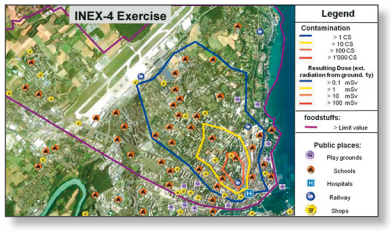
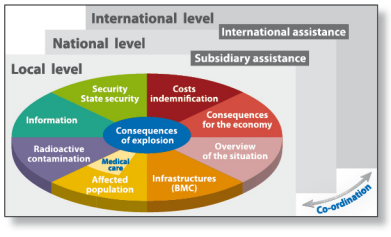
Radiological Protection
2013

Summary of the Fourth International Nuclear Emergency Exercise (INEX-4)

Exercise Conduct and Evaluation Questionnaires





OECD
BETTER POLICIES FOR BETTER LIVES

NEA
NUCLEAR ENERGY AGENCY

Radiological Protection

Summary of the Fourth International Nuclear Emergency Exercise (INEX-4)

Exercise Conduct and Evaluation Questionnaires

NEA No. 7143

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of 34 democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Republic of Korea, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.

This work is published on the responsibility of the OECD Secretary-General.

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1 February 1958. Current NEA membership consists of 31 countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, the Republic of Korea, the Russian Federation, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include the safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information.

The NEA Data Bank provides nuclear data and computer program services for participating countries. In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

Foreword

The INEX-4 exercise was designed to allow participants to investigate the national and, in some cases, international arrangements for responding to widespread radiological contamination of the urban environment from a radiological dispersal devise (or dirty bomb), and the consequence management issues likely to be raised in the medium to longer term after such an event. The experiences of participating countries were gathered through an evaluation questionnaire and are summarised in this report.

The INEX-4 series was developed in 2008, and conducted throughout 2010 and 2011 with 17 participating countries using the INEX-4 scenario for an event involving a radiological dispersal device. An INEX-4 evaluation questionnaire was developed to document the process and the results of this exercise, which was designed mainly to test emergency responses/actions related to consequence management and transition to recovery. The conclusions drawn from the INEX-4 experiences varied greatly, but this was to be expected given the nature of the scenario and the involvement of organisations outside the nuclear community.

This report provides a high-level summary of how participating countries conducted national exercises, which included five topical areas organised into nine main subjects that were derived from the questionnaire: decision making on protection strategies, public health, monitoring and assessment capability, safety and security of populations and infrastructure, and planning for recovery. It describes the key outcomes of countries' experiences for future scrutiny, analysis and reporting by the WPNEM. Best practices and lessons for improving national and international emergency response arrangements are also identified in the report.

Acknowledgements

The WPNEM wishes to express its gratitude to the United States Department of Energy (DOE) for the important contribution of its staff to the drafting of this report.

List of acronyms and abbreviations

Bq/cm^2	Becquerel (s) per square centimetre
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IEC	Incident and Emergency Center
INEX	International Nuclear Emergency Exercise
IXP	International Exchange Program
JRODOS	Java Real-time On-line Decision Support System for Off-Site Emergency Management
mSv	millisievert(s)
mSv/a	millisievert(s) annual
mSv/y	millisievert(s) per year
µGy/h	microGray(s) per hour
µSv/h	microsievert(s) per hour
NATO	North Atlantic Treaty Organization
NEA	Nuclear Energy Agency
NNSA	National Nuclear Security Administration
NRC	U.S. Nuclear Regulatory Commission
PNNL	Pacific Northwest National Laboratory
RANET	Response Assistance Network
RDD	radiological dispersal device
RODOS	Real-time On-line Decision Support (system)
WHO	World Health Organization
WPNEM	Working Party on Nuclear Emergency Matters

Table of contents

Appendices

Tables

Executive summary

The INEX-4 consequence management exercise, part of the OECD Nuclear Energy Agency's ongoing series of International Nuclear Emergency Exercises (INEX), was developed under the auspices of the NEA/CRPPH Working Party on Nuclear Emergency Matters (WPNEM) in response to members desire to better prepare for the longer-term response to a nuclear or radiological emergency. The INEX-4 exercise was designed to allow participants to investigate the national and, in some cases, international arrangements for responding to widespread radiological contamination of the urban environment from a radiological dispersal devise (or dirty bomb) and the consequence management issues likely to be raised in the medium to longer term after such an event. The experiences of participating countries were gathered through an evaluation questionnaire and are summarised in this report.

