8 hours and different objectives were defined to test certain aspects of crisis management during this exercise, namely:

• The introduction of the newly revised nuclear and radiological emergency plan;

• The alarming and mobilization in real time of the participating authorities and services;

• Making decisions about protective measures for the population and / or the food chain;

• The flow of operational information between the various partners and crisis cells;

• The deployment of the emergency and emergency services on the ground;

• The elaboration of the crisis communication of the authorities.

This exercise was organized by the National Crisis Center (FPS Home Affairs), in cooperation with the Federal Agency for Nuclear Control (FANC), the federal services of the governors of Hainaut and Namur, the municipalities of Fleurus and Farciennes, the emergency services involved, as well as the operator of the site. It was also planned that the Haute Ecole Louvain in Hainaut (HELHa), a specific partner for this exercise, put media emphasis on the participants and played the role of concerned citizens.

The exercise IREX 2018 took place in conditions that are as close to reality as possible. The start time of the exercise was therefore not known by the participants and the alarm took place outside of office hours. As part of this exercise, local residents could witness the deployment of the emergency services on site or the use of the internal sirens of the site. However, no action was expected from them.

In case of a real nuclear incident, the population concerned will be alerted by the authorities, namely via the BE-Alert system. In the context of this exercise this alarm was be simulated. So in reality no BE-Alert message will be sent to citizens.

However, this exercise was also an opportunity to sensitize the population to the good reflexes in the event of a nuclear incident. Everyone's safety was central to these exercises. Everyone was therefore asked to check whether he or she knows exactly what to do in the event of a nuclear incident: what are the good reflexes that must be taken for their own safety and that of the family?[1]

Simulated and real communication strategy

For this exercise, the D5 tested the entire POCC working method at national, provincial and municipal levels by coordinating analysis, strategy and crisis communication within an integrated DS Cell. In order to implement the entire POCC, a simulation of the media pressure was planned in collaboration with a school of journalism. In order to make the media pressure more real, telephone contacts were possible towards all the actors of crisis management; especially towards the members of the Discipline 5 or the persons in charge of the various cells put in place. Any communication from the simulants was preceded by the mention EXERCISE IRE 2018. The result of this simulated pressure was visible on an ad hoc platform accessible by all the participants in the exercise (particularly the members of the D5, who are responsible for analyzing it). As part of the deployment in the field, the IRE website reserved the right to activate its siren alert. The BE-alert and 1771 systems were only used by the authorities in a simulated way.

[1] For more information visit *www.nucleairrisico.be*

Given the deployment in the field, the use of a helicopter and the triggering of sirens on the site, it is important to inform the population actively. The exercise was announced on the website (and social media) of the National Crisis Center. A canvas of text was also made available to the authorities and services involved in the exercise. The Communes of Farciennes and Fleurus ensured to provide information to their inhabitants especially to the residents of the site.

There was no press support planned during the exercise. The first impressions of the different actors were shared by the National Crisis Center directly after the exercise. Both before and during the exercise, the participants (actors or simulants) as well as the accompaniers and evaluators, were asked to respect this strategy, not to give any comments to the media on the preparation, the content and the course of the exercise.

Main actors actively participating in the exercise

- The Institute of Radioelements (IRE)
- Directorate General Crisis Center (DGCC)
- Radiological evaluation cell (CELEVAL)
- The Federal and Field Measurement Cells (CELMES)
- The Information Cell (CELINFO)
- The duty service of the National Crisis Center
- The Federal Coordination Committee (COFECO)
- Police Zone "Brunau" (Fleurus, Pont-à-Celles, The Good Villers)
- Crisis cells of the communes of Fleurus and Farciennes
- The emergency center 112 Hainaut
- Marie Curie Civil Hospital Charleroi
- FPS Home Affairs (the National Crisis Center and Civil Security), Public Health and Mobility;
- The federal police and defense;
- The Federal Agency for Nuclear Control (FANC);
- The Federal Agency for the Safety of the Food Chain (FASFC);
- Centre Régional de Crise Wallon (CRC-W);
- The federal services of the governors of Hainaut and Namur;
- The Hainaut East emergency zone;
- CP-Ops including heads of different disciplines such as medical personnel, fire services, army.

Country	Date	Brief description of the exercise scenario
Belgium	20th November 2018	On Tuesday, November 20, 2018, at 04:00 am, a fire started in the heating system of IRE, detected by the automatic detection system while a truck trailer with tank containing 700 Litres of radioactive effluents was in the hall B6D. The tires of the trailer caught on fire. The fire escalated and there was a release of 64 GBq of Cs-137 from liquid evaporated from the tank. The humidity present in the B6 (hot-cells lab) provoked the desorption of I-131 accumulated in the active

		cool filters (a fraction of the 130GBq inventory, depending on the activation of supplementary filters).

Table 2. Brief description of the observed exercise

Brief description of the nuclear emergency planning in Belgium

The Belgian (and international) authorities act at various levels to reduce nuclear risks: **identification** and **analysis** of the risk, **preventive measures** to reduce the risk or its impact, **contingency plans and procedures** to prepare for an accident, emergency **management** during and immediately after an accident, and taking **action** after an emergency to get back as quickly as possible to normal.

On the national level, the nuclear emergency response organization is governed by the "Nuclear and Radiological Emergency Plan for the Belgian Territory", established by the Royal Decree of 17 October 2003 (revised in 2018). This plan aims at ensuring the coordination of the protective measures for the population and the environment in case of a nuclear accident or for any other radiological emergency situation which could lead to an overexposure of the population or to a significant contamination of the environment. In comparison with emergency exercises, in cases of a real nuclear incident, the population concerned will be alerted by the authorities, namely via the BE-Alert system.

The nuclear emergency plan in Belgium primarily applies to the following sites: Doel and Tihange (Engie), Mol-Dessel (Studiecentrum voor Kernenergie SCK-CEN, Belgonucléaire and Belgoprocess) and Fleurus (Institut National des Radioéléments, IRE). This plan is also activated for other emergency situations, which can occur either on the Belgian territory (accident during the transport of radioactive materials or radiological emergency resulting from a terrorist attack for instance) or nearby (EdF nuclear power plant of Chooz for instance).

Figure 1. Nuclear Emergency plan for the Belgian territory

In case of an emergency, the off-site operations are directed by the "Governmental Crisis and Coordination Centre" (CGCCR), under the authority of the Minister of Internal Affairs. The implementation of the actions decided at the federal level and the management of the intervention teams are under the leadership of the Governor of the Province concerned.

Activation involves **cooperation** between municipal, provincial, regional, federal and international crisis structures. It is **mandatory** for the operator of a nuclear site to **report** any incident on its site to the competent authorities (FANC, Crisis Centre). Based on the initial **risk assessment**, using the technical information from the operator, the government determines the **alarm level**. Besides the CGCCR, there are other actors involved in emergency planning in Belgium such as COFECO, CELEVAL, CELMES, ECOSOC and CELINFO.

COFECO defines the general emergency strategy and takes the fundamental decisions (necessity and extent of the urgent measures to be taken to protect the population and/or the food chain or the drinking water supply) and assumes the political responsibility. COFECO follows the advices of the evaluation- and the socio-economic cells;

CELEVAL evaluates the situation from the radiological and technical point of view, based on the information coming from the affected site, from the field measurement cell and from organizations represented within the cell, and advises COFECO on the protective measures for the population and the environment. CELEVAL is also in charge for defining the environmental radioactivity measurement strategy;

CELMES co-ordinates all the activities related to the collection and validation of radiological information transmitted either by the field measurement teams or by the monitoring network, called TELERAD, and implements the measurement strategy defined by CELEVAL;

ECOSOC advises COFECO on the socio-economic consequences of the decisions taken or to be taken, is in charge of the management of these consequences, informs COFECO on the follow-up of the decisions in the sectors concerned and ensures the return to a normal socio-economic situation after the accident;

CELINFO is in charge of communication with the population, the media, the neighboring countries and the specific target groups.

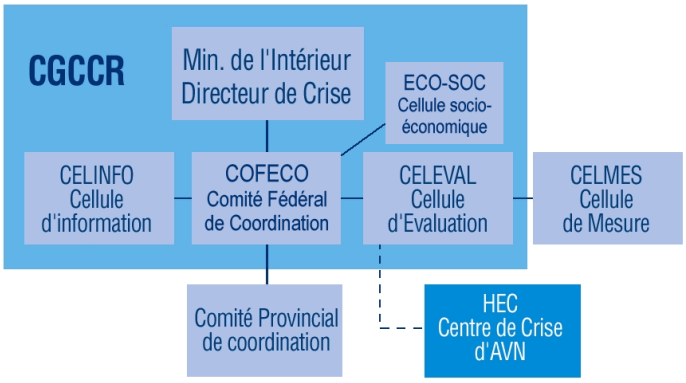


Figure 2. Main actors involved in emergency planning in Belgium.

Citizens that live in a nuclear zone 20km close to the nuclear power plant (10km for IRE Fleurus) are asked to:

- ***Be informed***. Read the recommendations. Consult the reference website *www.nuclearrisk.be* or find out information from ***their local authority***.
- Suscribe to BE-Alert, to be alerted in an emergency situation.
- The first recommendation in the event of a release of radioactivity is to ***take shelter***.
- In the event of a radioactive discharge, the authorities may recommend taking stable ***iodine tablets***. If you don't have any at home, you can get them from your ***local pharmacy***.

Method

Non-participatory observation

Non-participatory observation was chosen as the method to be used for identifying different aspects of uncertainty impact on different actors involved in emergency management. In non-participatory observation a researcher *"watches the subjects of his or her study, with their knowledge, but without taking an active part in the situation under scrutiny"* (Perko, Abelshausen et al. 2017). The observational study is based on the description of behaviors and the identification of patterns. The observation process was conducted while following the protocol described in the document "Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers" (Perko, Abelshausen et al. 2017). During the emergency situation, the observers were not allowed to intervene or participate with questions. They used a specific form to keep notes of the exercise developments (see Annex) and took photos of the situations. After the debriefing, they were allowed to conduct interviews with participating actors, if deemed necessary.

After the exercise, the observers participated in a meeting to discuss their notes and the uncertainties that were present during the emergency. The goal was to identify uncertainties, gain insight into the way they were addressed and handled during the emergency exercise, as well as the assumptions and decisions made by the involved actors.

Observation points

The non-participatory observation focused on identifying uncertainties that were present during the communication and decision-making processes of the involved actors in four settings (see table 2). It is of crucial importance to understand the way these actors assess the situation and how they decide to react. Therefore their actions and decisions were observed by at least one observer for each of the observed points.

Since the exercise was on the federal level, we managed to observe different settings that were involved in different cities in Belgium. First of all, one of the observers was there at the place of the accident (IRE) to observe the CP-Ops and different disciplines involved. In situations where an accident happens in the Walloon part of Belgium (in this case in IRE, Fleurus), SCK•CEN does the local coordination as well as measuring and vice-versa. Therefore, we had two observers at the SCK•CEN local coordination and one

with the field measurement team. The crisis centre with the different cells (COFECO, CELEVAL, CELMES, etc) whose functions were mentioned earlier is located in Brussels. This setting (radiological evaluation cell) was observed by one of the CONFIDENCE observers.

Setting	Location	Number of observers	Date	Tool
SCK•CEN Measurement Team	SCK•CEN and IRE	1	20 November 2018	Notes
Crisis Centre, CELEVAL and CGCCR duty service room	Brussels	1	20 November 2018	Notes
Local Coordination Team	SCK•CEN	2	20 November 2018	Notes
CP-Ops	IRE	1	20 November 2018	Notes

Table 2. Observation settings during the exercise

Figure 3. SCK-CEN Measurement team

Figure 4. Local Coordination of the measurement teams

Figure 5. The location where the CP-Ops took place.

Figure 6. CELEVAL, one cell of the crisis centre.

Analysis and reporting

Throughout the discussion of the emergency exercise observation, the notes of observers were analysed from which uncertainties were then deducted and categorized as described below. Often in the notes, direct quotes are used to include the voices of the participants.

The analysis is included in the report which amongst others, will serve to identify some points where observers can focus more in future observations.

Results

In this section we summarize the main actions or decisions that took place during the observed exercise that lead to different aspects of social uncertainties. The focus is to see what kind of uncertainties exist and how do the actors act under or respond to these uncertainties. We then group them according to different aspects these societal uncertainties are related (see figure 3).

SCK•CEN Measurement Team

The main uncertainties encountered at the SCK measurement team where related to technical issues, for example the reliability on new equipment, a colleague's ability to work with it (depending on whether they had taken previously a dedicated training course or not), whether the equipment can work without internet or not. They had to try a new system and had difficulties getting acquainted to it. There were also other aspects of uncertainties noticed in this setting, regarding decision-making, communication and lack of information. Measurement team members had no information no information about the situation or the release in the site and had no access to information related to measurement data of other teams. Several members of the team did not know how to enter the results in the new system.

Figure 7. Measurement Team entering data in Suivo

Crisis Centre Brussels

In the crisis centre, most uncertainties were related to communication. People were called to be informed about the emergency and were told to be on stand-by. This raised some uncertainties about what "stand-by" means. Other uncertainties were related to the use of an electronic logbook where the different cells could have access to information of the development of the situation and actions of other teams, but which crashed a number of times, requiring the temporary use of an alternative means to record information (Excel file), and causing information loss and problems with the information flow between the different cells. There were also some uncertainties related to decision-making related for instance to helicopter measusrements, decisions regarding sheltering, and the distribution of printed information
The exercise flow was disrupted by a real event (street protest) due to which the role of the federacal crisis coordination was limited to a person simulating this cell.

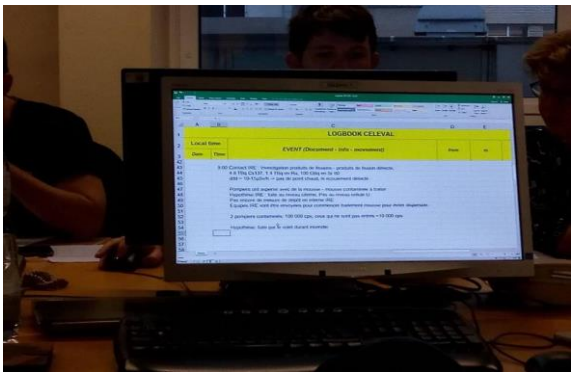


Figure 8. Person responsible for the electronic logbook uses Excel as backup information logbook

Local Coordination of Measurement Teams

Uncertainties in the local coordination team were caused mainly by lack of information and other problems with communication. For instance, the phone number of local coordination cell could not be directly reached. This caused delay and communication problems. There were also uncertainties related to interpretation and perception of wind direction. Regarding the updates of the situation, some actors were not sure whether they should communicate and to what extent. They had no information about which radionuclide was the contaminant. Regarding decision-making, there were uncertainties about how to react in situations when unforeseen actions interfere with the intervention.

Figure 9. The local coordination team discusses the situation

CP-Ops, IRE

In the beginning of the exercise, at the nuclear iInstallation there was no information about the communication officer and location of the decontamination unit. There were also decision-making uncertainties, for instance who is responsible with specific tasks, where to send the contaminated victim, whether to take and use dosimeters or not. In addition, there were uncertainties due to lack of communication and coordination, mismatch of plans and lack of a common plan to be followed by all disciplines. Some disciplines were missing and this also caused communication difficulties. The rescuers had to stop for security clearance and this took a lot of time, which caused "security vs. safety" uncertainties.

Uncertainties grouped based on different aspects

Aspects	Uncertainty
Technical Reliability	• Reliability of new equipment/ tools (Suivo) • Personnel trained to work with new equipment. • Dependence on internet connection. What if there is no connection? • Multiple communication tools. "If you have 3 communication sources and they give different information, confusion is caused". • How to enter particular measurement results in the new system? (Measurement Team Member cannot enter 0. It automatically turns into 1). • You don't know where you are on the map in relation to the source. • Technical problems with the helicopter (they needed to land and restart equipment).
Decision-making	• Which route to follow? How to arrive faster? • How to balance time & operational efficiency? How to drive and deal with the system in the tablet at the same time? • What does one have to do when asked to be stand-by?

	• What to do regarding sheltering? Recommend the reflex action if the accident is unlikely to require this? Radiological experts considered it unnecessary while the decision-making cell decided reflex actions. • Who should decide about the helicopter AGS? • What kind of measurement strategy shall we apply? • How to proceed in situations when there are unforeseen actions interrupting the action (car accident; traffic jam; lack of equipment; technical problems)? • Where to send the contaminated victim? • Fear and concern regarding possible contamination. How to act? • To get/ use the dosimeters or not?
Lack of information	• No information to the measurement team members regarding the release or other conditions until arrival. • No access to information related to measurement of other teams. • Unclear what happened at the local level and who intervened or not. • Uncertainty about what is going on? Need for fast information and advice provided to the decision-making cell. • Transmition of information between cells if electronic logbook crashes • Where does the higher dose of contamination of one firefighter come from? • How to manage information so that people that come later can follow what is going on? Only show it on the screen or print it? • Lack of information related to the situation in local coordination room. • When will the measurement team be there ready to measure? • Uncertainties and concerns on the local population level. What is going on? • Which radionuclide is the contaminant? • How to get information (history on GPS)? • No information about the IRE communication officer. • No information regarding the location of decontamination unit. • Where to send the contaminated victim? • D2 rescuer was not well informed about the measures that had to be taken and how. • No information if dosimeters are needed or not.
Communication & task delegation	• How to express and interpret wind direction? • Mismatch of orders. The local coordinators ask for them to leave but in the tablet there is no task displayed.

	• Uncertainty: a) which language to speak in the radio? b) did I get the message correctly? • Uncertainties related to location of team 2 due to miscommunication. • How to establish contact with civil protection? • "I hope they will transfer this information". Uncertainties related to reliability of communication and information transmission. • No updates of the situation due to broken communication. • Uncertainties regarding what should be communicated and to what extent. • How to establish contact with military? • Uncertainties regarding reliability to communication. "They told us that these numbers have been checked one week ago and everything was ok. Now, we cannot reach anyone." • Uncertainties due to difficulties in radio communication and noise. • Who is responsible where? • Troubles with communication due to missing disciplines. • Uncertainties due to mismatch of plans between disciplines. No common plan to be followed by all disciplines.
Security	• One observer is asked to pull over for security check. Was allowed to leave after she told she has to observe. Safety or security? • How to deal with standard security measures in real emergency situations? *"For the exercise, permission to enter was asked in advance, but what would happen in real emergency situations?"* • "*Is military informed about the drone? It is not allowed to use drone in the domain*?" • Security clearance took a lot of time for the rescuers.
Personal issues; worries; concerns	• How will I solve it with my child? I have to intervene at 6am. He only goes to school at 8am. • Lack of trust in information given related to wind direction. • Should I cancel the appointments? Will I be back in time? • Worry about family members. • Uncertain whether the measurement team members are safe in the place they are being sent. • Uncertainties and concerns on the local population level. What is going on? • Fear and concern of policemen regarding possible contamination. How to act?

Table 3. Different aspects to which social uncertainties are related.

Summary of findings

Uncertainties may emerge in different stages of radiological situations and they relate to different aspects such as legal, technological, financial, political, socio-ethical aspects, communication and stakeholder engagement in these situations (Perko, Abelshausen et al.).

In this report we described the nuclear emergency exercise that happened in Belgium on 20th November 2018. Since the exercise was on the federal level, the observers from the CONFIDENCE project observed four different settings in different cities that were involved in the exercise and are involved in real emergency situations. The goal of this observation and this report was to identify what kind of uncertainties were raised during the emergency situation and how did the involved stakeholders respond and react in this situation.

During this emergency exercise we found that the main aspects of social uncertainties that the involved actors were faced with, were decision-making, lack of information, communication and task delegation, technical reliability, security, and personal uncertainties such as lack of trust, worry for family members, etc. During this observation, we noticed no socio-ethical uncertainties.

Being that these uncertainties have their consequences when decisions are made under them, it is of crucial importance to discuss the causes of their existence, to talk about and communicate them freely so that we can find solutions and reduce them in further exercises and real emergency situations.

References

Perko, T., et al. Decision Processes Related to Norm Contamination and Remediation: Focus on Uncertainties**:** 1-31.

Perko, T., et al. (2017). Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers**:** 6-40.

Other figures from first results, media articles and emergency notifications

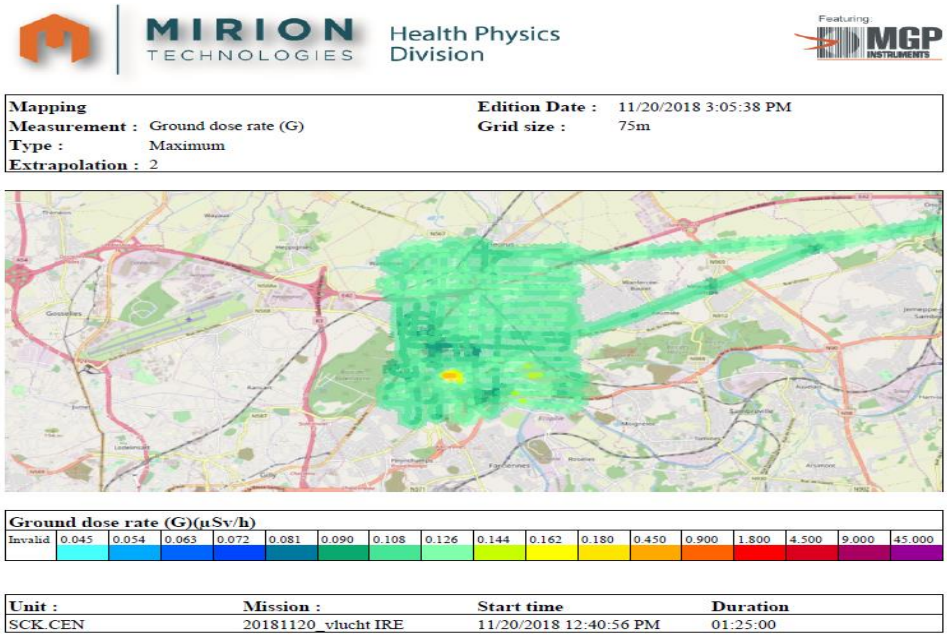


Figure 10. First results of data analysis with the helicopter. Ground dose rates.

Un exercice d'"incident radiologique" met en panique les habitants de Fleurus

BELGA Publié le mardi 20 novembre 2018 à 07h41 - Mis à jour le mardi 20 novembre 2018 à 07h45

CHARLEROI **Un exercice simulant un "incident radiologique", pourtant prévu et annoncé aux riverains par les autorités communales, a provoqué quelques inquiétudes mardi matin parmi des habitants de Fleurus, communique le Centre de crise national, qui coordonne l'exercice.**

> Hugues Bayet plus que jamais l'homme fort de Farciennes

Des appels sont parvenus aux numéros d'urgence 112 et 101, selon le porte-parole, alors qu'il n'y a pas lieu de s'inquiéter. Le Centre, dépendant du SPF Intérieur, demande à la population de ne pas paniquer. Il s'agit d'un exercice nucléaire, qui a débuté avant l'aube, vers 5h00 du matin, et doit se poursuivre durant la journée. L'exercice est d'ampleur assez "limitée", selon Benoit Ramacker, porte-parole du Centre de crise, ce qui justifie qu'il n'a pas fait l'objet de communications fournies envers la presse. Au niveau communal, les habitants des environs avaient cependant bien été informés, affirme-t-il.

L'exercice simule un "incident radiologique" sur le site de l'I.R.E., l'Institut National des Radioéléments, à Fleurus dans le Hainaut. "On teste le nouveau plan d'urgence nucléaire", précise Benoit Ramacker. "Les habitants ont pu entendre les sirènes internes du site, et voir aussi des véhicules de secours se diriger vers l'endroit".

Aucune action n'est attendue de la part de la population. L'exercice est organisé par la DG Centre de Crise en collaboration avec l'Agence Fédérale de Contrôle Nucléaire (AFCN), "les Services fédéraux auprès des Gouverneurs du Hainaut et de Namur, les Communes de Fleurus et Farciennes, les services de secours concernés ainsi que l'exploitant du site", avaient annoncé les autorités à la mi-npvembre.

Belga

Figure 11. Electronic news article about the "panic" caused by the drill.[2]

[2] http://www.dhnet.be/regions/charleroi/un-exercice-d-incident-radiologique-met-en-panique-les-habitants-de-fleurus-5bf3ab1ecd70e3d2f6cd83d4 (accessed on 20th of Nov. 2019)

Un exercice d'«incident radiologique» provoque la panique à Fleurus

Mis en ligne le 20/11/2018 à 07:48 Par Belga

Des appels sont parvenus aux numéros d'urgence 112 et 101, selon le porte-parole, alors qu'il n'y a pas lieu de s'inquiéter.

Un exercice simulant un « incident radiologique », pourtant prévu et annoncé aux riverains par les autorités communales, a provoqué quelques inquiétudes mardi matin parmi des habitants de Fleurus, communique le Centre de crise national, qui coordonne l'exercice. Des appels sont parvenus aux numéros d'urgence 112 et 101, selon le porte-parole, alors qu'il n'y a pas lieu de s'inquiéter. Le Centre, dépendant du SPF Intérieur, demande à la population de ne pas paniquer.

Il s'agit d'un exercice nucléaire, qui a débuté avant l'aube, vers 5h du matin, et doit se poursuivre durant la journée. L'exercice est d'ampleur assez « limitée », selon Benoit Ramacker, porte-parole du Centre de crise, ce qui justifie qu'il n'a pas fait l'objet de communications fournies envers la presse. Au niveau communal, les habitants des environs avaient cependant bien été informés, affirme-t-il.

Nouveau plan d'urgence

L'exercice simule un « incident radiologique » sur le site de l'I.R.E., l'Institut National des Radioéléments, à Fleurus dans le Hainaut. « *On teste le nouveau plan d'urgence nucléaire* », précise Benoit Ramacker. « *Les habitants ont pu entendre les sirènes internes du site, et voir aussi des véhicules de secours se diriger vers l'endroit* ».

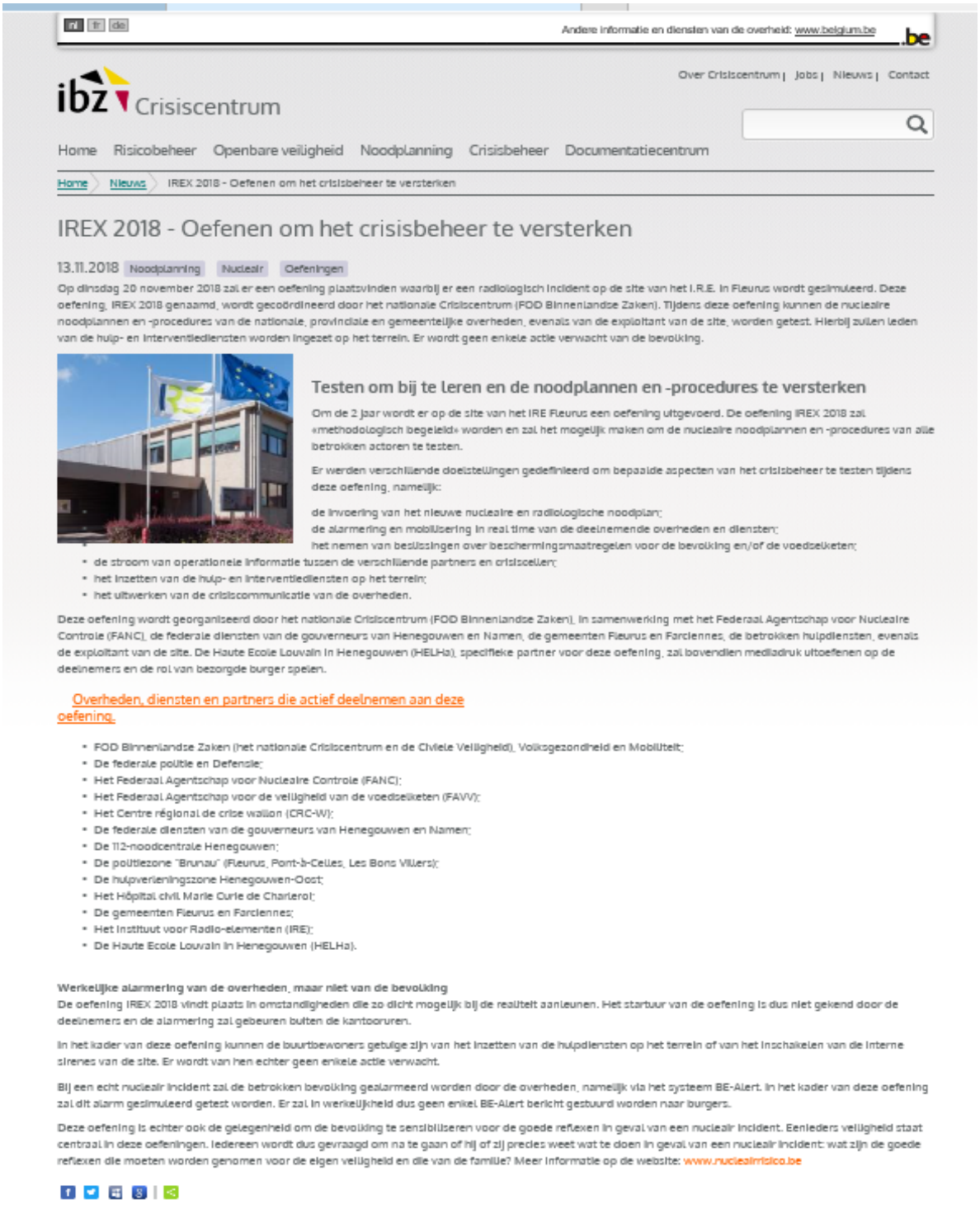
Aucune action n'est attendue de la part de la population. L'exercice est organisé par la DG Centre de Crise en collaboration avec l'Agence Fédérale de Contrôle Nucléaire (AFCN), « *les Services fédéraux auprès des Gouverneurs du Hainaut et de Namur, les Communes de Fleurus et Farciennes, les services de secours concernés ainsi que l'exploitant du site* », avaient annoncé les autorités à la mi-novembre.

Figure 12. Another news article mentioning the concern caused by the accident.[3]

[3] https://www.lesoir.be/191034/article/2018-11-20/un-exercice-dincident-radiologique-provoque-la-panique-fleurus (accessed on 20th of Nov. 2019)

Figure 13. Emergency exercise notification by FANC.[4]

[4] https://fanc.fgov.be/nl/nieuws/irex-2018-oefenen-om-het-crisisbeheer-te-versterken (accessed on 20th of Nov, 2018).



nl | fr | de

Andere informatie en diensten van de overheid: www.belgium.be

ibz Crisiscentrum

Over Crisiscentrum | Jobs | Nieuws | Contact

Home Risicobeheer Openbare veiligheid Noodplanning Crisisbeheer Documentatiecentrum

Home > Nieuws > IREX 2018 - Oefenen om het crisisbeheer te versterken

IREX 2018 - Oefenen om het crisisbeheer te versterken

13.11.2018 Noodplanning Nucleair Oefeningen

Op dinsdag 20 november 2018 zal er een oefening plaatsvinden waarbij er een radiologisch incident op de site van het I.R.E. in Fleurus wordt gesimuleerd. Deze oefening, IREX 2018 genaamd, wordt gecoördineerd door het nationale Crisiscentrum (FOD Binnenlandse Zaken). Tijdens deze oefening kunnen de nucleaire noodplannen en -procedures van de nationale, provinciale en gemeentelijke overheden, evenals van de exploitant van de site, worden getest. Hierbij zullen leden van de hulp- en interventiediensten worden ingezet op het terrein. Er wordt geen enkele actie verwacht van de bevolking.

Testen om bij te leren en de noodplannen en -procedures te versterken

Om de 2 jaar wordt er op de site van het IRE Fleurus een oefening uitgevoerd. De oefening IREX 2018 zal «methodologisch begeleid» worden en zal het mogelijk maken om de nucleaire noodplannen en -procedures van alle betrokken actoren te testen.

Er werden verschillende doelstellingen gedefinieerd om bepaalde aspecten van het crisisbeheer te testen tijdens deze oefening, namelijk:

de invoering van het nieuwe nucleaire en radiologische noodplan;
de alarmering en mobilisering in real time van de deelnemende overheden en diensten;
het nemen van beslissingen over beschermingsmaatregelen voor de bevolking en/of de voedselketen;

- de stroom van operationele informatie tussen de verschillende partners en crisiscellen;
- het inzetten van de hulp- en interventiediensten op het terrein;
- het uitwerken van de crisiscommunicatie van de overheden.

Deze oefening wordt georganiseerd door het nationale Crisiscentrum (FOD Binnenlandse Zaken), in samenwerking met het Federaal Agentschap voor Nucleaire Controle (FANC), de federale diensten van de gouverneurs van Henegouwen en Namen, de gemeenten Fleurus en Farciennes, de betrokken hulpdiensten, evenals de exploitant van de site. De Haute Ecole Louvain in Henegouwen (HELHa), specifieke partner voor deze oefening, zal bovendien mediadruk uitoefenen op de deelnemers en de rol van bezorgde burger spelen.

Overheden, diensten en partners die actief deelnemen aan deze oefening.

- FOD Binnenlandse Zaken (het nationale Crisiscentrum en de Civiele Veiligheid), Volksgezondheid en Mobiliteit;
- De federale politie en Defensie;
- Het Federaal Agentschap voor Nucleaire Controle (FANC);
- Het Federaal Agentschap voor de veiligheid van de voedselketen (FAVV);
- Het Centre régional de crise wallon (CRC-W);
- De federale diensten van de gouverneurs van Henegouwen en Namen;
- De 112-noodcentrale Henegouwen;
- De politiezone "Brunau" (Fleurus, Pont-à-Celles, Les Bons Villers);
- De hulpverleningszone Henegouwen-Oost;
- Het Hôpital civil Marie Curie de Charleroi;
- De gemeenten Fleurus en Farciennes;
- Het Instituut voor Radio-elementen (IRE);
- De Haute Ecole Louvain in Henegouwen (HELHa).

Werkelijke alarmering van de overheden, maar niet van de bevolking

De oefening IREX 2018 vindt plaats in omstandigheden die zo dicht mogelijk bij de realiteit aanleunen. Het startuur van de oefening is dus niet gekend door de deelnemers en de alarmering zal gebeuren buiten de kantooruren.

In het kader van deze oefening kunnen de buurtbewoners getuige zijn van het inzetten van de hulpdiensten op het terrein of van het inschakelen van de interne sirenes van de site. Er wordt van hen echter geen enkele actie verwacht.

Bij een echt nucleair incident zal de betrokken bevolking gealarmeerd worden door de overheden, namelijk via het systeem BE-Alert. In het kader van deze oefening zal dit alarm gesimuleerd getest worden. Er zal in werkelijkheid dus geen enkel BE-Alert bericht gestuurd worden naar burgers.

Deze oefening is echter ook de gelegenheid om de bevolking te sensibiliseren voor de goede reflexen in geval van een nucleair incident. Eenieders veiligheid staat centraal in deze oefeningen. Iedereen wordt dus gevraagd om na te gaan of hij of zij precies weet wat te doen in geval van een nucleair incident: wat zijn de goede reflexen die moeten worden genomen voor de eigen veiligheid en die van de familie? Meer informatie op de website: www.nucleairrisico.be

Figure 14. Emergency notification made by the Crisis Centre.[5]

[5] https://centredecrise.be/nl/news/noodplanning/irex-2018-oefenen-om-het-crisisbeheer-te-versterken (accessed on 20th of Nov, 2018).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 662287.

EJP-CONCERT

European Joint Programme for the Integration of Radiation Protection Research

H2020 – 662287

Internal report

Uncertainties during and after a nuclear emergency exercise (04/07/2018): Results from a non-participant observation study in Greece

---

S. Economides, K. Irodiadou, E. Mestousi
D. Mitrakos, V. Tafili
EEAE

Reviewers: Tanja Perko, SCK•CEN

Work package / Task	**WP 5**	**5.2.3. Conceptualization and management of uncertainties in emergency exercises in EU countries**
Deliverable nature:	**Intermediate document**	
Dissemination level: (Confidentiality)		
Contractual delivery date:	**N/A**	
Actual delivery date:	**1st November 2018**	
Version:	**1.0**	
Total number of pages:	**28**	
Keywords:	**Observation, nuclear emergency exercise, social uncertainties**	

Introduction

This report presents the results of the observation of the emergency exercise conducted in Greece on the 4th of July 2018. The observation was conducted as part of the work described in the CONFIDENCE Project (Task 5.2.3.), with the aim to gain insight into the way uncertainties are addressed and handled during emergency exercises. The observation focus was on the information flow and communication between the exercise players, on the decision making process, on the assessment of the data available during the exercise and on public information actions.

Description of the observed exercise

The observation took place during an exercise with regard to a hypothetical major nuclear accident in a nuclear power plant abroad, resulting to a large radioactivity release with a potential transboundary impact on the Greek territory. The exercise focused on the assessment of the situation and the potential need to take measures in the early phase, before analytic measurements of the actual contamination of the country is available. The competent teams and staff of the Greek Atomic Energy Commission, i.e. the organization responsible for assessing the situation and proposing to the General Secretary of Civil Protection the appropriate protective and other response actions, were involved in the exercise. The scenario was progressively escalated up to the point of a hydrogen explosion resulting to the release of a large amount of radioactivity to the atmosphere, which, due to adverse meteorological conditions, is then transported towards Greece, where as a result of the rain increased contamination occurs in a broad area in the country.

Country	Date	Brief description of the exercise scenario
Greece	4th of July 2018	A severe nuclear accident abroad resulting to a large radioactivity release with a potential transboundary impact on the Greek territory. The main objective of the exercise was to evaluate the capacity for assessment of the radiological impact and the decision making process, with special attention on the information provided to the public during the various phases of the emergency, in particular before measurements are available.

Table 3. Brief description of the observed exercise

Brief description of the emergency preparedness and response plans in Greece

Nuclear or radiological emergencies response system in Greece is integrated in the general civil protection system. Since there are no nuclear facilities in the national territory, nuclear emergencies are relevant with severe nuclear accidents that may happen abroad.

Severe accidents at nuclear installations abroad are covered by Annex R of the National Plan for Civil Protection “Xenokratis”. According to the plan, the Greek Atomic Energy Commission (EEAE) is responsible for information collection, activation of the plan, assessment of the situation and proposal of measures to higher levels of the plan hierarchy, namely the General Secretary for Civil Protection. EEAE activates and coordinates any radioactivity measurement campaign around the country in which various laboratories countrywide also participate in case of an emergency and acts as the contact point for receiving and

communicating information to the IAEA and EC, through the established emergency response mechanisms (USIE, ECURIE). Greece has in place bilateral agreements for early notification in case of a nuclear accident with neighboring countries operating nuclear power plants.

Current national emergency plans

The General Civil Protection (Emergency) Plan (GCPP) under the code name "Xenokratis" (Ministerial Decision No. 2025, Approval of the General Plan for Civil Protection, Government Gazette Folio No. 12/B/19.01.1998) has been revised and re-approved in 2000, after the legislative restructuring of the responsibilities related to the management of national disasters of all kinds and the establishment of the General Secretariat for Civil Protection. After governmental approval, it was published in the Government Gazette in 2003 (Ministerial Decision No. 1299, Approval of the General Plan for Civil Protection, under the Code Name "Xenokratis", Government Gazette Folio No. 423/B/10.04.2003). In particular, Annex R of the GCPP concerns the response to an emergency situation from important and extensive radioactivity contamination due to nuclear accidents taking place outside the country.

EEAE is the authority responsible for activating the GCPP Annex and also assigned with the assessment of the radiological situation and the proposal of the appropriate protective and other response actions to the General Secretary of Civil Protection.

The assessment of the situation and the potential impact on Greece territory is based on atmospheric dispersion calculations (main system in use is JRODOS, US NOAA HYSPLIT is also used complementary) and radioactivity monitoring through the telemetric radioactivity monitoring network and measurements by the laboratories across the country participating in emergency response. Information, available from the accident country and through European and international channels, on the condition of the plant and the sequence and evolution of the accident is also used.

Information activities in case of an emergency

The provisions about the information of the public in case of radiological or nuclear emergencies are described in the Ministerial Decision No 2739, Regulation on informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological emergency, Government Gazette Folio No.165/B/15.03.1994, as well as in the Annex R of the General Plan for Civil Protection "Xenokratis".

Depending on the demand for information from the public, a range of tools to ensure broad dissemination and transparency is adopted. These include press releases and responses to media, press conferences etc. Real time environmental radioactivity monitoring data (telemetric network) are available through EEAE website during emergencies. A link to EURDEP is also provided.