The INEX-4 series was developed in 2008, and conducted throughout 2010 and 2011 with 17 participating countries using the INEX-4 scenario for an event involving a radiological dispersal device. An INEX-4 evaluation questionnaire was developed to document the process and results of the exercise, which was designed mainly to test emergency responses/actions related to consequence management and transition to recovery. The conclusions drawn from the INEX-4 experiences varied greatly, but this was to be expected given the nature of the scenario and the involvement of organisations outside of the nuclear community.

The evaluation questionnaires completed by each participating country provided detailed information on the national approaches taken with respect to each of the exercise objectives and on issues relating to the international interfaces between countries. In collaboration with the NEA Secretariat, staff from the United States Department of Energy (DOE) reviewed each completed questionnaire to identify and summarise the essential information derived from the exercise for consideration by WPNEM members. Questionnaire results, good practices, and opportunities for improvement related to nine major subjects – exercise scenarios, decision-making, optimisation, public health, safety and security, communication and notification, radiological management, planning and recovery, and termination of actions/ countermeasures – derived from the questionnaire are summarised.

This report provides a high-level summary of how participating countries conducted the national exercises and identifies the key outcomes of the countries' experiences for future scrutiny, analysis and reporting by the WPNEM. Best practices and lessons for improving national and international emergency response arrangements are also identified in the report.

1. Introduction

Recognising the value of INEX-3 in terms of the lessons and issues identified, the WPNEM developed the INEX-4 exercise to continue the exploration of the issues arising from the post-crisis phase response to an emergency. The objectives were to address directly the topical interest in emergency management, in particular the contamination of the urban environment and the transition to recovery. The basic concepts for INEX-4 were:

- to continue an investigation of the themes first addressed in INEX-3 by conducting a series of national exercises;
- to facilitate an investigation of post-crisis emergency management;
- to allow countries to exchange their experiences.

INEX-4 addressed the issues arising in consequence management and transition to recovery from a malicious act involving a radiological dispersion device in an urban environment. However, the INEX-4 design specifically excluded the early crisis phase, including notification, although it was noted that issues arising during this phase may need to be addressed in the future. To assist exercise organisers in their INEX-4 planning, a set of technical materials were prepared and each participating country was invited to perform its own exercise evaluation using a common questionnaire, with the intent to share, as appropriate, its experience internationally.

The INEX-4 scenario and timeline was defined as an event involving a radiological dispersal device (RDD) in an urban environment that was designed to test responses/actions related to consequence management and transition to recovery. Examination of the INEX-4 exercises was undertaken by compiling the responses and analysing the content from participating countries in order to extract common issues, lessons learnt, possible best practices and specific areas for improvement. With the kind support of the National Nuclear Security Administration (NNSA) staff and the United States Department of Energy (DOE) sponsored staff, the WPNEM collated, summarised, and analysed input from 17 countries that conducted INEX-4 exercises between November 2010 and December 2011. In collaboration with the NEA Secretariat, staff from the United States Department of Energy (DOE) reviewed each country's responses to questions and identified the key points that were analysed and summarised for further review and action by the WPNEM.

The countries included in this review are listed in Table 1 in chronological order of the exercise dates.