Method

Settings

The exercise focused on simulating the response in relation to the assessment of the situation and the decision making process for protective and other response actions. The participants of the exercise were divided in two different rooms, the main conference room (Room A, Figure 1) and the small conference room (Room B, Figure 2). Room A was used for Staff Office (SO), which is the main decision-making entity chaired by EEAE Chairman, as well as by the public information team (PR). Room B was used by the experts supporting teams for radiological assessment (RA), e.g. models simulation, dose estimation. The observers were three in total: two of them in Room A and one in Room B.

Setting	Location	Number of observers	Date	Tool
Room A	EEAE	2	4 July 2018	Notes
Room B	EEAE	1	4 July 2018	Notes

Table 4. Observation settings during the exercise

Figure 1. Overview of the Room B during the exercise.

Figure 2. The staff office and the communication expert working in Room A.

Observation protocol

The observation was based on the protocol described in the document "Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers" (Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H., 2017). The observers used a specific form to keep notes of the exercise developments (see Annex).

Procedure

Non-participant observation methodology was used. The objective of the observers was to take notes during the exercise to capture the discussions and decisions taken by the people involved in the emergency exercise (e.g. decision makers, experts and other participants of the exercise).
The goal was to identify uncertainties, gain insight into the way uncertainties are addressed and handled during the emergency exercise, as well as the assumptions and decisions made. The observers did not take any active part in the interactions during the exercises.

All notes collected during observations were treated as confidential. Summaries of notes will be exchanged between task members, but not distributed outside the group.

Analysis and reporting

Thematic analysis of the notes from the observation was carried out; uncertainties were deducted and categorized as described below.

Background info

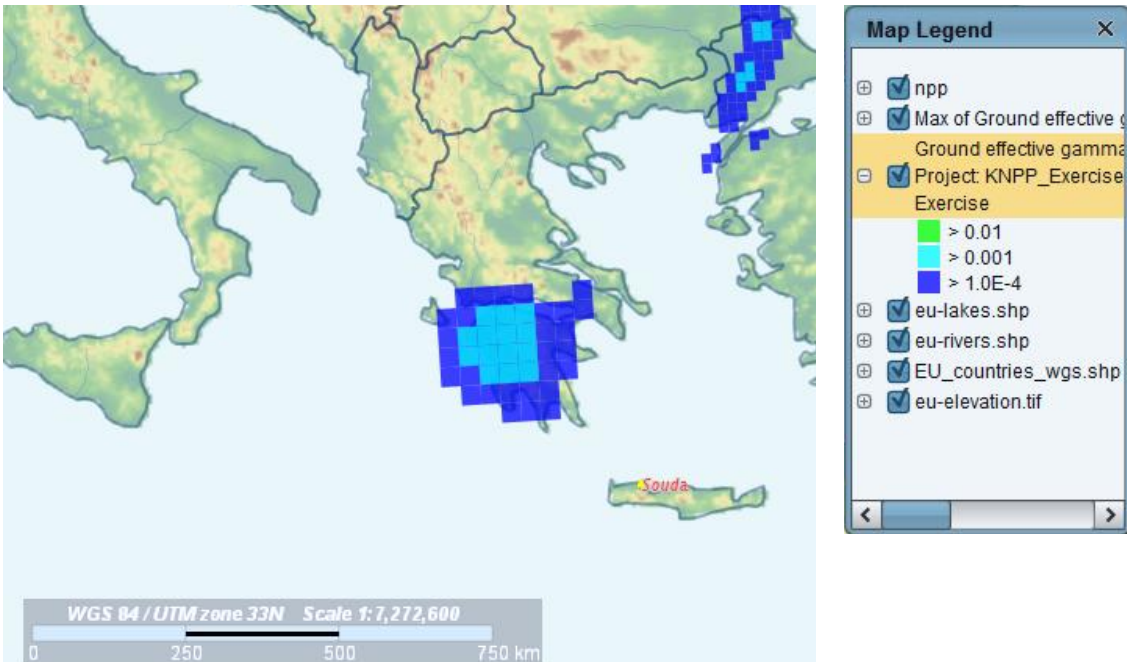
No areas in Greece are covered by the emergency planning zones of nuclear power plants abroad. Therefore, according to IAEA categorization, such an emergency belongs to category IV. The need for protective or other response actions in the first phase of the emergency is evaluated on the basis of the assessment of the radiological situation (atmospheric dispersion, dose estimation, radioactivity measurements e.g. air gamma dose, aerosol measurements). EEAE Chairman, taking into account the analysis and assessmement of the expert teams, is responsible for proposing to the General Secretary for Civil Protection the appropriate response actions.

The distance of the nearest nuclear power plant from Greece is of the order of 300km. Nevertheless, as it has been shown by the past nuclear accidents and as it has evaluated in our national hazard assessment, an impact of a large release from these plants, such that it should not be omitted from a radiological protection point of view, cannot be ruled out even though distances are relatively long. At present, this type of emergency planning is under revision taking into account the latest European legislation and international standards.

The source terms assumed are based on the generic source term used in IAEA (2013) for the estimation of emergency planning zones. Relying on past re-analysis meteorogical data, release date and time were chosen, so that the radiological impact on Greece would be significant.

Two different source terms were used during the evolvement of the exercise. At the first phase of the accident (before indications of potential containment damage were available), it was assumed that the containment will remain intact mitigating the release to the atmosphere. In this phase the source term used was taken to be equal to 10% of the generic source term. Indicative results produced in this first phase are shown in Figure 3. Later in the course of the exercise, as new information was becoming available, it was inferred that damage of the containment is a significant possibility and it was decided to continue the assessment with the assumption of containment failure. In this phase, the source term was taken equal to that of IAEA (2013). Examples of the JRODOS results produced in this case, regarding the estimation of the potential impact in Greece are given in Figure 4.

As it is shown in Figure 3, even if the lower source term is used, the atmospheric dispersion calculations predict spots in the country where the deposition cannot be ignored in terms of radiation protection.



These areas, in light blue in Figure 3 are defined using the Operational Intervention Level (OIL3) of IAEA (IAEA 2017) expressed in ground dose rate with a threshold value equal to 1μSv/h. As proposed by IAEA, in areas where ground dose rate is higher than OIL3 value, food restrictions are warranted until sampling measurements become available.

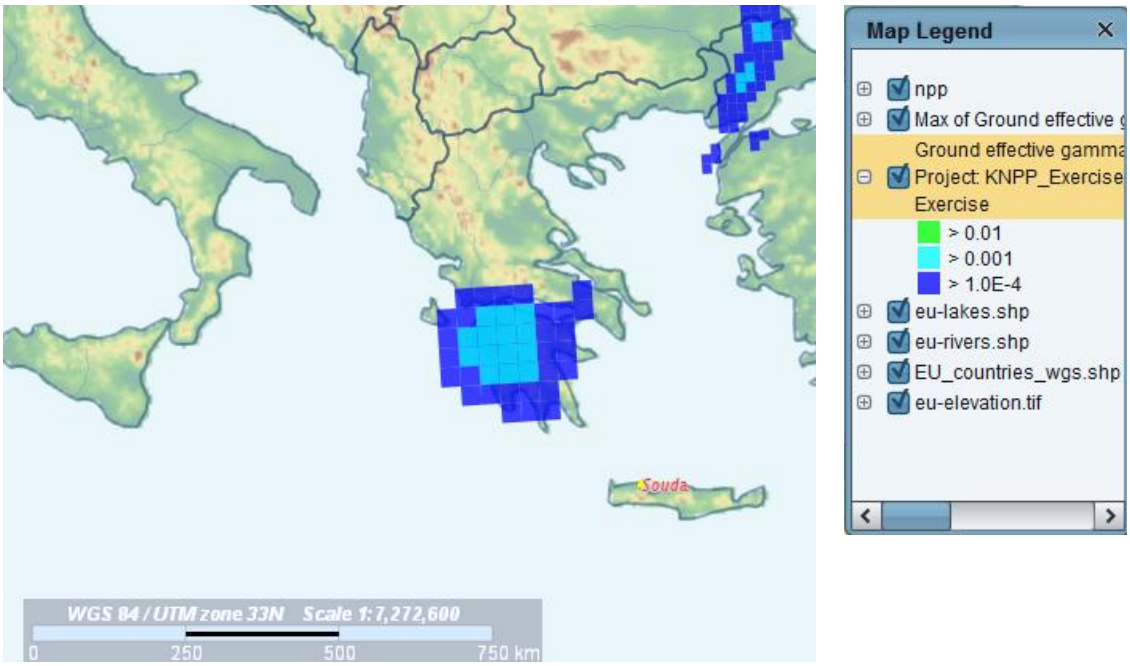


Figure 3. Ground dose rate (mSv/h), as calculated with JRODOS. Source term is equal to 10% of the radioactivity amount proposed in IAEA (2013). Release duration is 10 hours with constant rate. Re-analysis meteorological data are used obtained from US NOAA NOMADS.

As the scenario was evolving and new information was becoming available, it was made clear that a severe damage to the containment cannot be precluded, with a possibility to occur within the next hours to a day. Accordingly, it was decided to keep on assessing the situation by using the assumption of loss of confinement function, employing the source term used in IAEA (2013) (i.e. 10% of the core inventory of a generic 3000MWth plant is released within 10 hours). Calculated dose rate, in this case, is shown in Figure 4. As expected, due the higher amount of radioactivity released, the area exceeding OIL3 (colored areas) is significantly broader, covering a large part of the country. Suprisingly, this source term results also to plume exposure levels that are significant compared to internationaly proposed dose criteria. More specifically, the calculated thyroid dose (Figure 5) reaches, in parts of the country, levels (colored) that exceed the corresponsing dose criteria (50mSv). Sheltering is the only feasible protective measure that could be considered in this case. However, significant doubts arise with regard to where and when sheltering should be implemented. Altough, thyroid exposure is important primarily for children and pregnant women, yet, such a discrimination in implementing or suggesting measures might result to loss of public trust and unjustified reactions from people.

Due to the large distance from the plant, no urgent response (a minimum time window of the order of a day until the plume reaches the country is anticipated), compared to that of the accident country, is expected during such an emergency. As already mentioned, the main response aspects examined are relevant with the assessment of the radiological situation, the management of the large uncertainties regarding the potential impact in the country, as well as public information and trust aspects. It is recognized that despite the lower radiological impact and the larger time frame for response, the goal of retaining public trust and assuring an optimized response, taking into account non-radiological aspects

and public reaction, might turn to be a challenging issue. We note the lack of international guidance and the lack of an existing approach through Europe for addressing transboundary impact at longer distances, which could facilitate significantly a consistent assessment and decision making among the countries. In this frame, a series of challenging issues and uncertainties have been traced during the course of the exercise. Uncertainties exist both in the first phase of the assessment and decision making regarding the protective and other response actions and the appropriate public information issues, and in the later phase of arranging and implementing an appropriate radioactivity measurement campaign for the radiological characterization of the actual impact. A more detailed description and categorization of the uncertainties is given below in Table 5.

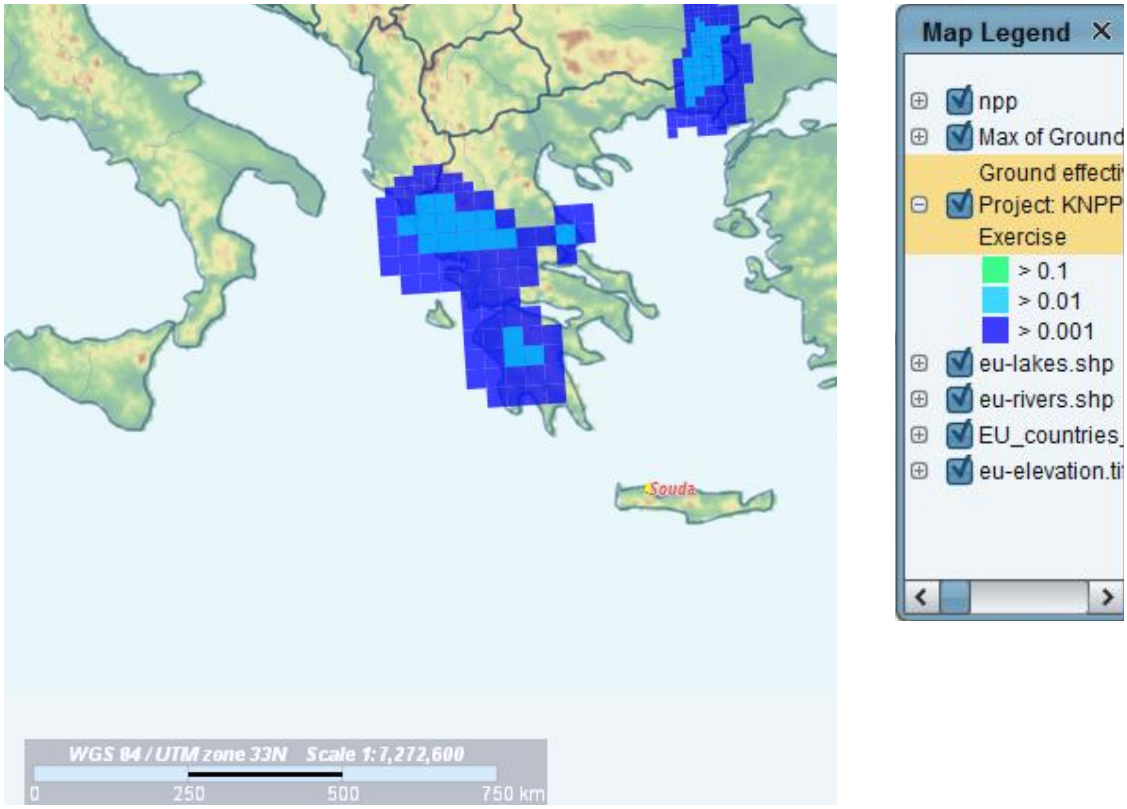


Figure 4. Ground dose rate (mSv/h), as calculated with JRODOS. Source term is taken equal to that proposed in IAEA (2013). Release duration is 10 hours with constant rate. Re-analysis meteorological data are used obtained from US NOAA NOMADS.

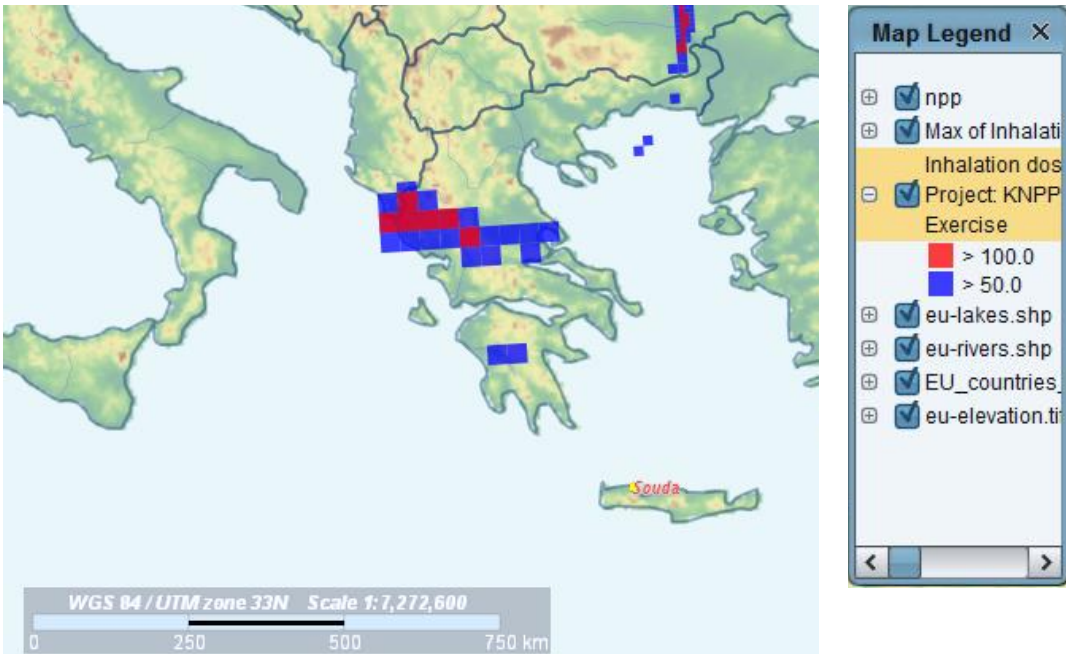


Figure 5. Thyroid dose (mSv), as calculated with JRODOS. Source term is taken equal to that proposed in IAEA (2013). Release duration is 10 hours with constant rate. Re-analysis meteorological data are used obtained from US NOAA NOMADS.

Results

In the following section we summarize the main actions and decisions that took place during the exercise and the uncertainties raised. As explained above, these are mainly related to the assessment of the situation, the implementation of protection actions and public information. Some of them emanate mainly from the very serious difficulties in predicting the timing of the release and the dispersion of the plume in large distances. Process-related uncertainties, as well organizational issues that have been identified, are also presented.

- ***Radiological assessment (Room B)***

Nuclear technology and radiological assessment team was gathered in room B. They were asked to assess the conditions of the plant and potential accident event sequence, based on available information. At the beginning, the team was not in the position to provide a concrete prediction of the accident evolution, due to the lack of knowledge of the severe accident management capabilities of the plant itself. A significant release, nevertheless, could not be ruled out at that point. Trajectories calculations were performed, in order to evaluate the potential for the plume to be directed toward Greece in the unfavorable case of a release within the next hours/day. The calculations showed that the prevailing weather was towards Greece.

As the accident was evolving, it became apparent that a core melt in the reactor was imminent. The team, however, could not make a justified judgement neither on the order of the release magnitude, nor on the timing of it. Since at that time there were no strong indications about an imminent containment failure, it

was decided to rely on a moderate source term in line with the assumption of retaining the confinement function of the reactor containment. Lacking more specific information, the team used a source term based on the generic source term provided by IAEA (IAEA 2013), adjusted to the reactor power. As it is shown from the results, a release would result to spots with increased radioactivity deposition in Greece. Even though some significant radiological impact cannot be excluded, the locations that would be affected could not be specified, due to the very large uncertainties inherent to the calculations and the overall assessment.

Later on it became clear that a containment damage is expected during the next hours/days. Atmospheric dispersion and dose calculations were repeated using a much more conservative source term as provided by IAEA (2013). The results showed increased thyroid dose which warrant sheltering to protect the public during plume passage. However, it was not clear how sheltering could be undertaken effectively across the country in relation with the timing of the plume arrival. Results also showed increased contamination, above IAEA OIL3, in a relatively broad area across the country. Recognizing the large uncertainties in the calculations, it was not possible to define the areas where the measures should be implemented.

- ***Response actions – decision making (Room A)***

From the moment that the radiological assessment results confirmed the concerns about the arrival of the plume in Greece, the decision making body dealt mainly with a. the protective actions and the public information implications and b. the radiological surveillance.

a. *Protective actions.* An open discussion took place, since the members of the SO were encouraged to propose and justify the available options. The discussion was mainly focused on sheltering and on food restrictions.
   The possibility that no measures are taken at all until radioactivity measurement results are available was also discussed.

   The implementation of sheltering was discussed in detail, since it proved to be the most appropriate measure of protection during the plume way over Greece. The decision makers expressed their doubts on whether the public is familiar with the sheltering conditions. Also, it was not easy to decide how areas in the country will be advised to follow the sheltering as a precautionary measure for the whole time period of the plume way and specific regions will gradually follow the sheltering advice.

   Similarly, a long discussion took place regarding the implementation of the food and feed restrictions. The main question was about the geographical areas required to implement these restrictions and how this will be communicated. The implications were broadly understood and discussed.

   In the end, the decision made was that in case the plume enters the country according to the dispersion models protective actions are taken.

b. *Radiological surveillance.* Different opinions about the proper approach were recorded; there was not confidence that the country has the adequate infrastructure and technical means to conduct a radiological surveillance campaign under time pressure. Innovative methods, such as the use of drones, were suggested. Sometimes the questions raised were more than the answers.

- ***Public information (Room A)***

It was clear since the beginning of the exercise that the public information needs might be really high. To this purpose, EEAE communication team drafted the main messages to be communicated to the public in the different stages of the simulated emergency. The uncertainties identified are related to the following aspects:

Target group of messages communicated: the initial announcements were addressed to the general population, covering the need of framing the situation and keeping them informed about the emergency itself and the possibility of radioactive contamination. As the emergency evolved, it became evident by the dispersion models results and the internal discussion that the country will potentially be affected by the radioactive plume. The communication team was involved in the discussion and wondered if the countermeasures would be announced by EEAE or other governmental body and in which manner. It was not possible to specify the affected areas, fact that created more complications in proposing specific messages.

Protective actions announcement: There were doubts on whether EEAE is ready to communicate about protective actions; the drafting of the appropriate messages required a lot of time and it proved a very complicated process. The difficulties were mainly related to aspects such as the use of the appropriate language.

Interference of difficulties on decision making about emergency response with the public communication: The uncertainties that the decision-making body had to deal with had a direct impact on the effectiveness of public communication activities.

It became clear by the discussion that the announcement of e.g. sheltering for one day is not adequate. There were concerns that we need to be ready to specify the measures in full detail; for example, what sheltering means? It was agreed that there is lack of information material ready to be released immediately by EEAE with the purpose of explaining in a profound and simple way the actions that the population is advised to take.

Thematic area	Uncertainty
Radiological impact assessment	• How credible the result are? • What will the actual event sequence of the accident (e.g. will the containment be damaged), timing and pattern of the release be? • Can we count on expecting to have timely and adequate information on the plant conditions and release? • We know that the assessment is conservative, but how much conservative?
Decision-making	• Can we decide on protective actions based only on dispersion models results or should we wait until measurements of radioactivity in the country are available? • How the public will react in each of the above options? • Should we propose protective or other response actions as soon as possible to assure our credibility and public safety feeling and trust, even before information regarding the actual release is available? What the non-radiological impact of these actions could be? Is indeed any action justified from the actual doses, considering that the calculations are based on significantly conservative assumptions? • In which areas these actions shall be implemented? Does such a distinguishment make sense, in such a distance from the reactor, before we have actual measurements? • When the actions will be implemented? • Water contamination: it is not clear what water sources should be restricted or monitored. • Would the message "we are not in a position currently to assess the degree of the impact in the country" be acceptable? • It is possible that people decide by their own to take actions, which are not justified.
Food and feed restrictions	• Food and feed restrictions will be imposed only in affected (as spotted by the models results) regions? What about the neighboring ones? Or due to the large uncertainties the whole country should be potentially warranted for such restrictions in the early phase, until actual measurements are available (see also the fourth point in decision-making above)?
Sheltering	• How we explain why we suggest sheltering in a specific region and not in a neighboring one? • Is the term "sheltering" clear to the public? What implies (e.g. closed windows, no ventilation)? • Should we made special reference to and suggestion for children and pregnant women or this will lead to confusion and loss of public trust or feeling of safety?
Radiological surveillance of the affected areas	• How it will be achieved in a timely and effective manner? • Are we able to estimate the time needed to have an adequate picture of the contamination?

	• What kind of methodology will be chosen in order to be able to cover large areas in relatively short times? • The country will ask for help from other European countries or through the RANET? • Are we ready to deal with such an emergency in terms of resources required?
Public information	• Are we ready to communicate about protective actions? • How we deal with questions doubting the effectiveness of the measures taken? Or comparing national measures with other countries' decisions? • Doubts on whether we are ready to communicate about protective actions • At which point other bodies (e.g. Ministry of Health, Ministry of Environment) will be involved in public information actions?

Table 5. Uncertainties identified during the exercise conducted in Greece on the 4th of July 2018.

- ***Other uncertainties***

During the exercise, other uncertainties also emerged, related mainly to the proper implementation of the emergency response plans and, specifically, with (a) the clarity of roles and responsibilities (b) the ability to respond effectively in a timely manner. Also, there were doubts and discussions about the resources available, at organizational and national level, to cope effectively with such an emergency situation.

The observation of the radiological assessment experts resulted also in a group of uncertainties related to technical aspects of dispersion models that if are not well-defined can affect the outcome and harm the credibility of the radiological assessment itself.

Another set of uncertainties is related to internal organizational and communication-related issues. Problems were identified in the information flow among different teams/experts involved, as well as to logistical arrangements (availability of rooms for team meetings, malfunctions of printers and computers used, difficulty in finding the templates or pre-existing information material, doubts about the procedure of the "dark site" activation) that may affect the effectiveness of the response. Confusion was also identified in the internal communication of the emergency situation, i.e. the IT department, the telephone center operators were not informed on time about the evolving emergency.

Summary of findings

The observation took place during an exercise that was based on a scenario with “inherent uncertainties” for a non-nuclear country, such as Greece. The decision making process proved quite challenging, because a nuclear emergency in a neighboring country could entail the implementation of protective actions, relying mainly on the dispersion models results and taking into account non-radiological factors, such as the psychological impact and the high perception of risk. In other words, the uncertainties identified are related to the assessment of potential transboundary radiological consequences to the Greek territory, but also on the interference of the social and political context in the decision making process.

Regarding the protective actions, different options were considered and discussed. The most prevailing uncertainty is the one related to the definition of the geographical zone of protective actions implementation; subsequently, this uncertainty affects also the content and the success of the public information actions e.g. press releases, tweets.

Uncertainties related to the organizational aspects of the response and shall be taken into account for the timely completion of specific tasks were also emerged.

References

EEAE (2018), Evaluation report of the emergency response exercise of the 4th of July 2018 (internal report), July 2018.

Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H. (2017). Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers. SCK-CEN.

IAEA (2013), Actions to protect the public in an emergency due to severe conditions at a light water reactor, EPR-NPP PUBLIC PROTECTIVE ACTIONS 2013, IAEA, Vienna.

IAEA (2017), Operational intervention levels for reactor emergencies and methodology for their derivation, EPR-NPP-OILs 2017, IAEA, Vienna.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 662287.

EJP-CONCERT

European Joint Programme for the Integration of Radiation Protection Research

H2020 – 662287

Internal report

Uncertainties during and after a nuclear emergency exercise (11/12/2018): Results from a non-participant observation study in Norway

---

Authors:

Yevgeniya Tomkiv (NMBU)

Reviewers: Tanja Perko, SCK•CEN

Work package / Task	**WP 5**	**5.2.3. Conceptualization and management of uncertainties in emergency exercises in EU countries**
Deliverable nature:	**Intermediate document**	
Dissemination level: (Confidentiality)		
Contractual delivery date:	**N/A**	
Actual delivery date:	**11.12.18**	
Version:	**1.0**	
Total number of pages:	**38**	
Keywords:	**Observation, nuclear emergency exercises, drill, social uncertainties**	

Introduction

This report presents the results of the observation of a table top exercise in nuclear emergency response conducted in Norway within the Confidence Project, Task 5.2.3. The objective was to gain insight into the way uncertainties are addressed and handled during emergency exercises, by looking at the information flow and communication between actors, as well as the assumptions and decisions made under emergency exercises.

We focus on the societal and ethical uncertainties raised by participant actors during the emergency exercise. We specifically explore manifested or latent uncertainties around issues such as public compliance with recommended actions, potential social consequences of the recommended actions, the level of stakeholder and public engagement planned and the efficiency of the recommended actions.

Description of the observed exercise

Background

The Russian floating nuclear power plant Akademik Lomonosov has for the past eight years produced electricity and heat for residents and industry in Pevek in north-east Russia. It will now return to the St. Petersburg shipyard to undertake scheduled maintenance, dispose of spent fuel and reload new fuel. Since the power plant does not have its own propulsion, it is towed by tugs in two stages - first from Pevek to Murmansk, and so on from Murmansk to St. Petersburg.
Each leg takes around three to four weeks depending on the weather. Norwegian authorities have been notified beforehand of the trail that will take place in May-June, and monitor this during transport through Norwegian Economic zone where it follows normal shipping.

At the end of May, the floating NPP is located along the coast south-west of Stavanger. Here, a serious incident occurs with large radioactive emissions. This leads to the mobilization of nuclear emergency organization and summoning of the Crisis Committee, as well as the Crisis Committee advisors to provide professional support to the secretariat (NRPA). A large discharge with this wind direction leads to a need for quick implementation measurements and impact mitigation measures in several areas.

Focus of the exercise

The exercise took form of a table-top exercise and started with the Crisis Committee being summoned at 0800 May 31 (fictitious date / time). Upon attendance, the Crisis Committee received a thorough review (30 min) of both the course of events and the implementation of the various measures which was decided on May 30.

- Securing areas
- Indoor
- Iodine tablets
- Cleaning of contaminated people
- Measures in food production

- Dietary advice

The participants received input on the status of the various measures that have been implemented, advice on adjusting measures and proposals for new consequence-reducing measures, which the Crisis Committee had to discuss and consider.

The Crisis committee was then presented with further development of the scenario and feedback from the regional sector, which formed the basis for issues and dilemmas that Crisis Committee had to decide on.

There were 4 main topics to be discussed during the exercise:

- Evacuation: is it a recommendation or an order, which institutions will be implementing it, what consequences will it have locally and nationally and how to evaluate this radiological countermeasure against the consequences implementation will have for public.
- Reputational issues: food production in local (and national) fish farms and agriculture, other sectors (tourism, oil and gas etc.), health issues in the region
- The ship wreck: clarification of the Crisis Committee's authority to handle the wreck, what kind of resources should be immobilised, need for monitoring in the area, how will the interaction work between the Crisis Committee and other authorities work in handling a Russian vessel, what other actors should be involved.
- Consequences of the measures implemented in the acute phase for the late phase and normalization: how will the interface between the Crisis Committee and other stakeholders work in the further handling of the accident (e.g. decontamination, waste and health issues, food safety).

Brief description of the nuclear emergency preparedness in Norway

The Norwegian Nuclear Preparedness Organisation consists of the Crisis Committee for Nuclear Preparedness, the Crisis Committee's Advisors, and the County Governors. The Crisis Committee for Nuclear Preparedness is represented by the following central authorities: the Norwegian Radiation Protection Authority (NRPA), The Directorate for Civil Protection and Emergency Planning, The Armed Forces, The Directorate of Health, the Coastal Administration, The Food Safety Authority, The National Police Directorate and the Ministry for Foreign Affairs. The NRPA is head of and secretariat for the Crisis Committee. The county governors are the Crisis Committee's representatives on the regional level (cf. royal decree of 23 August 2013). They have the responsibility to coordinate preparedness and recovery at the regional level in cooperation with the municipality administrations and local offices of various authorities. The County Governor has a regional R/N emergency preparedness committee that meets occasionally in peacetime and can be summoned on a short notice in case of an accident.

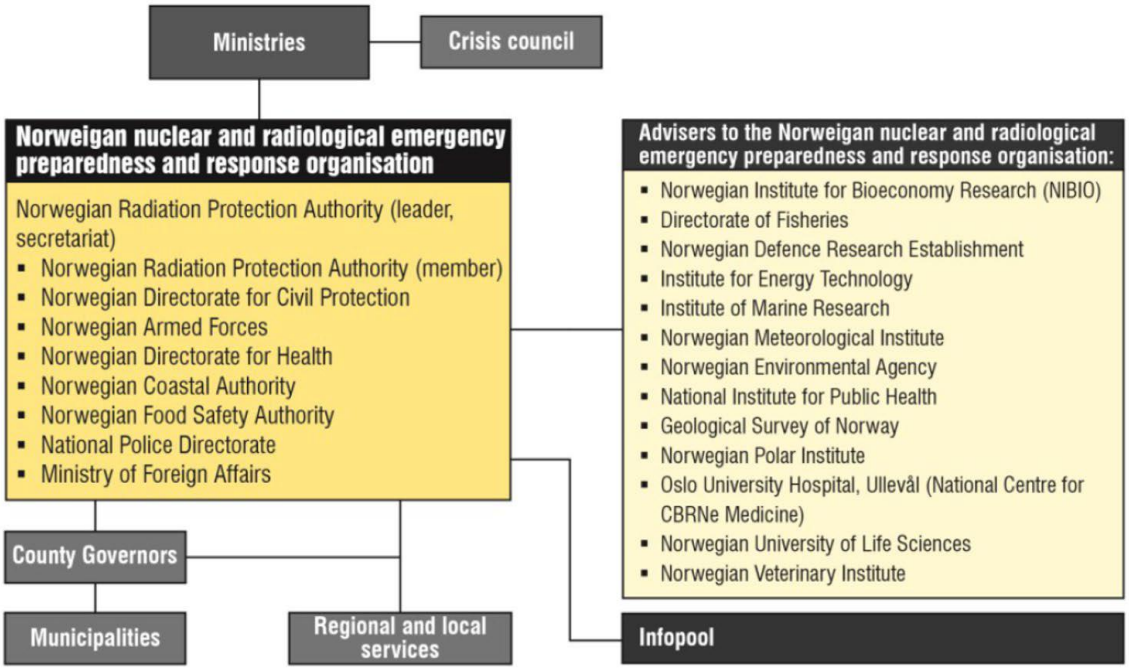


Table X The current Norwegian Nuclear and Radiological Preparedness Organization (Royal Decree 2013).

The Norwegian government has taken the six scenarios into account in order to prioritize the needs and plan the best possible nuclear preparedness in Norway. The scenarios are based on systematization of experience from past events and assessments of existing or future activities. The primary target group for the scenarios is all actors who have a role in nuclear preparedness.

- Large airborne release from a facility abroad (e.g. Chernobyl)
- Large airborne release from a facility in Norway (e.g. form one of the research reactors)
- Local incident in Norway - random location (like above but during transport or use of sources)
- Local incident that evolves over time (e.g. Litvinenko case)
- Release to the marine environment (e.g. from submarine)
- Incident abroad that does not directly affect Norwegian territory (e.g. Fukushima)

Method

Settings

The exercise took place in the operation room of the Crisis Committee for Nuclear Preparedness. Members of the Norwegian research team were not allowed to observe the exercise as they lacked security clearance required to participate in such exercise. Therefore, an alternative observer was provided by NRPA and trained in accordance with the research protocol prior to preforming the observation.

Observation protocol

Based on the document “Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers” (Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H., 2017) a protocol for the observation was developed. It covers mainly the relevant events

occurred during the emergency exercise, the time this events took place and the related uncertainty emerged (see **Error! Reference source not found.**).

Table 6. Protocol for the observation

Procedure

Non-participant observation methodology was used. The objective of the observers was to take notes during the exercise to capture the discussions and decisions taken by the people involved in the emergency exercise (decision and opinion makers, first respondents and other participants of the exercise).

The goal was to identify uncertainties, gain insight into the way uncertainties are addressed and handled during emergency exercises, as well as the assumptions and decisions made under emergency exercises. The observers did not take any active part in the interactions during the exercises.

All notes collected during observations were treated as confidential. Summaries of notes will be exchanged between task members, but not distributed outside the group.

References

Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H. (2017). Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers. SCK-CEN.

Royal Decree. 2013. *Nuclear Preparedness: Central and Regional Organisation*. Royal Decree of 23. August 2013. StrålevernHefte 30. Østerås: Norwegian Radiation Protection Authority. ttp://www.nrpa.no/publikasjon/straalevernhefte-30-nuclearpreparedness-central-and-regional-organisation-royal-decree-of-23-august-2013.pdf.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 662287.

EJP-CONCERT

European Joint Programme for the Integration of Radiation Protection Research

H2020 – 662287

Internal report

Uncertainties during and after nuclear emergency exercises (26/10/2017; 09/11/2017; 25/10/2018): Results from non-participant observation studies in Slovakia

---

Authors:

Tatiana Duranova, Jarmila Bohunova

(VUJE)

Reviewers: Tanja Perko, SCK•CEN

Work package / Task	**WP 5**	**5.2.3. Conceptualization and management of uncertainties in emergency exercises in EU countries**
Deliverable nature:	**Intermediate document**	
Dissemination level: (Confidentiality)		
Contractual delivery date:	**N/A**	
Actual delivery date:	**November 30, 2018**	
Version:	**1.0**	
Total number of pages:	**38**	
Keywords:	**Observation, nuclear emergency exercises, drill, social uncertainties**	

Introduction

This report presents the results of the observation of three emergency response exercises conducted in the Slovak Republic within the CONFIDENCE Project, Task 5.2.3. The objective was to gain insight into the way uncertainties are addressed and handled during emergency exercises, by looking at the information flow and communication between actors, as well as the assumptions and decisions made under emergency exercises.

We focus on the societal and ethical uncertainties raised by participant actors during the emergency exercise. We specifically explore manifested or latent uncertainties around issues such as public compliance with recommended actions, potential social consequences of the recommended actions, the level of stakeholder and public engagement planned and the efficiency of the recommended actions.

Description of the observed exercises

Members of the research team observed three emergency response exercises in the Slovak Republic (Table 1).

The first two exercises consisted on an on-site emergency in the Bohunice NPP and Mochovce nuclear power plants (NPP) when the whole response organisation (all players) has been involved. Civil society was not involved in these exercises. The third exercise consisted on full size on-site (Bohunice NPP) - off-site coaction. From the on-site side of Bohunice NPP the whole emergency response organisation, including employees has been involved. From the off-site side following organisations have been involved: Nuclear Regulatory Authority of Slovak Republic (NRA SR), at regional level, Trnava region - the whole Regional Crisis Staff, first responders and schoolchildren.

Table 1. Brief description of the observed exercises

Emergency exercise	Date	Brief description of the exercise scenario
1. Bohunice NPP	October 26, 2017	Exercise was based on the simulated incident under the conditions NPP Bohunice V-2 at the simulator of VUJE training centre Trnava. Simulated incident was related to the release of radioactive materials out of the NPP site so, that protective measures for the NPP Bohunice employees and population near the Bohunice NPP were required.
2. Mochovce NPP	November 9, 2017	Exercise was based on the simulated incident under the conditions NPP Mochovce (EMO12) at the representative full scale simulator and its progression to the severe accident at units 1 and 2. Exercise included part of NPP under construction - MO34. Simulated incident was related to the release of radioactive materials out of the NPP site so, that protective measures for the NPP Mochovce employees and population near the Mochovce NPP were required.

3.	**Bohunice NPP - Trnava region coaction**	October 25, 2018	Exercise was based on the simulated incident under the conditions NPP Bohunice V-2 at the representative full scale simulator and its progression to the severe accident. Simulated incident was related to the release of radioactive materials out of the NPP site so, that protective measures for the NPP Bohunice employees and population near the Bohunice NPP were required. Exercise players: NPP - the whole emergency response organisation, including employees; Nuclear Regulatory Authority; Regional level: the whole Regional Crisis Staff in Trnava; First responders; Schoolchildren.

Brief description of the nuclear emergency response organisation in Slovakia

The crisis management structure of the Slovak Republic could be presented by the following scheme with more details.

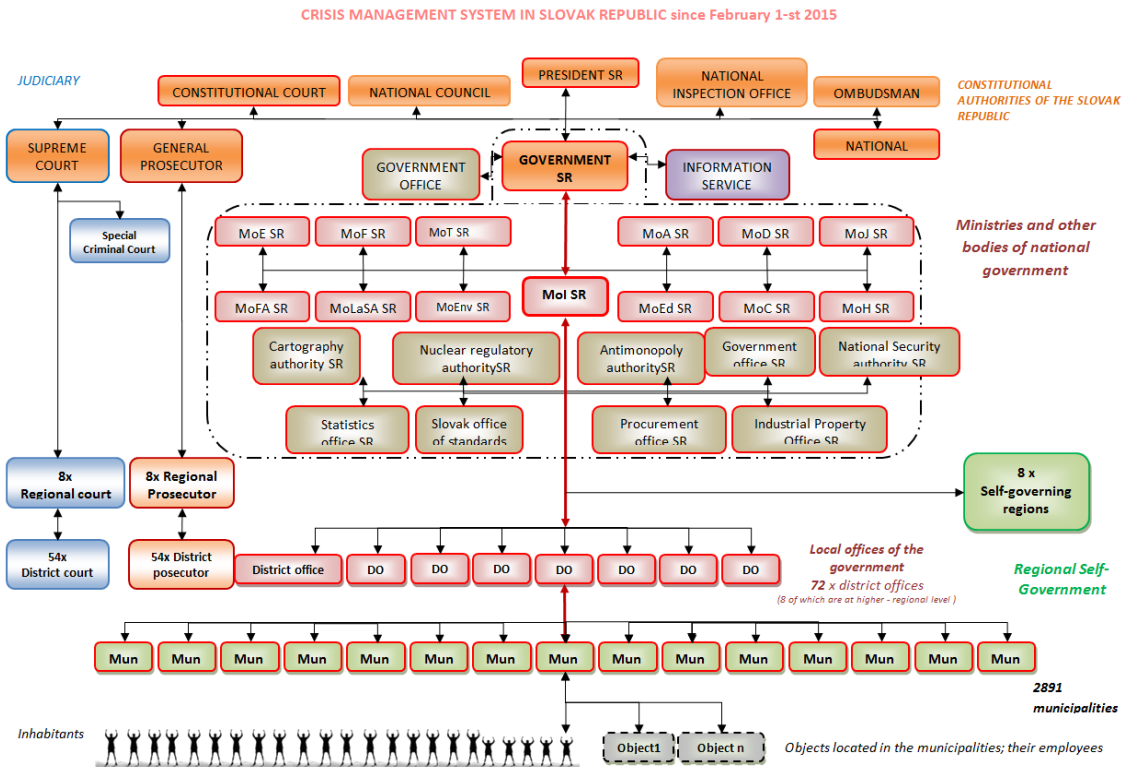


Figure 6. Crisis management system in Slovak Republic since February 1st, 2015

More basic structure of cooperating organisations with indicating of management connections is given below in relation to the crisis situation.