Table 2: Participating countries listed chronologically by exercise date

Date of exercise	Country
12 November 2010 and 30 November 2010	Norway
16 November 2010	Switzerland
23 November 2010	Spain
25 November 2010	The Netherlands
18 January 2011	Chinese Taipei (Taiwan) ROC
26-27 January 2011	Slovak Republic
8 February 2011 and 16 March 2011	Finland
15 February 2011	Pakistan
17 February 2011	United Kingdom
23-24 February 2011	Hungary
1 March 2011	Canada
14-15 March 2011	Poland
23 March 2011	Czech Republic
14 June 2011	Austria
16 November 2011	Slovenia
17 November 2011	France
14 December 2011	Germany

1.1. Purpose and scope

This report provides the high-level summary of the INEX-4 experiences. It summarises the evaluation of how countries conducted their national exercises and it identifies the key outcomes of their experiences. It sets the stage for further review and discussion by WPNEM of the INEX-4 experience from multiple perspectives and the articulation of the key issues arising. These include the lessons learnt, potential policy-level outcomes, recommendations and best practices, and other follow-up activities derived from the exercises. It is intended to provide suggestions for a proposed INEX-4 evaluation workshop. It compares approaches, analyses the implications for decision-making, and identifies key needs related to longer-term consequence management and other elements of the exercise.

1.2. Report contents and organisation

Sections 2-10 of this report tackle the five key INEX-4 exercise topics arranged into nine major subject areas and a summary of conclusion derived from the questionnaire. Under each subject, a high-level summary of INEX-4 questionnaire results about how countries conducted the exercise is presented, followed by any good practices and opportunities for improvement identified as a part of the reviewers' assessment and highlighted for future consideration. The summarised information is not all inclusive, nor does it relate to every country; it represents some of the key information provided by one or more responding countries.

2. Exercise scenario(s) overview

All participating countries provided a description of their emergency management structures; some included organisation charts. Each country implemented its emergency management structure using the INEX-4 scenario to test its existing structures and to identify what works and where improvements could be made. Information included in this section summarises how the scenario was used by participating countries, the countries' input regarding the materials included, and information regarding the exercise evaluation questionnaire. Some good practices and improvement opportunities are also highlighted.

2.1. Information about the technical scenario

INEX-4 was developed around a single scenario based on a contamination footprint arising from the malicious use of a radiological dispersion device in an urban environment. The start of INEX-4 exercise play was clearly identified as being after the crisis/early phase was ended. Additionally, to ensure an efficient investigation of the topical areas over the extended times associated with the post-crisis situation as well as a common evaluation basis, INEX-4 was designed as an "issues-driven" table-top exercise to be conducted individually by each participating country. Players were challenged to fully investigate issues and develop their plans for managing the consequences and the transition to recovery in response to the topic areas and associated scenario developments. While issues related to the crisis management were inevitably discussed during the exercise, crisis phase play was considered out of scope of the INEX-4 framework and technical materials were not developed to support such play. Criminal justice aspects associated with a malicious event were also considered to be out of scope of the exercise framework; however, this did not preclude individual countries from including these in their own exercises in a manner consistent with the overall exercise framework.

2.2. Variable scenario information

The wide range of answers indicates that countries adapted the scenario to their particular needs. Information provided in response to questions related to the scenario variables is summarised in Table 2.

Table 3: Summary of responses about scenario variables

Scenario variable	Summary of responses
Location (city) of the detonation	Cities and locations (arena/stadium) were identified. One country used a "generic" city instead of an actual city for its scenario. One country used two detonation locations.
Season and general weather conditions for the follow-on response and transition to recovery	From spring to winter, with and without precipitation, and with and without wind.
Type of area affected (residential, industrial, tourist, etc.)	Urban, residential, tourist, recreational, embassies, transportation, business, commercial.
Size of area affected	Between 0.3 km^2 and 36 km^2.
Number of individuals injured in the initial explosion	Between 20 and several hundred.
Number of individuals in the downtown area at the time of the explosion	Number of people in the affected areas ranged from 500 to 50 000.
Number of hospitals in the area	Between 0 and 5. Private offices and healthcare clinics were also considered in some responses.
Number of individuals reporting to each hospital in the area	Between 5 and 300.
Number of people in the evacuation zone at the beginning of the "follow-on response"	Between 200 and 12 000.
Number of businesses in the evacuation zone at the beginning of the "follow-on response"	Between 10 and several thousand. Census data were identified as a resource for the information in one response.
Number and location of shelters set up at the beginning of the "follow-on response"	Between 1 and 6. Public buildings, schools, and universities were identified as resources.
Number of people each shelter is housing	150 people or more. Shelters were identified as housing between 150 and 1 500 people.
Number of hotels closed	Between 0 and 20.
Number of guests relocated	Between 20 and 2 000.
Products affected	Primarily market goods, including a vineyard.

2.3. Additional information about the scenario not included above

The number of RDD devices or detonations was kept to one for all but one country, which used two. Contamination spread was kept within country borders for all but one country. However, there were some exercises where at least one embassy (considered foreign soil) within the affected area was identified as being affected.

Several responders discussed some minor modifications and further development of the base-line scenario. These modifications included using a computer simulation, e.g. real-time on-line decision support (RODOS) system for off-site emergency management, descriptions of psychological behaviour of people in this situation, and a document that summarised details of the early phase of the exercise. In addition, country-specific information in the form of maps, decontamination data, history, etc. were developed and provided to players. Additional decision-aiding tools were identified (see Section 3 in this report).

Countries beginning the exercise at the intermediate/late phase (after the initial response phase) provided information to the players that included critical/immediate countermeasures (protective actions) that were assumed to have been completed. Those countermeasures included sheltering, evacuation, use of cordons, treatment of injured, monitoring/sampling, forensic investigations, psychological care, and initial and ongoing public information and international notifications. The basis for which countermeasures were assumed to have been taken (implemented, continuing, terminated) at the start of the exercise was not typically addressed in the questionnaires. In addition to the countermeasures, public information that was assumed to have been disseminated included emergency situation status, protective measures, potential health impacts, injuries, and traffic modifications. This information was assumed to be provided by media centres, press releases, bulletins, and public television. Identified international community information was provided by briefings to embassies and to the IAEA Incident and Emergency Centre (IEC) through established channels.

Some countries identified some problems that they encountered with the base-line scenario data. The problems that were reported in the questionnaire included the following:

- Inconsistencies in the figure on page 29,[1] "Emergency Workers Dose Rate (Far Field)", could only be resolved once the workshop was under way.
- Exercise organisers and players were unable to reconstruct the dispersion prognosis part.
- Additional information was needed to reflect the progress in national crisis management from time zero to the start of exercise Part 1 and further to Part 2.
- Specific problems existed in using the decision support system RODOS (RDD-module) for reproducing the 137Cs contamination maps for the exercise.

2.4. Information provided to exercise players

In general, the player materials developed for the base-line scenario were considered to be appropriate for use by national planning teams. It was noted that the materials could have been more concise (fewer pages) and that customisation was necessary to make them relevant to national level participants. Prepared player information and materials included exercise and scenario information, maps, computer simulations, photographs, the INEX-4 exercise guide, feedback forms, and evaluation questionnaires. Some background information about RDD was provided by one country. Information was identified as being provided to players between the day of the exercise and over a month prior to the exercise. In one case a presentation was made to explain the exercise goals. One response indicated a problem with the cartography format, stating it was not always compatible with players' formatting systems.

Exercise play was limited to one location, not necessarily one room, for most countries, but one response indicated that there were three locations where play took place. Video conferencing and online communication tools were identified as methods for maintaining communications between locations.

Participation in the INEX-4 exercise by neighbouring countries was identified as being relevant to two responses and included observation roles, embassy participation, and sharing of exercise materials. Control at the borders, dissemination of information to foreign tourists, and addressing foreign tourist needs were discussed, as was handling deaths and injuries of foreigners.

1. NEA/CRPPH/INEX(2009)7 "INEX 4: Guide for National Planning Committees".

2.5. Additional national objectives and observations

Some responses identified additional objectives, primarily related to improving and strengthening regional and national responses. In some cases, initial/immediate response phases were exercised as an introduction to the INEX-4 exercise on consequence management and transition to recovery phases.