Decision-making authorities at different levels are:

- National level: Government of the Slovak Republic with its executive body - Central Crisis Staff
- Regional level: Chairperson of District office in the seat of region - Chairperson and Crisis Staff
- Municipality level: mayor
- NPP level: Shift Supervisor/Emergency Response Organisation Director.

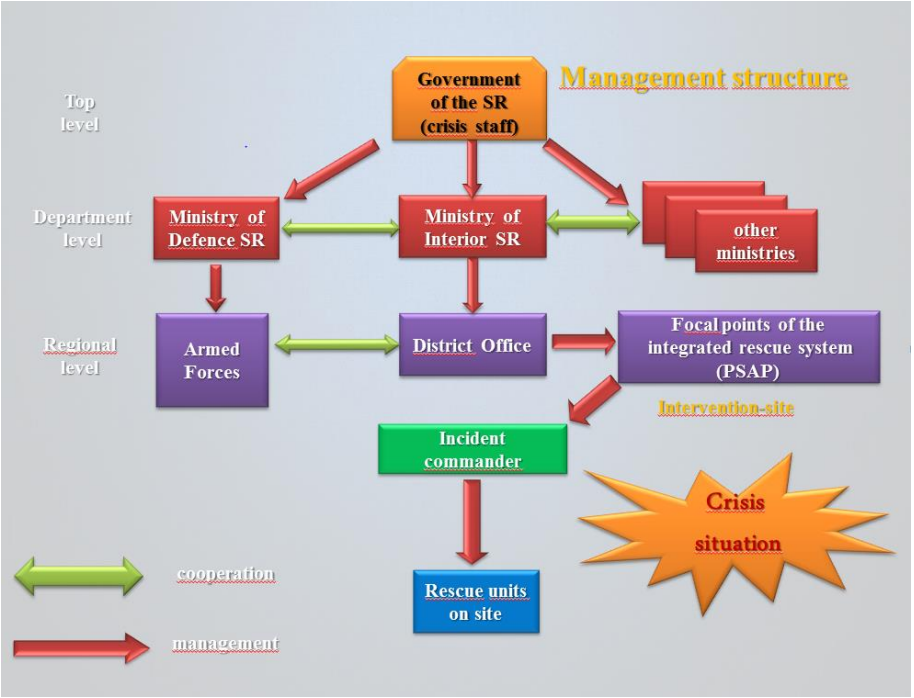


Figure 7. Management structure in case of an accident

Method

Settings

In the first exercise the observation took place in two settings: i) emergency response centre of Bohunice NPP and ii) assembly point - sheltering and follow-up evacuation of Bohunice NPP employees. One observer participated in each setting.

In the second exercise the observation took place in five settings: i) medical centre - decontamination of injured person , ii) multiple crash during evacuation from NPP, iii) assembly point - sheltering and follow-up evacuation, iv) emergency response centre - meeting of group leaders, v) debriefing of the exercise. One observer participated in each setting under the exercise timing coming through them one after another.

In the third exercise the observation took place in two settings: i) Regional Civil Protection and Crisis Management Office and ii) check point: schoolchildren evacuation - arrival and decontamination. One observer participated in each setting under the exercise timing coming through them one after another.

Observation protocol

Based on the document "Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers" (Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H., 2017) a protocol for the observation was developed. It covers mainly the relevant events occurred during the emergency exercise, the time this events took place and the related uncertainty emerged (see **Error! Reference source not found.**).

At the end of the emergency exercise, if possible, open informal interviews were carried out with emergency actors to clarify some aspects of the notes.

Observation place: Name of the observer: Date:		
Time	Action / observation (identify event, actor, actions, decision, statement)	Notes / issues (uncertainty and how is it addressed / approach)

Figure 8. Protocol for the observation

Procedure

Non-participant observation methodology was used. The objective of the observers was to take notes during the exercise to capture the discussions and decisions taken by the people involved in the emergency exercise (decision and opinion makers, first respondents and other participants of the exercise).

The goal was to identify uncertainties, gain insight into the way uncertainties are addressed and handled during emergency exercises, as well as the assumptions and decisions made under emergency exercises. The observers did not take any active part in the interactions during the exercises.

Additional brief informal interviews were conducted immediately after the exercise in order to discuss decisions taken and understand behaviour of the exercise participant.

The observers presented themselves and provided short information on the project and their task and objectives during the exercise at the exercise debriefing.

All notes collected during observations were treated as confidential. They have been provided in a scanned notes form to the exercise managers on request. Summaries of notes will be exchanged between task members, but not distributed outside the group.

The pictures documenting observation at Regional Civil Protection and Crisis Management Office in Trnava (Bohunice NPP region) and at check point (Galanta, "Vincov les", schoolchildren evacuation, decontamination) have been taken in agreement with the GDPR requirements confirmed by signature of attendance list by participants.

Pictures are documenting Regional Crisis Staff (Trnava) work during the table-top exercise and particular steps within different protective actions at check point "Vincov les".

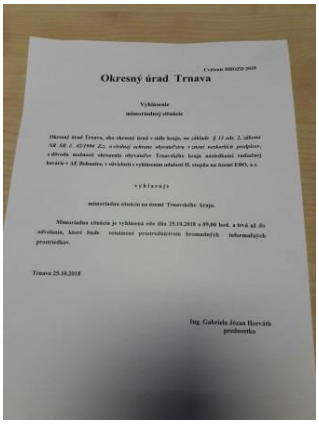

Okresný úrad Trnava

Figure 9. Regional Crisis Staff - table top exercise

Figure 10. Helpers preparation and briefing - secondary school students

Figure 11. Monitoring and decontamination of bus, recording and dron observation

Figure 12. Decontamination of fireman

Figure 13. Monitoring and preparation for decontamination

Figure 14. Decontamination of persons

Figure 15. Medical care

Analysis and reporting

Thematic analysis of the notes from the observation and the informal interviews was carried out. Uncertainties were deducted, categorized and described.

A report of each exercise was made available to those responsible for the emergency exercise and they provided feedback and comments.

References

Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H. (2017). Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers. SCK-CEN.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 662287.

EJP-CONCERT

European Joint Programme for the Integration of Radiation Protection Research

H2020 – 662287

Internal report

Uncertainties during and after a nuclear emergency exercise (06/06/2018): Results from a non-participant observation study in Slovenia

---

Authors:

Nadja Zeleznik (EIMV), Benjamin Zorko (JSI)

Reviewer: Tanja Perko, SCK•CEN

Work package / Task	**WP 5**	**5.2.3. Conceptualization and management of uncertainties in emergency exercises in EU countries**
Deliverable nature:	**Intermediate document**	
Dissemination level: (Confidentiality)		
Contractual delivery date:	**N/A**	
Actual delivery date:	**October 2018**	
Version:	**1.0**	
Total number of pages:	**28**	
Keywords:	**Observation, nuclear emergency exercises, drill, social uncertainties**	

Introduction

This report presents the results of the observation of an emergency response exercise conducted in Slovenia within the Confidence Project, Task 5.2.iii. The main objectives are to collect observations on potential uncertainties connected to the emergency exercise management, to the gain insight into the way uncertainties are addressed and handled during emergency exercises, to look at the information flow and communications between actors, as well as the assumptions and decisions made during emergency exercise which represent a kind of real-world conditions.

The focus of the observational study was to identify mainly the societal and ethical uncertainties raised by participant actors during the emergency exercise. We specifically explore manifested or latent uncertainties around issues such as public compliance with recommended actions, potential social consequences of the recommended actions, the level of stakeholder and public engagement planned and the efficiency of the recommended actions. However, the exercise was limited with predefined scenario of the exercise and to the extend of actors involved in it. In case there would be different scenario and also more actors, the uncertainties could be also different.

Abbreviations used

ACPDR Administration of the Republic of Slovenia for Civil Protection (CP) and Disaster Relief
CBRN Chemical, Nuclear, Biological and Radiological
CC Command Centre
CSFRW Central Storage Facility for Radioactive Waste
EADRCC Euro-Atlantic Disaster Response Coordination Centre
EARS Environmental Agency of the Republic of Slovenia
ERDS Emergency Response Data System
ECURIE European Community Urgent Radiological Information Exchange
ELMU Ecological Laboratory with a Mobile Unit
ENAC Early Notification and Assistance Convention website
ENN Early Notification Network – automatic measurement system
EU European Union
EU – MIC European Union – Monitoring and Information Centre
ESC External Support Centre
GOC Communication Office of the Government of the Republic of Slovenia
IAEA International Atomic Energy Agency
IRSPANOD Inspectorate of the Republic of Slovenia for Protection Against Natural and Other Disasters
JSI Jozef Stefan Institute
KI Potassium Iodide
Krško NPP Krško Nuclear Power Plant
LPZ Long-Term Protective Action Planning Zone in the event of an accident at the Krško NPP
MCRS Motorway Company of the Republic of Slovenia
MESP PR Ministry for Environment and Spatial Planning Public Relation
MMHU Mobile Meteorology and Hydrology Unit
NCMC National Crisis Management Centre
NCRS Notification Centre of the Republic of Slovenia

NCRC Notification Centre of the Republic of Croatia
NSS Nuclear Society of Slovenia
OCC GPD Operations and Communications Centre of the General Police Directorate
OSC Operational Support Centre
PAZ Precautionary Action Zone in the event of an accident at the Krško NPP
PRR Protection, Rescue and Relief
PR Protection and Rescue
RNC Regional Notification Centre
RS CP Republic of Slovenia Civil Protection
RWMA Radioactive Waste Management Agency (ARAO)
SAF CBRN Chemical, Biological, Radiological and Nuclear Defence Battalion of the Slovenian Armed Forces
SNSA Slovenian Nuclear Safety Administration
SRPA Slovenian Radiation Protection Administration
SRC Slovenian Red Cross
TSC Technical Support Centre
UPZ Urgent Protective Action Planning Zone in the event of an accident at the Krško NPP
UN – OCHA United Nations Office for Coordination of Humanitarian Affairs

Description of the observed exercise

Members of the research team observed one emergency response exercise in Slovenia related to Krško NPP. The exercise was announced to the institutions involved, but the scenario was not known in advance for the participants. The participants in the exercise were Krško NPP, NCRS, RNC Brežice, EARS and SNSA. During the exercise became clear what was the scenario, which foreseen the fire in the main control room of NPP and the evacuation of control into the emergency control room. The information circulated to the involved participants from SNSA is given in Annex 1.

The following information about exercise were distributed in advance to involved – Table 1:

Players	Krško NPP, NCRS, RNC Brežice, EARS, SNSA
What is simulated	MESP PR, media, public and others according to the needs
Scenario	Not known in advance
Exercise implementation	Start at cca 13:30 pm Real meteorological data are considered Exercise follow the real time Connections and ERDS is in function
KID SMS	Yes, for participating institutions
ECURIE	Yes (fax for simulation)
USIE	Training of failure of USIE webpage (fax for simulation)

Table 1: Brief information of the observed exercise

Brief description of the nuclear and radiological emergency plan in Slovenia

Nuclear and radiological accidents are incidents that pose a direct threat to people and the environment, and require the implementation of protective measures. All incidents do not necessarily turn into accidents. An incident may also mean a reduction in nuclear or radiation safety, which requires an appropriate response from the authorities.

To mitigate the consequences of of the nuclear or radiological accident, and to manage all the activities related to such an event, a dedicated national plan shall be implemented and enforced. In Slovenia, The National Emergency Response Plan for Nuclear and Radiological Accidents [1] which was prepared by the Administration of the Republic of Slovenia for Civil Protection and Disaster Relief (ACPDR) of the Ministry of Defence (MoD) has been established for such purposes.

The plan covers accidents at the Krško Nuclear Power Plant (NPP), accidents in other nuclear and radiation facilities in the Republic of Slovenia (RS), nuclear and radiological accidents abroad with a potential impact on Slovenia, and other radiological accidents involving ionising radiation sources.

All emergency response plans for nuclear and radiological accidents and activities at all levels of planning must comply with the National Emergency Response Plan for Nuclear and Radiological Accidents. Plans are prepared by:

- the ACPDR regional offices (regional plans)
- the municipalities (municipal plans)
- the Krško NPP (work plan)
- the RWMA (for the CSFRW at Brinje) (work plan)
- the ministries (action plans)

Basic Assumptions of the Plan

A. The National Emergency Response Plan for Nuclear and Radiological Accidents is designed for the event of an accident which would result in a major release of radioactive substances into the environment or the irradiation of people, specifically for the event of:

- a nuclear accident
- a radiological accident
- an accident abroad

B. The Notification Centre of the Republic of Slovenia (NCRS) and RNCs are the main points of contact for the reception of initial incident reports in Slovenia.

C. The National Emergency Response Plan for Nuclear and Radiological Accidents is based on predetermined intervention and other levels that found in Decree on Dose Limits, Radioactive Contamination and Intervention Levels, Official Gazette of the RS, No. 18/18 [2]:

- Intervention levels are expressed in terms of avertable doses at which protective measures for the population at risk are introduced.
- Action levels are levels of food contamination at which food control is introduced.
- Operational intervention levels are directly measurable levels at which protective measures for the population are introduced; they are derived from intervention and action levels.

D. The National Emergency Response Plan for Nuclear and Radiological Accidents is very detailed for the event of a nuclear accident at the Krško NPP and based on the level of risk of an incident occurring at the Krško NPP. The level of risk is declared by the power plant and, if necessary, coordinated with the SNSA beforehand.

- Level 0 – an unusual event is declared when an incorrect action or a situation out of control of the personnel could affect the safety of the power plant and lead to a higher level of risk.
- Level 1 – an alert is declared in the event of a situation which results or could have resulted in the reduction of safety at the nuclear power plant. A minor release of radioactive substances is possible, but no serious risk to the environment is anticipated.
- Level 2 – a site emergency is declared in the event of a situation which results or could have resulted in a major failure of the power plant's safety functions and consequently a risk to the nuclear power plant personnel and the nearby population. A release of radioactive substances may occur or has already occurred to such an extent that the implementation of protective measures at the nuclear power plant is required, including the evacuation of the plant and the area under its direct control.
- Level 3 – a general emergency is declared when there is a risk of damage to the core, or a risk of the melting of the core, with the possibility of damage to the containment building, or when this has already occurred. A release of radioactive substances into the environment is possible or has already occurred to such an extent that the implementation of protective measures is required in the area outside the nuclear power plant.

E. The National Emergency Response Plan for Nuclear and Radiological Accidents in the event of a nuclear accident at the Krško NPP is based on pre-determined protective measure planning zones:

- The Precautionary Action Zone (PAZ) is the area within a 3 km radius of the Krško NPP. In this area, preventive evacuation of the population (if possible) begins immediately upon the declaration of a general emergency.
- The Urgent Protective Action Planning Zone (UPZ) is the area within a 10 km radius of the Krško NPP. Protective measures in this area are implemented on the basis of the development of an accident and on the basis of measurements.
- The Long-Term Protective Action Planning Zone (LPZ) is the area within a 25 km radius of the Krško NPP. Protective measures are implemented on the basis of measurements.
- The Area of General Preparedness is the entire territory of Slovenia. Protective measures are implemented on the basis of measurements.

Entire settlements are included in the PAZ, UPZ and LPZ zones, even if they extend beyond the imaginary circle with the Krško NPP as its centre.

F. The population in the area at risk receives timely and objective information on the extent of an accident, its consequences, the mitigation and elimination of consequences, and on disaster management

G. Slovenia informs the rest of the world of incidents and may, where appropriate, also request assistance (of the International Atomic Energy Agency (IAEA), of the EU through the ECURIE, of other international organisations within the EU Civil Protection mechanism, and of those countries with which it has signed bilateral or multilateral agreements).

Response Concept and National Plan Activation

The response concept in the event of a nuclear accident at the Krško NPP is based on the risk level classification. The response concept for other incidents included in this plan is based on the consultation with the SNSA. Figure 1 shows the response in accordance with the National Emergency Response Plan for Nuclear and Radiological Accidents.

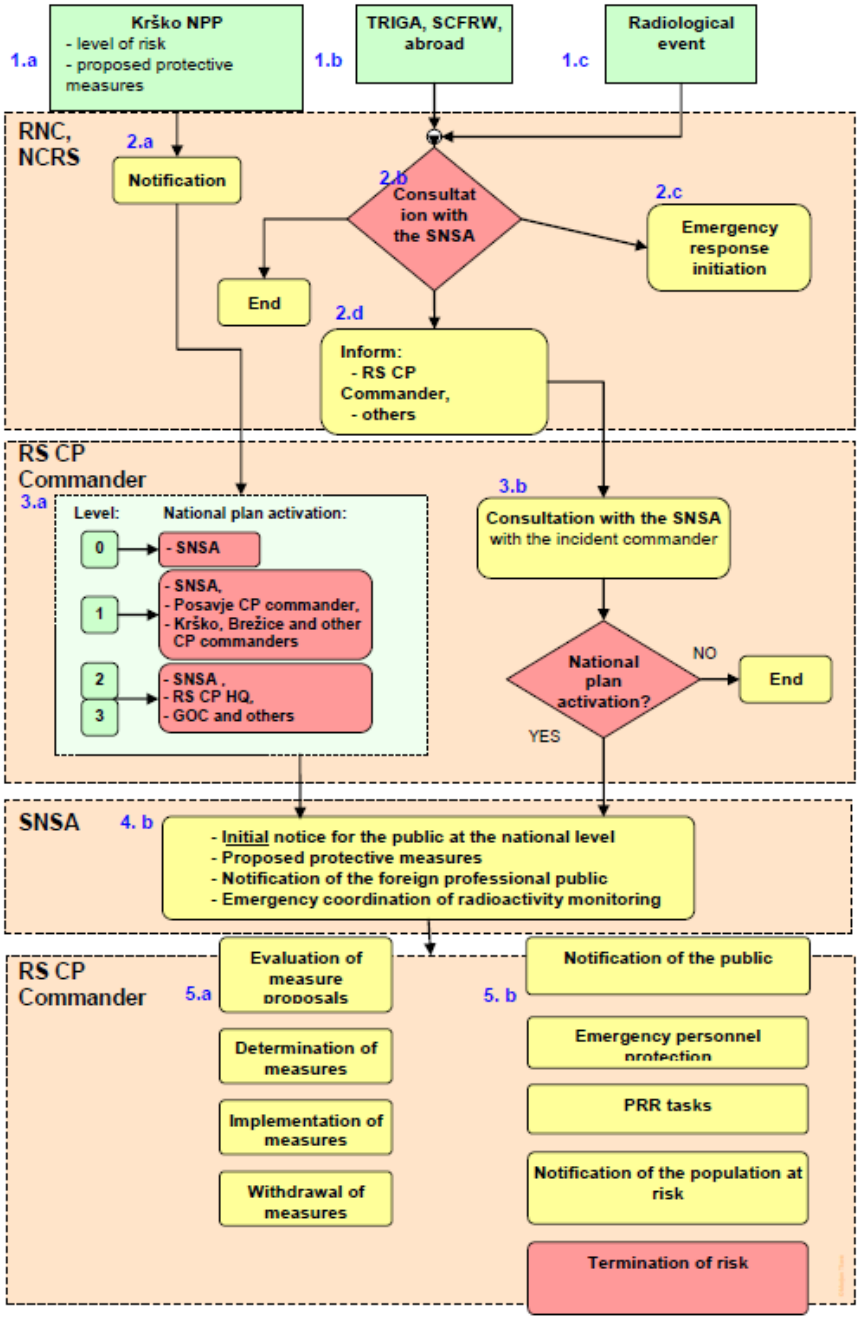


Figure 1: Response Concept for Nuclear and Radiological Accidents

Monitoring, notification and warning

Competent authorities and organisations monitor the operation of the Krško NPP and other nuclear and radiation facilities in Slovenia. Furthermore, they supervise the handling of radioactive sources and other radiation sources, as well as monitor environmental radioactivity.

Notification of Nuclear and Radiological Accidents

Initial notification of a nuclear or a radiological accident is provided by nuclear or radiation facilities (the Krško NPP, TRIGA research reactor and CSFRW), or radioactive source holders, the police, citizens, the RNC or the NCRS, or the SNSA. Information on a nuclear or a radiological accident abroad comes directly to the NCRS or the SNSA.

Notification of incidents at the Krško NPP are shown in Figures 2-4. In the event of other incidents, the NCRS notifies the SNSA and consults with the SNSA duty inspector on further activities (notification, emergency response).

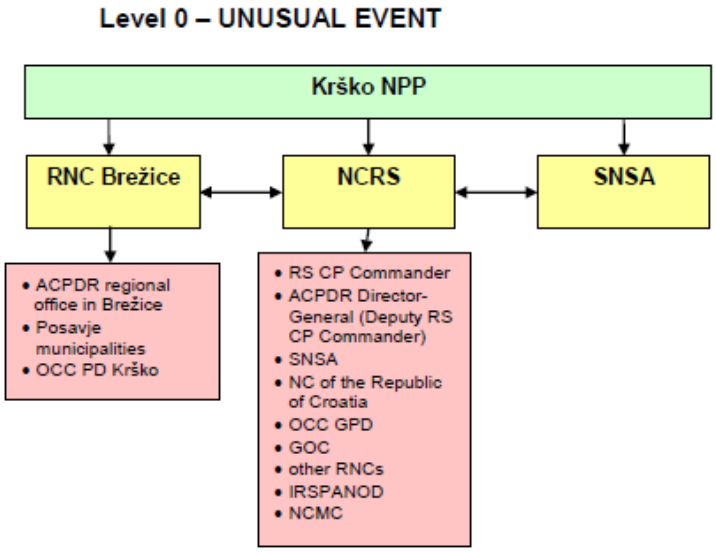


Figure 2: Notification of Competent Authorities at Zero Level of Risk at the Krško NPP

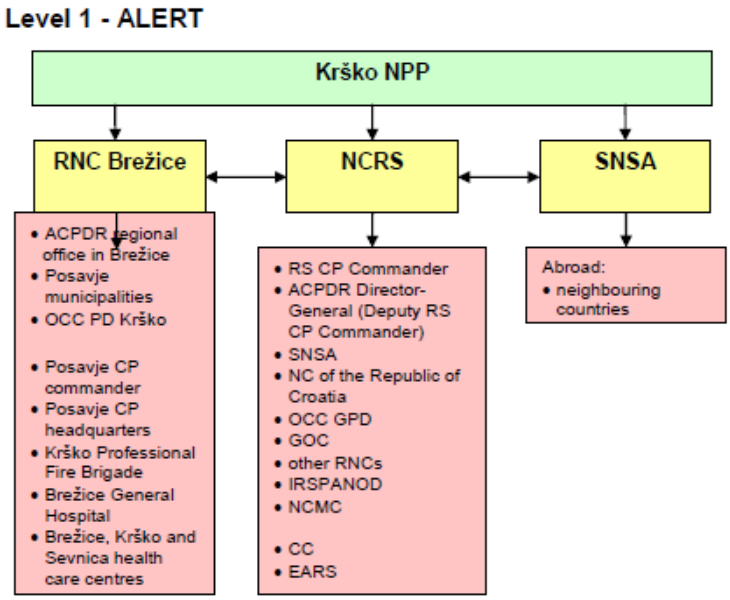


Figure 3: Notification of Competent Authorities at First Level of Risk at the Krško NPP

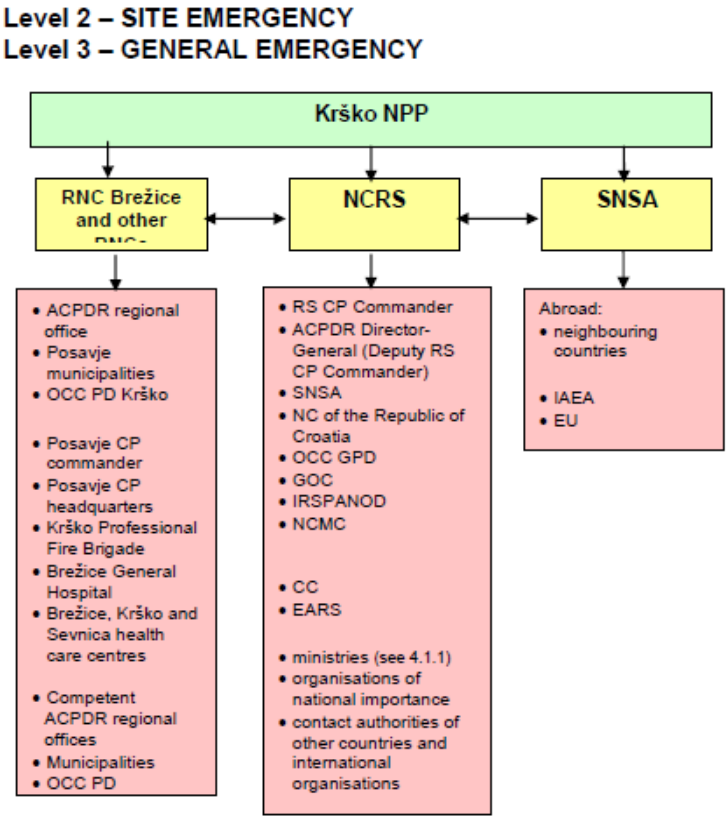


Figure 4: Notification of Competent Authorities at Second and Third Levels of Risk at the Krško NPP

Notification of the General Public of Nuclear and Radiological Accidents

The public must be informed of a nuclear or a radiological accident in a timely and objective manner. National-level draft press releases are prepared by the SNSA and, if possible, coordinated with the entity responsible for the incident. The first national-level press release is formulated and submitted for publication by the SNSA. Further press releases are formulated and submitted for publication by the SNSA in cooperation with the Public Relations Office of the MESP, until the activation of the RS CP Headquarters (HQ). Following the activation of the RS CP HQ, press releases, based on drafts of the SNSA, are formulated, updated and submitted for publication by the RS CP HQ. This task is performed by the ACPDR Public Relations Officer or a Public Relations Officer of the Ministry of Defence, as appropriate. If necessary, the GOC, within its competence, is also included in public information activities. The public may also be informed of an incident directly by the entity responsible for its occurrence. Foreign general public is informed by the GOC. The authors of press releases must submit them for information to the NCRS, competent RNCs, the SNSA, the GOC, competent regional and municipal CP headquarters, the RS CP Headquarters, the information centres and the entity responsible for the incident, if known. Press releases are submitted every three hours or every 30 minutes following any major change. Public information in the event of accidents is released through the media which, in accordance with the Public Media Act (Official Gazette of the RS, No. 110/06) and to the request of national authorities, public companies and institutions, are liable to immediately and free of charge release emergency information related to serious risk to lives, health and property of people as well as the cultural and natural heritage and safety of the state. In such cases, responsibility for immediate release of public information from national authorities falls to the following:

- Television Slovenia – all programmes
- Radio Slovenia – all programmes
- Slovenian Press Agency (SPA)
- other electronic media

The NCRS publishes daily and special information bulletins prepared on the basis of national-level press releases and containing more detailed information.

Notification and Warning of the Population in the Area at Risk

Notification of the population in the area at risk must be consistent with the notification of the general public. Information on a nuclear or a radiological accident will be delivered to the citizens by the national and local media, and by other local means. The population in the area at risk will be informed of the enforcement of protective measures by an alarm signal announcing imminent threat (warning). Instructions for the implementation of measures will follow the warning and will be delivered by the national and local media, or by other appropriate means (e.g. an edict). In the event of a nuclear accident at the Krško NPP, upon the activation of regional emergency response plans for nuclear and radiological accidents and upon the activation of the national emergency response plan in whole, the regions accepting the evacuated inhabitants of the Posavje region organise regional-level information centres. At the national level, the information centre is organised by the ACPDR. In the event of other nuclear and radiological accidents, information centres are organised as appropriate. Information centres deliver information to the citizens on:

- the consequences of an accident
- the effect of an incident on the population and the environment

- the expected assistance
- the mitigation measures
- the implementation of personal and mutual protection
- the cooperation in the implementation of protective measures

Activation of forces and resources

Activation of competent authorities and services in the event of a nuclear accident at the Krško NPP is determined in advance. In the event of other nuclear and radiological accidents, however, activation depends on the consultation between the RS CP Commander and the SNSA. Units, services and other operational structures of PRR forces within the competence of the state are activated by the NCRS, based on the decision by:

- the RS Government
- the RS CP Commander or his deputy
- the ACPDR Director-General or his deputy
- the national rapid response unit commander or his deputy

On the proposal of the head of emergency response or the SNSA, the NCRS obtains consent of the authorities responsible for the activation, and in-turn activates a specialised mobile unit and other organisations competent for giving advice on the implementation of emergency response.

A proposal for the activation and use of SAF capabilities may be put forward by the RS CP Commander, on the proposal of the head of emergency response. Following the RS Government decision (in the case of emergency, the decision is taken by the Minister of Defence), the NCRS submits the request or the decision to the command centre (CC). Based on the order issued by the Chief of General Staff of the Slovenian Armed Forces (GS SAF), the SAF Force Commander activates the appropriate SAF command, unit or service.

CP members and other national PRR forces are summoned by the ACPDR or the competent ACPDR regional office. The ACPDR and its regional offices also govern all matters relating to salary compensations and reimbursement of costs incurred by CP members and other protection, rescue and relief forces (professional and voluntary) in the implementation of protection, rescue and relief. In the event of a nuclear accident at the Krško NPP, national PRR forces (national and regional units), leaving for the affected area, gather at their assembly points and head for the logistics centres of the ACPDR regional offices in Novo mesto, Celje, Trbovlje, Ljubljana and Maribor. There, based on the requirements of the affected municipalities, they are assigned a site and issued a work order.

In the event of other incidents, national protection, rescue and relief forces (national and regional units), leaving for the affected area, gather at their assembly points and head for the emergency response site where the head of emergency response assigns them a worksite.

The activation of competent bodies and services in the event of a nuclear accident at the Krško NPP is conducted in accordance with the declared level of risk at the Krško NPP (Figure 5).

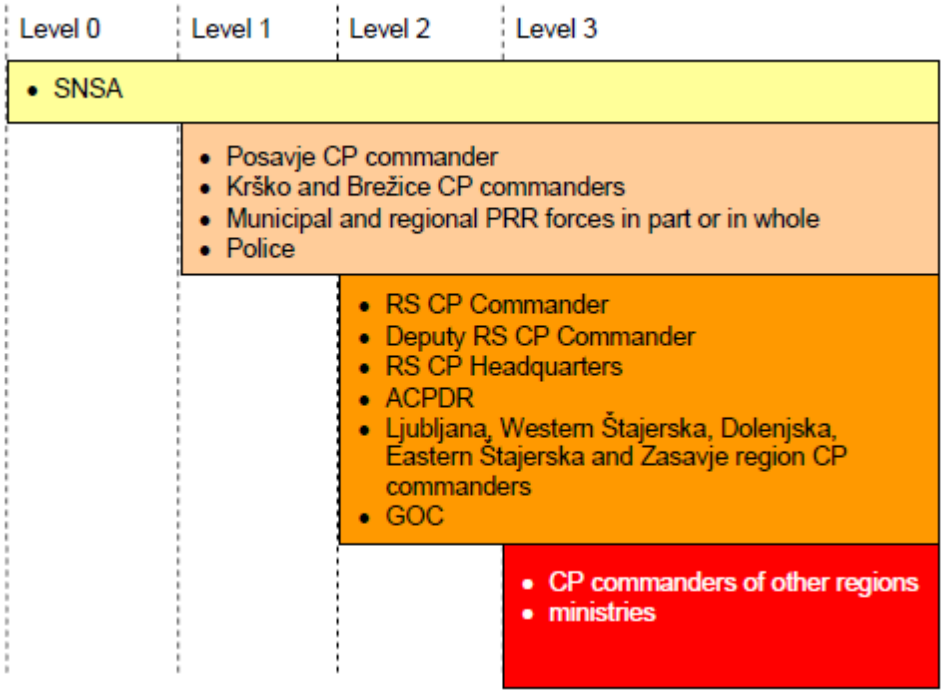


Figure 5: National-Level Activation in the Event of a Nuclear Accident at the Krško NPP.

International Assistance

Unless otherwise provided by a bilateral agreement, international assistance may be requested by the RS Government or the RS CP Commander. Requests are addressed to the European Commission Monitoring and Information Centre, the neighbouring and other countries, and international organisations, in line with international agreements (e.g. the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency). International assistance is coordinated by the ACPDR and the SNSA. International assistance is based on the actual needs and may include:

- services offered by experts, rescue units and services
- treatment of people exposed to radiation
- protection and rescue equipment
- material assistance (food, drinking water, clothing, footwear, animal feed, medicines, and other resources for free distribution to the population at risk to alleviate the consequences of an accident)
- use of airports, means of transport and other means of assistance on land and in the airspace of another country, as part of the international assistance efforts

Based on the decision of the RS CP Commander, individual experts, rescue units and services as well as material assistance from other countries are gathered in the national logistics centre in Ljubljana and in regional logistics centres. These centres are direct collection points for assistance arriving to Slovenia by road and railway. The organisation and operation of the centres lie within the competence of the ACPDR and its regional offices.

For receiving assistance delivered to Slovenia by planes, the following airports have been designated: the Ljubljana Jože Pučnik Airport, the Maribor Edvard Rusjan Airport and the Cerklje ob Krki airfield (except in the event of a nuclear accident at the Krško NPP).

The reception and referral or the delivery of the means of assistance to the relevant logistics centres or directly to the affected area by planes lies within the competence of the ACPDR regional offices in Kranj, Maribor and Breţice.

Emergency Environmental Radioactivity monitoring

Emergency environmental radioactivity monitoring is based on the regular monitoring programmes and is increasingly conducted in the event of an incident, both in terms of sampling rate and sample measurements as well as in terms of an increased number of locations. The purpose of emergency monitoring is to provide information:

- to allow the calculation of population doses and hence the basis for the recommendation of protective measures, for the withdrawal of measures, for rehabilitation etc.
- to assess the emergency personnel doses while conducting activities in contaminated areas
- to assess radioactive contamination of the environment

Emergency monitoring data are the following:

- dose rate in the environment and the assessment of received dose levels in a given period
- concentration of radionuclides in the air
- surface contamination of soil and precipitation radioactivity
- contamination of water, food and animal feed

Emergency radioactivity monitoring is coordinated by the SNSA. The functional scheme of emergency monitoring is provided in Figure 6.

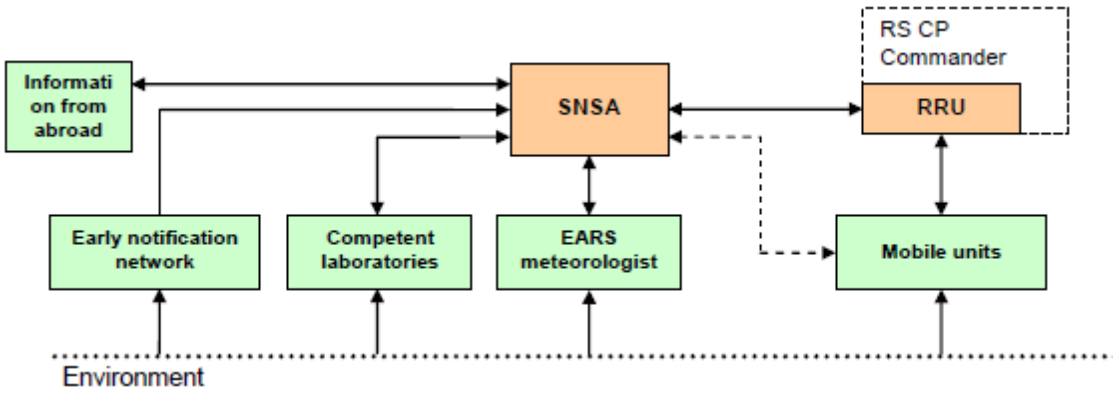


Figure 6: Emergency Radioactivity Monitoring

The early notification network provides immediate measurement results from automatic gauges and probes in the environment and basic information required by the SNSA for dose assessment. Mobile units carry out measurements in the field. Their work is directed by the SNSA, while they are operationally managed by the RRU. Orders and measurement results go through the RRU or, if technically possible, they are transmitted directly. The laboratory measurements are carried out by the approved laboratories.

Slovenia is included in bilateral (Austria, Croatia, Hungary) and wider international exchange of radiological data (EU, IAEA).

Radiation and contamination measurements at national borders have increased the surveillance of persons and goods.

An EARS meteorologist, the supporting member of the Dose Assessment Expert Group at the SNSA, provides interpretation of meteorological data and results of meteorological models, and, if necessary, communicates with specialised meteorological centres.

In the event of a nuclear or a radiological accident abroad it is necessary to establish radioactivity monitoring at the national border. By measuring the contamination of persons and goods, this is conducted by CBR CP units, the ELME capabilities, the Institute of Occupational Safety, and the SAF CBRN Battalion.

Method

Settings

In the exercise the observation took place at the premises of the Slovenian Nuclear Safety Administration, Ljubljana, at their emergency respond center. This center include 2 specially equipped rooms with all technical documentation (e.g. Krško NPP SAR and technical specifications, procedures and instructionas for assessment and emergency management), support technogy, IT and other means for communications and management of emergency situation.

More details about the observation setting are shown in Table 2.

Exercise	Setting	Location	Number of observers	Date	Tool
1	SNSA emergency respond centre	Ljubljana	1	6th of June 2018	Notes

Table 2. Observation settings during the exercise

Observation protocol

Based on the document Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers [3] a protocol for the observation was developed. It covers all important relevant events occurred during the emergency exercise with short description of action, actor, decision or statement, the time these events took place and the related notes which pointed out possible uncertainties and how they could be adressed (table 3). The main objective of the exercise is the identification of societal uncertainties in the emergency response in European countries. It will focus on in the behaviour of people involved in emergency exercises (decision and opinion makers, first responders and other participants of the exercise) in order to identify uncertainties, gain insight into the way uncertainties are addressed and handled during emergency exercises, by looking at the information

flow and communication between actors, as well as the assumptions and decisions made under emergency exercises

At the end of the emergency exercise, if possible, open informal exchanges were carried out with emergency actors/officers to clarify some aspects of the notes. The records form exercise were reviewed and amended by the SNSA staff.

Observation place: Name of the observer: Date:		
Time	Action / observation (identify event, actor, actions, decision, statement)	Notes / issues (uncertainty and how is it addressed / approach)

Table 3. Protocol for the observation

Procedure

Non-participant observation methodology was used. The objective of the observers was to take notes during the exercise to capture the discussions and decisions taken by the people involved in the emergency exercise (decision and opinion makers, first respondents and other participants of the exercise).

The goal was to identify uncertainties, gain insight into the way uncertainties are addressed and handled during emergency exercises, as well as the assumptions and decisions made under emergency exercises. The observers did not take any active part in the interactions during the exercises. Some photos (1-4) present the atmosphere during the emergency exercise in the emergency respond centre at SNSA and also the way the respond is organised and managed. Basically, at SNSA there is a group of officers with different roles and responsibilities, coordinated by the director of emergency responds, supported by different groups for evaluation and coordination of accident, and communicators to perform the exchange of information. In order to support the effective management of the emergency, the computer-based communication system is developed (SID) to record all actions, interactions and steps during the emergency event.

All notes collected during observations were treated as confidential. Summaries of notes will be exchanged between task members, but not distributed outside the group.