Additional responses discussed the arrangements made for the handover of responsibilities, the likelihood that the crisis phase could be in the public consciousness for an extended period of time, development of an evaluation report, and how the exercise scenario response could be different if conducted at a different location (town/rural instead of major city).

One country indicated that the design of this exercise allowed the focus to be on the concerns of the public instead of the radiological issues.

2.6. Evaluation questionnaire

Some countries reported that they experienced some difficulties during the national evaluation process owing to the detailed nature of the questions in the preparation manual and the evaluation questionnaire. Not all countries have fully developed policies and procedures for all areas of the evaluation questionnaire and in some cases a lack of time was identified as a limitation to completing the questionnaire. Some questions were identified as being overly technical, while others were identified as being purely strategic. Some topics were considered to be related to short-term consequences, which one country felt had detracted from their medium- to long-term consequence management focus. Not all questions in the questionnaire were unambiguous and the same or similar information was provided in response to more than one question. However, given the number of participating countries, the quantity of materials and detail contained in the completed questionnaires, this leads NEA and WPNEM to conclude that as far as "one size fits all" approach can be adopted across many member states the evaluation questionnaire was successful in delivering the results of INEX-4 exercises.

2.7. Lessons learnt

Good practices and opportunities for improvement were identified from the completed questionnaires as a part of the reviewers' assessment. The reviewers were tasked with identifying these practices whether they were from a single country exercise or reported by many countries as common experiences; the good practices identified were as listed below.

2.7.1. Good practices

- The exercise provided participants at all levels with a good opportunity to experience and respond to "real" situations.
- High-level decision-makers participated in the exercise.
- A lot of time was used for explanation and discussion of the exercise materials, the technical scenario and the scope of the exercise play.
- Conducting an early-phase exercise was perceived as a very good introduction to the "official" INEX-4 exercise.
- Fewer technical details in relation to the scenario allowed the participants to concentrate exclusively on their workshop/exercise activities.
- The extent of the event made it possible to apply more shifts in certain positions.

- Outcomes from the INEX-4 exercise provided the basis for developing emergency plans and arrangements for malicious acts, especially for the intermediate phase and transition phase to recovery.
- Emergency plans have been updated based on gaps identified during INEX-4.
- Elements of the INEX-4 scenario that were not covered during this exercise will be covered at a later time in an exercise/workshop that focuses on those topics.
- The INEX-4 scenario and materials will be re-used for other exercises and in fact have been used in an exercise that included insurance companies.
- Organisations that would respond to such incidents agreed to prepare location-specific materials for participants to use during the exercise.
- The participation of a crisis psychologist in the exercise to simulate and describe reactions of populations in affected areas and elsewhere was very useful in both preparation of and participation in the exercise.
- Outcomes from the INEX-4 exercise provided the basis for developing emergency plans and arrangements for malicious acts, especially for the intermediate phase and transition phase to recovery.

2.7.2. Improvement opportunities

With any generic scenario there will be issues with the provision of a single technical scenario/initiating event. The participating countries were required to adapt the generic materials to their national requirements. From the questionnaires, it is clear that many countries were able to manage this without too many difficulties. However, where NEA and WPNEM may be required to develop these types of materials in the future, it is worth noting the problems that were at several levels.

- Reduce complexity of the scenario (time jumps, a lot of players, radiological event not exercised before, etc.).
- Improve exercise materials e.g. by including values on maps or in tables.
- Include radiological information about the effects on the population and dispersal devices.
- Improve radiological monitoring and other scenario products.
- Conduct several workshops, instead of one- or two-day workshops/exercises, to exercise individual elements of the INEX-4 scenario.
- Develop decontamination techniques applicable to the conditions of historical (e.g., 14th century) towns/houses (including cellars).

3. Decision-making during the exercise

Decision-making during the exercise, as reported here, is broken down by decision-making authorities and processes, including the related criteria and basis for actions. Some good practices and improvement opportunities are recognised and also highlighted.

3.1. Decision-making authority

In the questionnaire responses, countries identified lead national organisations and decision-makers, discussed their authorities for the INEX-4 exercise scenario, and in some cases for nuclear power plant events. Some also discussed changes in authority for nuclear and/or radiological and other events.

More than one decision-maker was typically identified, usually with regard to specific levels of government. Most countries discussed unified co-ordinating groups and their roles, but some indicated that no unified group currently exists. The involvement of various stakeholders (including representatives of the private) was also discussed in some cases. Stakeholder involvement is discussed in more detail under Planning and Recovery (Section 9).

During decision-making transitions (for example, from consequence management to transition to recovery to long-term recovery) the organisations responsible for or involved in decision-making were identified and the "hand-over" process was discussed. In general, this process was identified as being more of a transition or "morph" as situations changed, instead of a being a clearly defined specific "hand-over" of responsibilities from one organisation to another. Transitioning was considered a natural and continuous process in terms of managing national and local responsibilities between collaborating entities and from the crisis phase through to recovery, even where the transitions were not necessarily synchronised between the different sectors of society.

3.2. Decision-making processes

Countries identified a multitude of emergency management issues that would need to be dealt with and in some cases the decision authority for such issues was identified. The need for close co-operation and co-ordination between decision-makers in multiple jurisdictions, for example national and regional decision-makers, was identified as a key factor for effective and timely response. Decision-making areas identified as national, regional, municipal, and/or local responsibilities included public health (food, water, shelter, psychological), transportation, continuity of services, security (public and crime scene), communications, economic consequences, radiation protection, and concerns related to schools and hospitals. Public health was identified as the first priority for decision-making. Safety, security, monitoring, restoration of services (utility, hospital, transportation, veterinary, computer), and material and financial needs were also identified as high priority areas. It was also recognised that decisions cannot be taken independently in these areas as the resources required to carry out actions are sometimes the same.

Countries also discussed existing decision-making processes for emergencies – primarily non-radiological events. Evaluations of emergency decisions were identified as taking place continuously during the event and at the end in a formal process that

includes lessons learnt. One country indicated that an evaluation would only be conducted if there were major mistakes; another country indicated that evaluations might be conducted after the event.

3.3. Lessons learnt

Good practices and opportunities for improvement were identified as a part of the reviewers' assessment. The reviewers were tasked with identifying these practices whether they were from a single country exercise or reported by many countries as common experiences; the good practices identified were as listed below.

3.3.1. Good practices

- In cases where multiple countries were involved, countermeasures were co-ordinated with other countries.
- Open and frank discussions amongst responding organisations ensure that decisions are coherent and consistent and will provide adequate and timely support to other jurisdictions if requested.
- Initiatives were launched to gain back public trust.
- Trainings courses were provided for response organisation officers and officials.

3.3.2. Improvement opportunities

- Clarify (primarily for management) the mechanisms for and timing of "hand-overs" between different decision-making authorities (mainly between the crisis and recovery phases).
- Improve co-ordination when multiple decision-makers are involved, for example, identifying a single focal point (primary decision-maker) when several "district decision-makers" are involved.
- Develop plans, procedures, and training to minimise the possibility of inadequate/incorrect decision-making.
- Include technical expert(s) on, or technical support within decision-making bodies or steering committees.
- Realistically assess and identify the response resources and capabilities within all responding jurisdictions, and the types of assistance that could be requested.
- Develop strategies for managing potential shortages in monitoring resources.
- Provide supporting evidence for recommended implementation of long-term countermeasures.
- Establish laws or regulations according to national need concerning the public health follow up from a radiological emergency.
- Develop national recovery procedures to facilitate consistent decision-making across the entire timeline of response.
- Ensure that the roles of response organisations are understood, recognised and documented for all types of radiological scenarios.