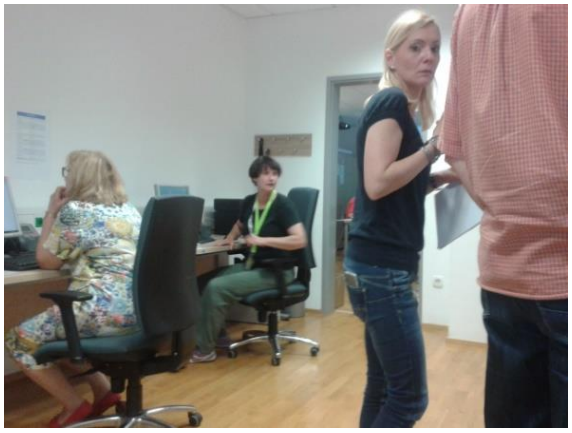


Photo 1. The emergency communicators at the SNSA

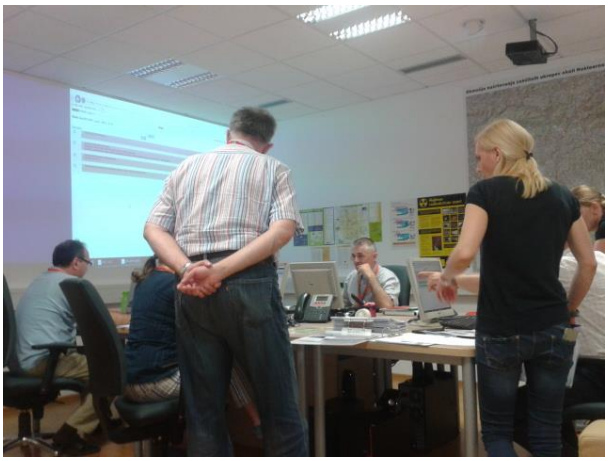


Photo 2. The Control group of SNSA for emergency with emergency director

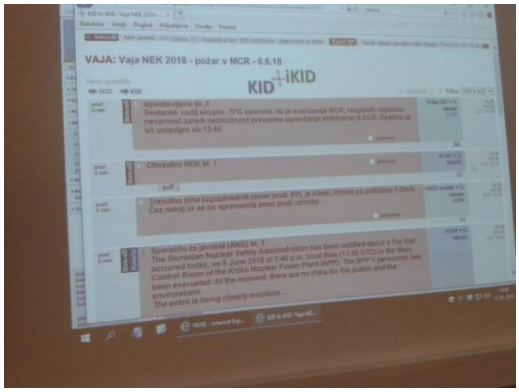


Photo 3. The Communication system for emergency management at SNSA

Photo 4. The groups for nuclear emergency assessment and dose assessment

Analysis and reporting

Thematic analysis of the notes from the observation (transcription is given in the Annex 2) was carried out. Uncertainties were deducted, categorized and described. A report of the exercise was made available to those responsible for the emergency exercise and they provided feedback and comments.

Results

In the following section we summarize the main actions or decisions that took place during the observed exercise that resulted in different socio-ethical and other uncertainties. The observations are divided in several areas, the chategorisation is subjective, based on decision of observer. The exercise was based on several presumtions: in the exercise several actors were involved (NPP, notification centers, environmental agency and nuclear regulatory authority) with unknown scenario in advance. After the exercise was finished it was clear that the scenario included the fire in the main control room at NPP, the evacuation of the operators in the emergency control room, the takeover of NPP management from emergency control room and related difficulties, the malfunction of several systems in the NPP which lead to the nobel gases releases. All related institutions were taking part, but the exercise did not include any of unofficial institution or member of the other support organisations, so all the issues of emergency respond connected with other support institutions (at municipal level) or even public were not included. Therefore, the identified uncertainties were classified in only 3 categories: uncertainties due to use of technical support system and other equipment which lead also to social uncertainties, uncertanities related to the implementation of roles and communication uncertainties.

Identified uncertanties

Use of technical support system and other equimpent

The emergency respond center at SNSA and also at other locations (external support center, technical support center, …) are all equipped with several computers allowing the responsible institutions and the staff to perform their tasks in case of emergency respond. At SNSA there is also in function Communication system during emergency event SNSA (KID – Komunikacijski sistem med izrednim dogodkom URSJV), computer-based system which allows for rapid communication and coordination as there are also other institutions included in the system. Such system (or even platform) assures the authomatisation of recording of all actions, decisions and steps. However, during the exercise it was clear that such authomatisation at different levels also pose several uncertainties:

- Login problems to start the dedicated computer linked in the KID at SNSA emergency center: the reasons can be new password (at SNSA location, or at other institutions), the officer is already connected with another computer or something else. The approach to mitigate this uncertainty is a technical (authomatic login, or similar), but also organisational, as all responsible would need to know the procedure and would need to be aware of login details.
- Appearance of records in the KID system: it was noticed that it would be better and more logical if the Status block in KID system would be on the top followed by Event sequence block.
- All technical equipments require electrical supply – need to be checked if auxiliary electric supply is installed in SNSA emergency center.

Implementation of roles

The extent of involved institution in the emergency depends on the risk level of emergency. So, for the case of exercise as it was decided, it was foreseen that the notification would come from NPP to SNSA. At 13.42 call to SNSA duty officer was obtained on the start of emergency event with which the EPR

procedures started. But at 13.56 there was a phone call from NPP informing that the at NPP they did not yet start with the emergency respond. Such problems with synchronisation of respond could be arbritrary due to fact that this was the exercise and would not appear in real case. However, such uncertainty should be checked again and the logic who informs who and who lead and who respond should be checked. The question is who starts the emergency respond and how the involved institutions would react. Similar challenge also arose with termination of emergency excersice – one group was still performing the exercise (as can be seen from the record at 17.27 and 17.32 in Annex 2) while the others were already finished the exercise. These uncertainties would need to be resolved, either by better procedures, or by improved communications.

Communication uncertainties

Some uncertainties arose during the communications between involved institutions although all technical equipment intended for communication was working. Great attention was given to warn in every communication that the event is an exercise to prevent any indication of real event. The communications within the SNSA was performed regularly and smoothly – from informing the staff about the states of the exercise and steps which need to be taken by director of emergency respond. All groups (for dose assessment, for analyses of nuclear accident, for control) and communicators were performing the respond in a harmonised and effective way so there were no uncertainties identified in this respect. The exercises at SNSA are performed regularly and it can be seen that the team is well prepared. The communication uncertainties arose with interactions with other centers:

- The consistency of written and oral information could be a challenge and could lead to wrong conclusions. There is procedure to check the real data in case of doubt. However, this is possible if the communication channels are working. A procedure on the communications between DID in NEK and at SNSA could help.
- The preparation of press releses for media could be another challenge as the information provided should be accurate and understandable. How to develop understandable press release.
- There is no procedure for communication with foreignes (other languages).
- There was a bit of confusion how the remarks on the press release should be included – at one point press release was sent out without taking into account the SNSA comment.
- More guidance should be developed how to report to public in case of very small level releases to environment (e.g. nobel gases releases to the environment).
- Some lines/channels of communication for case of emergency between NEK and SNSA were not used (special e-mails for communication in case of emergenc) and normal channels were used. Due to that the information was not received and also it was not known that the information was not exchanged.

Summary of findings

During the exercise some technical (related to the application of the emergency equipment), procedural (related to implementation of roles) and communicational (internal and inter-organizational

communication) uncertainties come out in the emergency exercise. The observed uncertainties are linked to the scenario of the exercise. In case the scenario would include also the other organisations from local area, or even the population, the uncertainties would be different.

During the exercise it was clear that the the staff at SNSA, NEK and other institutions which were involved in the scenario, are very well prepared and have established complete set of procedures and instructions to respond in case of the nuclear emergency. However, during the exercise some uncertainties were recorded which could lead to problems in real accident. They are divided in three areas, and all linked with either organisational or communication uncertainties. There is clearly opportunity for the improvement and authority may take the steps in order to mitigate them.

It would have been interesting to observe other sites which were involved in exercise in order to have a wider image of the decisions and to get more socio-ethical uncertainties, for example at NEk or in the involved notification centers.

With this observation we can conclude that there is a need to consider these socio-ethical dimensions during the decision making of the emergency exercises in order to be better prepared for a potential real situation. In that sense, it would be important to raise awareness about the importance of socio-ethical issues among those involved in emergency preparedness and responses. It would be also recommended to involve observation function more regularly to the exercises as such approach enable that more uncertainties are recognised and later corrected.

The observed exercise was relatively simple and foreseen only few institutions to be involved. But to be realy prepared, more emergency exercises including the affected population are needed. This would improve coordination and communication among the whole range of involved actors as well as prepare potentially affected population for a better response in case of real accident.

References

[1.] National Emergency Response Plan for Nuclear and Radiological Accidents, Version 3.0, 2010, RS, Govenmert of the Republic of Slovenia

[2.] Decree on Dose Limits, Radioactive Contamination and Intervention Levels, Official Gazette of the RS, No. 18/18

[3.] Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H. (2017). Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers. SCK-CEN.

Annexes

Annex 1: Circulated information to the participants: Instruction for participants at SNSA

Vaja NEK2018-1

Navodilo vadbencem URSJV

Igrajo	NEK, CORS, ReCO Brežice, ARSO, URSJV
Simulira se	MOP PR, mediji, prebivalstvo in ostale po potrebi
Scenarij	Ni znan vnaprej
Izvedba vaje	Začetek ob cca. 13:30 Upoštevajo se realni meteorološki podatki Vaja poteka v realnem času Zveze in ERDS deluje
KID SMS	DA, samo za sodelujoče organizacije
USIE	Trening izpada USIE spletne strani (faks za simulacijo)
ECURIE	Da (faks za simulacijo)
Opazovalka vaje	Nadja Železnik, EIMV

Komunikacija s simuliranimi

Telefon	01/472 11 79 ➔ najprej povejte koga kličete!
Faks	01/472 11 80
Izhodna e-pošta	nuid.ursjv@gmail.com
Obveščanje javnosti	adrema = nuid.ursjv@gmail.com objava na www = objava na IntraURSJV

VAJA - VAJA - VAJA

EXERCISE - EXERCISE - EXERCISE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 662287.

EJP-CONCERT

European Joint Programme for the Integration of Radiation Protection Research

H2020 – 662287

Internal report

Uncertainties during and after a nuclear emergency exercises (22/03/2018; 12/04/2018): Results from a non-participant observation studies in Spain

---

Authors:

Christian Oltra, Roser Sala, Silvia Germán & Sergi López-Asensio (CIEMAT-CISOT)

Reviewers: Tanja Perko, SCK•CEN

Work package / Task	**WP 5**	**5.2.3. Conceptualization and management of uncertainties in emergency exercises in EU**
Deliverable nature:	**Intermediate document**	
Dissemination level: (Confidentiality)		
Contractual delivery date:	**N/A**	
Actual delivery date:	**31st August 2018**	
Version:	**1.0**	
Total number of pages:		
Keywords:	**Observation, nuclear emergency exercises, drill, social uncertainties**	

Introduction

This report presents the results of the observation of two emergency response exercises conducted in Spain within the Confidence Project, Task 5.2.3. The objective was to gain insight into the way uncertainties are addressed and handled during emergency exercises, by looking at the information flow and communication between actors, as well as the assumptions and decisions made under emergency exercises.

We focus on the societal and ethical uncertainties raised by participant actors during the emergency exercise. We specifically explore manifested or latent uncertainties around issues such as public compliance with recommended actions, potential social consequences of the recommended actions, the level of stakeholder and public engagement planned and the efficiency of the recommended actions.

Description of the observed exercises

Members of the research team observed two emergency response exercises in Spain (

Table 3. Brief description of the observed exercise

). The first exercise consisted on an internal emergency in the Ascó nuclear power plant. The second exercise consisted on an internal emergency in the Vandellós nuclear power plant. Civil society was not involved in any of these exercises.

Emergency exercise	Date	Brief description of the exercise scenario
4. Ascó NPP	22nd March 2018	Loss of external power that affects the two units, subsequently it occur a fire in the Control Room of one of the units, that forces the use of the remote stop panel. The operative situation in this unit results in a LOCA (Loss of Coolant Accident) without external radiological affectation. The fire causes several injuries that would need medical care.
5. Vandellós NPP	12th April 2018	An earthquake of great intensity causes a fire and loss of external power supply. Throughout the emergency, the functionality of the auxiliary power water system and the CAT are affected, being necessary to use the CAGE. The PVRE (Emergency Radiological Surveillance Plan) is activated, which involves taking samples and carrying out measurements in the surrounding area. Due to the inoperability of the voice communication media, the use of TETRA terminals and satellite communication will be required for two hours. The Military Emergency Unit (UME) provides support in the management of the emergency. Various workers will have to receive health care.

Table 1. Brief description of the observed exercises

Brief description of the nuclear emergency plans in Spain

The emergency preparedness in the Spanish nuclear power plants is organized at two different but complementary levels (CSN, 2009):

- Internal response level. Established in the PEI (Site Emergency Plan) which is specific for each NPP.
- External response level. It is made up of three different, independent but complementary, guidelines:
    - The Off-site Emergency Plan (PEN) of each NPP, dated from 2006.
    - The Off-site Emergency Plan of Response and Support (PENCRA) at the national level, from 2005. To establish the mechanisms for a coordinated action, to provide extraordinary support at a national level and, where appropriate, also international assistance to the director of the PEN.
    - The Basic Nuclear Emergency Plan (PLABEN) from 2004. It is the basic guideline of nuclear emergency planning, which includes the basic criteria and principles of planning and radiation protection.

In case of an accident with potential international consequences, Spain has signed the agreements ECURIE (UE) and EMERCOM (IAEA) in which the Spanish regulator (CSN) acts as the national contact point.

The PEN establishes 4 emergency categories: I) pre-alert, II) emergency alert, III) emergency in the site, and IV) general emergency (CSN, 2009). Each category is associated to a situation, which defines the protection measures to be applied (Table).

Emergency category	**I**	**II & III**	**IV**	
		Situation		
Protection measures	0	1	2	3
Access control	No	Yes	Yes	Yes
Sheltering in place	No	No	Yes	Yes
Radiological prophylaxis (iodine tablets)	No	No	Yes	Yes
Food control	No	No	Yes	Yes
Animal housing	No	No	Yes	Yes
Evacuation	No	No	No	Yes
Decontamination	No	No	No	Yes

Table 2. Brief description of the observed exercises (CSN, 2009)

The information to the population is established in all the emergency plans, it is responsibility of the person in charge of the PEN, and it has to be carried out as the following (CSN, 2009):

- **Previous information** to potential affected population through leaflets (from CSN and General Directorate of Civil Protection) which include information about the risks, emergency response plans and planned behaviour in case of accident.
- **Information during a radiological emergency**, issued by the competent authorities and aimed at informing about the protection measures and behaviour recommendations. This information will be disseminated through all available means: public address system, radio, television, internet, SMS, etc.

The zones affected by the emergency preparedness and response are established in two main zones (Figure) (CSN, 2009):

- Zone 0: Area under the control of the operator, the protections measures are established in the PEI.
- Zone I: Area of application of the urgent measures, affects the municipalities of 10 km around the NPP
    - Zone I-A: area of 3 km around the NPP
    - Zone I-B: area between 3 and 5 km
    - Zone I-C: area between 5 and 10 km
- Zone II: Long-term measures area, affects the municipalities from 10 to 30 km.

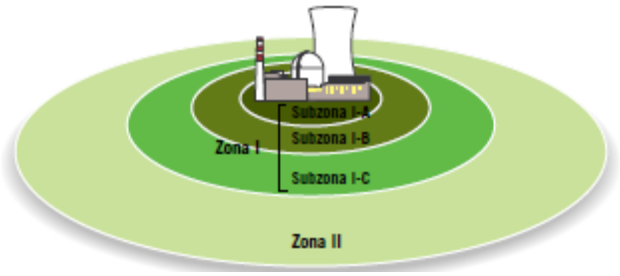


Figure 1 Areas affected by the protection measures of the emergency plans in Spain (CSN, 2009)

Description of main actors involved in emergency preparedness and response

In the "Safety Guideline 1.9 (Rev 1)" (CSN, 2006) it is established the procedure in the case of drills and emergency exercises in Spain. It is established that in case of an incident, accident or drill different groups have to be constituted to respond to the emergency situation.

These groups are organized into 4 levels: the national level (CSN), the regional level (government delegation in the region), local level (affected municipalities) and the affected nuclear power plant.

At the national level, CSN acts from the emergency room (Salem) sited in Madrid. It is in charge of the direction and coordination of the emergency. It is constituted by different groups of experts in charge of different issues (Table). At this level, the general direction of civil protection is also constituted at CECO.

General Direction of Civil Protection and Emergencies, in collaboration with the rest of public administrations, is responsible for emergency management and operations.

At the regional level, the Government Delegation acts as the Director of the Emergency at CECOP. There, different groups are also constituted to manage the emergency.

At the local level, affected municipalities organize in a local committee (CECOPAL) to follow the PAMEN plan.

In the NPP, CAT is constituted with a very similar structure than in Salem.

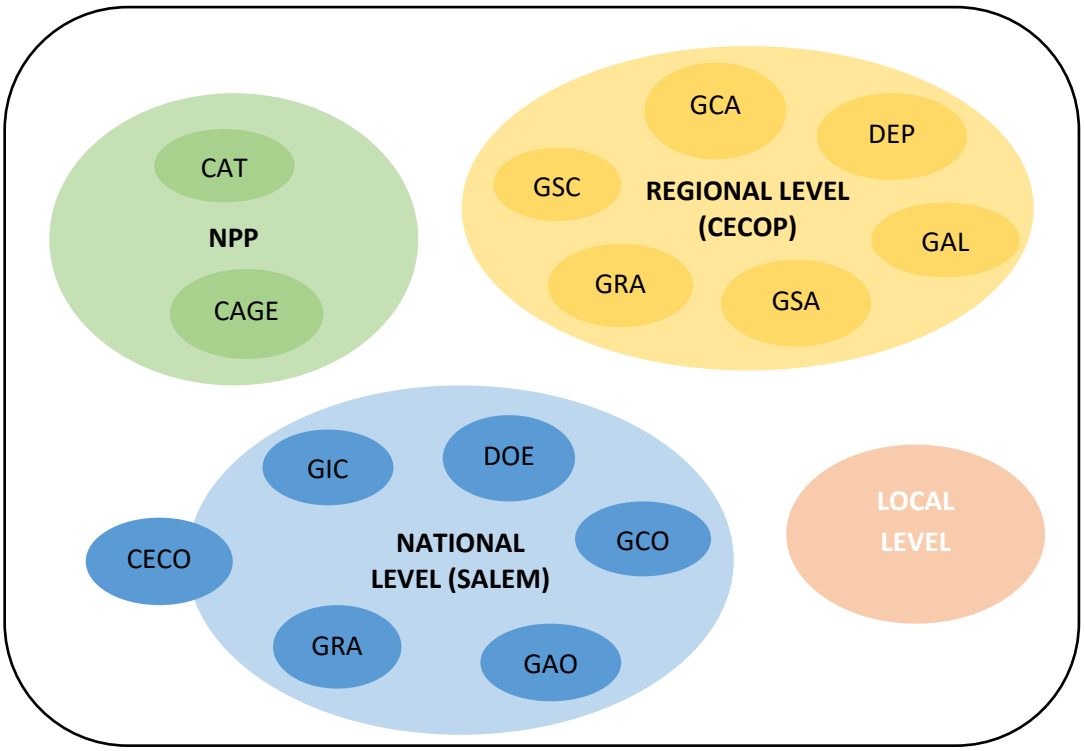


Figure 2. Agents involved in the emergency preparedness and response Spain (Own elaboration)

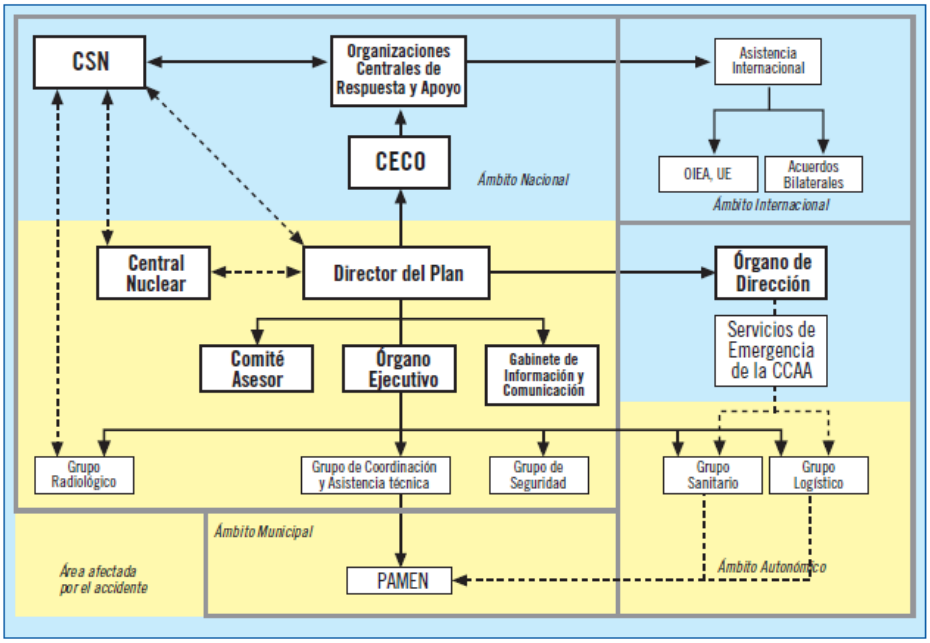


Figure3. Organization chart of the Nuclear Emergency Plans (CSN, 2005)

Acronym	Agent full name	Brief description
ORE	Organization of emergency responses	Operational structure established by the CSN
Salem	Emergency Room	Control centre and coordination of the actions of ORE at the national level
DOE	Director of the Emergency	In charge of directing and coordinating the activities of the CSN emergency response organization. The decisions about the concrete actions to protect the population are transmitted to the authorities of the emergency plans
GCO	Coordination Group	Maintain the ORE infrastructure and ensure the flow of information between all its organs
GAO	Operative analysis Group	Their mission is to analyse the causes of the accident and predict its possible future evolution. They inform the DOE about the measures that should be taken to lead the situation to a safe condition, bearing in mind that the decisions are taken in the nuclear installation.
GRA	Radiological Group	They analyse the situation generated by the accident, propose to the DOE the appropriate protection measures to reduce its radiological consequences in the population,

		the goods and the environment, as well as collaborate in its implementation.
GIC	Information and communication group	Provide the other ORE groups and the other actors involved with the information on the installation or location of the accident necessary for the development of their functions. It is the group in charge of preparing the information that must be sent to the population and the media.
CECO	Operational cooperation centre of the General Directorate of Civil Protection	State coordination committee
CECOP	Operational cooperation centre at the regional level	Outside emergency control centre
DEP	Director of the Emergency Plan	Responsible of the emergency at CECOP. Director of the plan (PEN). The person in charge is the government delegate in the region. He must establish measures to take, obtain and coordinate the necessary human and material resources and information to the affected public
GCA	Coordination and technical assistance group	Coordinates all the other groups. Responsible person is the chief of Civil Protection in the province. It is the contact point with PAMEN
GAL	Logistic support group	Specialized personnel from the regional level
GSA	Healthcare group	Local health services
GRA	Radiological Group	The chief of the group is a technical specialist from the CSN, assess the Plan Dire
GSC	Citizen security and public order group	Leaded by the commandant of the Civil Guard of the province, coordinates the police forces and the armed forces.
CAT	Technical support centre	Coordination Centre of the Site Emergency Plan, is normally located in a dependence near the control room of the nuclear power plant
CAGE	Alternative emergency management centre	NPP external support of the emergency response
CECOPAL	Local coordination centre	In charge of the coordination of the local actions. Located in most cases in the city councils
PAMEN	Municipal action plan in nuclear emergencies	Action plan from the affected population, at the local level. It is launched by the mayors of the affected populations at CECOPAL.