4. Optimisation

Optimisation is an important element of the decision-making process and is defined as keeping the magnitude of individual doses, the number of people exposed, and the likelihood of potential exposure as low as reasonably achievable below the appropriate dose constraints or reference levels, with economic, social, and political factors being taken into account whatever the exposure situation; i.e., planned, emergency, and existing.

Optimisation processes were discussed during the exercises and reported in the questionnaires. Guidance/policy documents were identified, including the identification of clean-up guidance. Optimisation processes were identified as either being based on existing documents or developed ad hoc. Individual actions within the protective strategies were primarily identified as being optimised collectively.

The impacts of decisions were primarily accounted for by identified staff or teams tasked with this responsibility and included continuous evaluation, public reactions, cost/benefit, and legal discussions. The person/organisation responsible for initiating the optimisation process was identified by most countries.

Information dissemination and communications processes were discussed, but not all countries provided an explanation of optimisation process to the public, media, or private organisations. Information was typically shared via media outlets and press releases. Some countries included stakeholders' input in the optimisation process whilst others indicated that the process to include stakeholders would be performed only after the optimisation processes related to populations, the environment, and private properties were terminated.

Protective action implementation was considered and reported in the questionnaires by all countries, but not all countries addressed protective action strategies in detail during the exercise. Food products, clean-up, monitoring, and the relocation and movement of individuals (including sheltering issues and transportation disruptions) were considered in the national exercises. For materials, goods, and/or products used, consumed, stored, produced, processed, etc. in the potentially contaminated area, dose limits for release were discussed.

Where long-term aspects of recovery were considered, they included the management of contaminated material, contamination control for potential drinking water reservoirs, public health, socioeconomic impacts, recovery, waste management, environmental and ecological impacts, public opinion and acceptance of mandatory measures, data related to contaminated persons, storage of radioactive wastes, and decontamination techniques. In some countries, it was noted that countermeasures applied after the Chernobyl accident are still in place 25 years later.

4.1. Lessons learnt

Good practices and opportunities for improvement were identified as a part of the reviewers' assessment. The reviewers were tasked with identifying these practices whether they were from a single country exercise or reported by many countries as common experiences; the good practices identified were as listed below.

4.1.1. Good practices

- It was recognised that public opinion, effective communications, and issues related to economics would play an important role in the effectiveness of any protective strategy.
- Relating to goods, constraints would be implemented (similar to recommendations after Fukushima): threshold for the dose rate at the surface of container etc. would be 0.2μSv/h or twice the background; for gamma/beta contamination it would be 0.4 Bq/cm^2.
- The local authorities recognised that long-term recovery aspects should be built into the Recovery Plan.

4.1.2. Improvement opportunities

- Develop a pre-defined optimisation strategy.
- New recommendations from the International Commission on Radiological Protection (ICRP) should be considered in emergency management procedures.
- Include response to "RDDs" in optimisation documents/procedures.
- Develop "shelter in place" guidance for private organisations, including what to do if personnel or customers choose to leave a potentially impacted area in spite of instructions from the authorities to stay indoors.
- Establish complementary local sector and government procurement rules for intermediate term/phase needs.
- Establish inter-departmental and inter-governmental consensus regarding optimisation processes, including reference levels and protective action levels (including advice to public, dose rate limits, evacuation zones).
- Develop co-ordination processes between organisations to reduce duplication of effort and improve efficiencies.

5. Public health

National response plans included public health guidance addressing health issues. Some countries discussed the need to have proper record-keeping processes for exposed individuals. It was also determined that the long term storage of this data would have to be addressed. Radiation exposures and dose records were discussed, including long-term follow-up, dose reconstruction, and epidemiological and public health investigations. Along with the responsibility for obtaining a registry of exposed individuals, the need to protect personal data and keep it private was also recognised.

Discussion of the registration of affected and potentially affected individuals involved the type of information that would be collected, who would be collecting information, the advantages and disadvantages of maintaining a registry, use of prescribed forms, long-term record storage, and advice for the people being registered. One country identified a central telephone number where people could register themselves.