Table 3. Actors involved in the emergency management

Method

Settings

In the first exercise the observation took place in two settings: the C.A.T. 2 (Technical Support Centre in Unit 2 of the NPP) and the emergency room (Salem) of the Nuclear Safety Council (in Madrid). Two observers participated in each setting.

In the second exercise the observation took place in a single setting: the CECOP (Operative Coordination Centre) in Tarragona. The decision to observe a second exercise from the CECOP was taken after the first observation, due to the realization that the main decisions affecting the population of the affected area were discussed there.

More details about each of the observation settings are shown in Table .

Exercise	Setting	Location	Number of observers	Date	Tool
1	C.A.T. 2 (Technical Support)	Ascó NPP	2	22nd March 2018	Notes
1	Emergency room (Salem) of the Nuclear Safety Council	Madrid	2	22nd March 2018	Notes and informal interviews
2	CECOP (Operative Coordination Centre)	Tarragona	2	12th April 2018	Notes and informal interviews

Table 4. Observation settings during the exercises

Observation protocol

Based on the document “Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers” (Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H., 2017) a protocol for the observation was developed. It covers mainly the relevant events occurred during the emergency exercise, the time this events took place and the related uncertainty emerged

At the end of the emergency exercise, if possible, open informal interviews were carried out with emergency actors to clarify some aspects of the notes.

Observation place: Name of the observer: Date:		
Time	Action / observation (identify event, actor, actions, decision, statement)	Notes / issues (uncertainty and how is it addressed / approach)

Table 5. Protocol for the observation

Procedure

Non-participant observation methodology was used. The objective of the observers was to take notes during the exercise to capture the discussions and decisions taken by the people involved in the emergency exercise (decision and opinion makers, first respondents and other participants of the exercise).

The goal was to identify uncertainties, gain insight into the way uncertainties are addressed and handled during emergency exercises, as well as the assumptions and decisions made under emergency exercises. The observers did not take any active part in the interactions during the exercises.

Additional brief informal interviews were conducted immediately after the exercise in order to discuss decisions taken and understand behaviour of the exercise participant. The two observers in each setting analysed and discussed the notes the day after in order to discern patterns related to uncertainties.

All notes collected during observations were treated as confidential. Summaries of notes will be exchanged between task members, but not distributed outside the group.

Figure 3. Photo of the Ascó NPP emergency drill. (ANAV)

Figure 4 Photo of the Ascó NPP emergency drill. (Bombers de la Generalitat).

Figure 5 Photo of the CECOP during the emergency drill of the Vandellós NPP. . (Diari de Tarragona)

Analysis and reporting

Thematic analysis of the notes from the observation and the informal interviews was carried out. Uncertainties were deducted, categorized and described.

A report of each exercise was made available to those responsible for the emergency exercise and they provided feedback and comments.

Results

In the following section we summarize the main actions or decisions that took place during the observed drills that lead to socio-ethical uncertainties: those decisions related to the application of protection measures to the population of the affected area.

Establishing Access Control Points

Establishing access controls in the roads around the nuclear power plant is one of the first measures directly affecting the local population discussed in the emergency exercises because this measure is mandatory in the emergency plans when situation 1 is reached. In both exercises, decision makers discuss whether access controls are needed in the area and whether access controls should be simply displayed on the ground or become effective and control the access to the first emergency planning zone. In the first emergency exercise observed, members in the Operative Coordination Centre (CECOP) were unsure about the most appropriate decision regarding the establishment of access controls. In the second emergency exercise, 13 access control points were established at the very beginning of the emergency. Some uncertainties were related to the potential effects of access controls. Mainly, if they would generate serious traffic problems in the highways and roads passing by the first emergency planning zone.

Evacuation of schoolchildren

The evacuation of schoolchildren is one of the decisions generating more discussion and uncertainties in both of the exercises. This protection measure generates important doubts in the decision making of the emergency:

- Which is the ideal moment of application of this measure?
- How to make it effective?
    - What is the most appropriate evacuation route?
    - Where the children should be directed? Criteria of comfort are discussed, access by the parents, emissions (depending on the wind) are discussed
    - How are the buses mobilized?
    - Who is responsible for the children once in the buses?
    - Is there enough room in the receiving municipalities to receive them?
- What will be the parents' reaction? Some of the participants argue that parents will try to pick up for the children, potentially generating some chaos. The basic assumption is that, given that the local population has already been notified, the parents with children in the first emergency zone must have already gone looking for the children.
- What kind of social effects will the evacuation have? Will this decision generate social alarm and panic? Some argue that the evacuation of schoolchildren would provoke the spontaneous evacuation of the entire population.
- Who is responsible for decisions on evacuation? In the emergency exercise 1, members of CECOP ask people in SALEM if evacuating schoolchildren is an adequate measure. Some of the members

at SALEM have doubts about the adequacy of this measure arguing that it was not technically necessary (it can create social alarm and unintended effects such as accidents) and the decision was taken by the CECOP unilaterally. Some of the members at SALEM consider it adequate given the situation.

It is even questioned if this evacuation really makes sense and the need to apply the measure in relation to what is established in the emergency plans.

Supply of iodine tablets

Another relevant set of uncertainties arise when decision makers consider the supply of iodine tablets to the local population. First, participants in the emergency exercises discuss whether the distribution of iodine tablets is needed. The main doubts have to do with:

- When should this measure be implemented?
    - When should iodine tablets be distributed among the affected population?
    - What is the most appropriate moment of administration?
- How to do the distribution effective?
    - Before or after the evacuation?
    - How is the best way to organize the distribution of the tablets?
    - Do people have access to the tablets?
    - Do they know where to find the tablets?
    - What would happen in summer if there were tourists in the area?
- Consequences in the population:
    - Will the distribution generate queues?
    - Potential chaos

In the first exercise, it seems to be unclear among participants if the tablets should be distributed by the authorities or if residents have already access to the tablets.

It does not arise at any time whether the population will comply with the recommendation to take them or whether people have basic information about these tablets.

Evacuation of zone 1

When decision makers decide to evacuate zone 1, it is assumed that Civil Protection and the municipalities will coordinate the evacuation. Two uncertainties are mentioned in the exercise regarding the evacuation of the local population. First, it is assumed by some that there would be a spontaneous evacuation of the zone. Although this is not discussed in depth in the exercise, some participants mention that given that the municipalities have been informed about the incident, the local population would have evacuated the area. A related uncertainty issue is associated with the reaction of the population: If they are evacuating, where would they go? This question is mentioned in the exercises. But there is not a discussion about this. Some assume that there would be panic among the population. For others, it is just an uncertain issue. Decision makers seem to trust the work of Civil Protection to carry out the evacuation.

Confinement of the population in Zone 3

When the confinement of the population in emergency zone number 3 is decided (once situation 2 is reached), there is little discussion about how to make it effective. Again, some participants express doubts about the reaction of the population: would they evacuate spontaneously?

Communication with the local population

During the exercise, there is the assumption that the local population is aware of the emergency (the sirens and the local governments should have alerted and informed the local population). Then, some of the participants in the exercise discuss whether the population is clearly informed about the situation and whether specific messages should be transmitted to the population. Some of the uncertainties expressed in relation to communication with the local population are:

- What type of messages should be transmitted to the local population? At some point, the need for a single message is discussed. The type of message and the way to communicate it to the affected population are not discussed.
- Is there a need to try to calm the population? Some participants assume that there would be panic among the population and that, therefore, there is a need for messages to calm people down. One participant specifically mentions that chaos must be avoided.

Action	Uncertainty
Establishment of access control points	What are the potential effects of access controls (in terms of traffic, reaction of the population)?
Evacuation of the schoolchildren	What is the most appropriate evacuation route? What will be the parents' reaction? What kind of social effects will the evacuation have? Will this decision generate social alarm and panic? Who is responsible for decisions on evacuation?
Distribution of iodine tablets	Should iodine tablets be distributed among the affected population? Which is the best way to organize the distribution of the tablets? Will the distribution generate queues? Do people have access to the tablets? Do they know where to find the tablets? What would happen in summer if there were tourists in the area?
Evacuation of emergency zone 1	Would the local population spontaneously evacuate? In case of evacuation, where would they go? Would the population panic?
Confinement of emergency zone 3	Would the local population spontaneously evacuate?
Communication with the local population	Is the local population actually informed about the incident? What type of messages should be transmitted to the local population? Is there a need to try to calm the population?

Table 6 . Summary of the socio-ethical uncertainties appeared in the emergency exercises

Other uncertainties

Other uncertainties not related with protection measures also emerged in both exercises. In the first exercise, in the CAT of the Ascó NPP, there were uncertainties mainly related to the **application of the procedure** and, specifically, with the identification of the specific code of the events. There were important doubts and discussions about the exact category of the incident, the exact time of declaration of a specific event (which had to be clearly reported in the emergency responses procedure), and the steps to be followed according to the different emergency plans: the Off-site Emergency Plan for the area (PENTA) and the Site Emergency Plan of the NPP (PEI). As stated by member of the NPP, "given the technical complexity of the drill, it is normal to have doubts as there may be lack of data, partial or confusing information, stress, etc. Anyway, the decisions are taken once they are matured and with the sufficient information".

Other set of uncertainties is related to **internal and inter-organizational communication** issues. In the first exercise, inside the NPP, the main doubts appeared in the transfer of information about fire in the control room and the injured people. A member of the NPP stated "we had some simulation problems that caused more doubts than expected regarding the injured people". Another set of communication uncertainties that come out in the first exercise was related to the radiological levels in the area surrounding the nuclear power plant. It seems that the radiological group inside the NPP did not have access to radiological levels for a relevant while. At the inter-organizational level, some communication difficulties with the regulatory agency and the Operative Coordination Centre were detected, mainly related to lack of clarity in the competencies of each actor of the emergency (who should take certain decisions and what is the role of each actor. In the second exercise the coordination with the municipalities is somewhat opaque (they were not present in the room and there was no explicit communication) and that was certain tension between the demands of CECOP to have precise action recommendations in relation to the evacuation, road cuts, etc. by the CSN.

While in the CAT of the NPP we found basically technical and communication uncertainties, more social uncertainties appear in SALEM and CECOP, possibly because of the different competencies of each of these bodies.

Summary of findings

Despite some technical (related to the application of the emergency procedure) and organizational (internal and inter-organizational communication) uncertainties come out in the emergency exercises, most of the socio-ethical uncertainties emerged are related to the application of the protection measures to the affected population.

Among the different protection actions considered and applied there are some that generate more uncertainties than others (see Table). For example, evacuation of zone IA and the confinement of zones IB and IC does not generate many explicit uncertainties and it is little discussed how to make them effective. Instead, the evacuation of schoolchildren generates clear uncertainties throughout the entire emergency period. Other measures such as the control of accesses or information to the local population, on the other hand, generate specific uncertainties at some point of the drill.

Uncertainties	Countermeasure					
	Access controls	**Evacuation of schoolchildren**	**Supply of iodine tablets**	**Evacuation**	**Sheltering in place**	**Information to the local population**
Is this action needed?	+	++	+	+		+
When should be implemented	+	+++	++			
How to make it effective		+++	+++		+	+
Potential consequences / effects	+	++	++			+
Reactions of the population		++		+	+	+
Compliance						

Table 7. Categorization and degree of uncertainty generated by each countermeasure

In general, evacuation of schoolchildren and supply of iodine tablets are the most controversial and unclear measures for the actors of the observed emergency exercises. On the contrary, very few uncertainties emerged when evacuation and sheltering in place are considered.

Regarding the specific uncertainties emerged, the most common is the time of implementation of the measure and how to make it effective. The need of the measure is questioned less, together with the potential consequences or effects of the measures and the potential reactions of the population.

Doubts about the compliance of the measures barely appear and it is assumed that the people is widely informed and will comply with the instructions. Very few details are commented about how protection measures would be transmitted to the affected population.

It would have been interesting to observe other sites in order to have a wider image of the decisions and to get more socio-ethical uncertainties, for example at CECO (at Madrid) or in the affected municipalities.

With this observation we can conclude that there is a need to consider these socio-ethical dimensions during the decision making of the emergency exercises in order to be better prepared for a potential real situation. In that sense, it would be important to raise awareness about the importance of socio-ethical issues among those involved in emergency preparedness and responses. Second, it would be great to incorporate the evidence from the research on nuclear emergency intended behaviour in the emergency plans (for instance, PEN plans). Finally, more emergency exercises including the affected population are

needed in Spain. This would improve coordination and communication among the whole range of involved actors as well as prepare potentially affected population for a better response in case of real accident.

References

CSN (2005). El CSN ante las emergencias nucleares. Guía del profesor. Ref. OFC-04.02

CSN (2006). Simulacros y ejercicios de emergencia en centrales nucleares. Guía de Seguridad 1.9 (Rev. 1). Ref. GS-1.9.06

CSN (2009). Emergencias en centrales nucleares. Ref. SDB-01.02

Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H. (2017). Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers. SCK-CEN.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 662287.

EJP-CONCERT

European Joint Programme for the Integration of Radiation Protection Research

H2020 – 662287

Internal report

Uncertainties during the INEX-5 Exercise on Notification, Communication and Interfaces Related to Catastrophic Events Involving Radiation or Radiological Materials (24-25/10/2017): a non-participant observation study

Authors:

Tanja Perko (SCK•CEN)

Work package / Task	**WP5**	**5.2.3. Conceptualization and management of uncertainties in emergency exercises in EU**
Deliverable nature:	**Intermediate document**	
Dissemination level: (Confidentiality)		
Contractual delivery date:	**N/A**	
Actual delivery date:	**28/01/2018**	
Version:	**1.0**	
Total number of pages:		
Keywords:	**Observation, nuclear emergency exercises, drill, social uncertainties**	

Introduction

This report presents the results of the observation of an international emergency response exercise. The observation was conducted within the Confidence Project, Task 5.2.3. The objective was to gain insight into the way uncertainties are addressed and handled during emergency exercises, by looking at the information flow and communication between actors, as well as the assumptions and decisions made under emergency exercises.

We focus on the societal and ethical uncertainties raised by participant actors during the emergency exercise. We specifically explore manifested or latent uncertainties around issues such as public compliance with recommended actions, potential social consequences of the recommended actions, the level of stakeholder and public engagement planned and the efficiency of the recommended actions.

Description of the observed exercise

The INEX-5 exercise series, part of the OECD Nuclear Energy Agency's ongoing series of International Nuclear Emergency Exercises (INEX), was developed under the auspices of the NEA Committee on Radiological Protection and Public Health (CRPPH) Working Party on Nuclear Emergency Matters (WPNEM). The INEX-5 exercise addressed the specific needs of Member States to test and provide a basis for enhancing national and international emergency management arrangements.

The main goals of the INEX-5 exercise were to allow participating countries to i) test or identify elements for improving their emergency management arrangements for notification, communication and interfaces related to catastrophic events involving radiation or radiological materials, and ii) exchange experience with other countries that have conducted and evaluated an INEX-5 exercise.

The following specific topical areas, which form the basis of the generic exercise play, were established:

(1) Decision-making on notification and communication strategies, including issues in optimisation (technical, economic and social factors), and international communication and coordination;

(2) Public information and communication;

(3) National and international support (personnel, equipment, etc.).

In order to meet specific national requirement, the National Planning Committees were allowed to introduce additional objectives to their exercises. However, they were encouraged to ensure that these could be adequately evaluated whilst within the common scope of the INEX-5 exercises. It was recommended that any additional objectives were established in a manner consistent with the common INEX-5 framework.

INEX-5 was a question-driven table-top exercise focusing on emergency management aspects of notification, communication and interfaces related to catastrophic events involving ionizing radiation and/or release of radioactive material. As such, the INEX-5 exercise scenario began as a potential nuclear or radiological event and included the notification and communication processes. During the course of the exercise, it then escalated into an nuclear or radiological event and included the notification and communication processes associated with that level of event. It coincided with a natural disaster that led

to a catastrophic event that involved international notification, communication and interactions associated with the needs likely to be beyond those available within the country.

The INEX-5 series allowed for national and regional play in each participating country or as a group in a region hosted by one of the participant countries. Two groups of countries decided to play the exercise at the regional level. The first group was formed by Austria, Croatia, Italy, Hungary and Slovenia, with Slovenia acting as the accident country. IAEA participated in the Slovenia regional exercise by acknowledging receipt of messages posted on USIE and posting the messages to be available for those countries which are specified by the playing States. The second group involved Germany and the Netherlands.

Method

Settings

The observation took place at the table top exercise for regional nuclear emergency (Belgium, France, Germany, Netherlands, Switzerland, Italy), at OECD-NEA.

Observation protocol

Based on the document "Research design for the observational study of emergency exercises in selected CONFIDENCE countries: Guidelines for researchers" (Perko, T., Abelshausen, B., Turcanu, C., Tafili, V. & Oughton, D.H., 2017) a protocol for the observation was developed. It covers mainly the relevant events occurred during the emergency exercise, the time this events took place and the related uncertainty emerged.

Procedure

Non-participant observation methodology was used. The objective of the observer was to take notes during the exercise to capture the discussions and decisions taken by the participants in the emergency exercise.

The goal was to identify uncertainties, gain insight into the way uncertainties are addressed and handled during emergency exercises, as well as the assumptions and decisions made under emergency exercises. The observer did not take any active part in the interactions during the exercise.

All notes collected during observations were treated as confidential. Summaries of notes were exchanged between task members, but not distributed outside the group.

Analysis and reporting

Thematic analysis of the notes from the observation and the informal interviews was carried out. Uncertainties were deducted, categorized and described.

Results

The observation study highlighted, among others, uncertainties in the feasibility of cross-border protective actions due to different approaches in different countries. There was also uncertaintiy in the interpretation

of maps by decision-makers in different groups, for instance: is it a prediction (threat) or does it refer to an actual release? Another source of uncertainty was the political pressure concerning the application of protective actions, e.g. if evacuation is decided in one country, there may be pressure to decide the same in a neighbouring country even if it is not feasible in the latter case.

Concerning iodine tablets intake, there were several differences in the preparedness for thus action in the different countries, which may lead to uncertainties in the application of this action.

Furthemore, different calculation models used resulted in differences and incomparability of results, which led to uncertaintiy on which model should be used (e.g. the ine in the accident country or the one available at national level).