The need for long-term health surveillance, including the possibility of health effects such as cancers, was identified as being determined by doctors and/or consultants. Risk assessment and conventional emergency health processes would be used as methods for long-term follow-up. Many countries noted that their population is not obligated to participate in long-term monitoring of its health conditions.

Dose reconstruction discussions included identification of responsible organisations, use of actual measurements and assumptions, ingestion, and inhalation as pathways for internal dose exposure, epidemiological investigation, and model characteristics. One country indicated that for a RDD event, both internal and external dose reconstruction would be completed.

In addition to medical treatment of radioactively contaminated persons, the need for psychological counselling and responsible organisations was identified. Timely post-disaster counselling is considered appropriate. In some cases, such as fire protection and police, mental health/crisis management services were identified as a part of their organisations. In another case, services would be obtained through contract with private companies. A crisis intervention team was noted as being staffed by volunteers (from the voluntary sector such as St. John Ambulance, Red Cross, Red Crescent etc.), in co-operation with general physician services.

Medical expenses were covered by national/federal healthcare systems and/or by insurance companies for individuals and businesses. It was noted that members of the public cannot generally be forced to undergo examinations and treatment. Treatment of foreigners would be carried out within the authority of valid agreements.

5.1. Lessons learnt

Good practices and opportunities for improvement were identified as a part of the reviewers' assessment. The reviewers were tasked with identifying these practices whether they were from a single country exercise or reported by many countries as common experiences; the good practices identified were as listed below.

5.1.1. Good practices

- Reception and information centres, identified for a nuclear power plant accident, could be operated for any nuclear or radiological event.
- Hospitals (with radiation expertise such as would be available for radiotherapy and nuclear medicine applications) are required to plan for providing diagnostic tests and treatment when necessary.
- Advising individuals to inform their physicians if they believe they have been affected by an event.
- The use of similar plans and procedures for dealing with infectious diseases could be used for handling radioactively contaminated individuals.
- A legal framework for terrorism victims and injured people was established.
- Strategies were in place for the dissemination of food and water information based on previous responses to flooding and swine flu events.
- Medical and psychological follow-up planning identified a multi-step approach, such as dividing hospitals into the categories of services such as “basic”, “regional”, and “central”.

5.1.2. Improvement opportunities

- Develop detailed contingency plans for areas without nuclear power plants.
- Develop long-term follow-up plans for individuals affected by radioactive contamination.
- Consider establishing a national radiation accident “registry” and database and appropriate data protection arrangements.
- Develop federal laws related to maintaining a “registry” of affected members of the public.
- Clarify how/if nuclear power plant accident requirements for “registry” might be applied to other nuclear/radiological events.
- Develop guidance for how to manage alternative opinions regarding consequences, professional differences, etc.
- Develop plans supported with operational documents related to public health management.
- Identify solutions regarding insurance companies’ payment exclusion for death, disability, or injury caused by atomic, nuclear, RDD, terrorist acts, etc.

6. Safety and security

The international planning group for INEX-4 clearly recognised when planning the exercise that a real RDD scenario will always trigger actions related to both safety and security. The objectives of the exercise were focused on the safety aspects in line with the given mandate. It was however recognised that it might be difficult to completely separate safety and security response and it was therefore decided to provide participating countries with a possibility to explore the interface and co-ordinating arrangements between the two areas. From a stricken state's perspective both aspects need to be taken into account during a real event considering concerted national priorities and decisions on actions. Besides, it may not be clear in the early stages of an event whether it was caused by an accident or a malevolent act.

From the submitted questionnaires, we draw the conclusion that these objectives of the exercise were addressed to different depths in different countries. We can however from the exercise material identify some lessons learnt and some good practices that are of general value for many states.

Safety and security-related information was identified as being shared both nationally (including locally and regionally) and internationally. Gaining public trust through transparent and truthful exchange of information was determined to be an important factor. Openness was considered a guiding principle, recognising limitations related to criminal investigations and the types of information to be shared. Responsible organisations and processes for sharing information were identified. Timeliness of the information for warning and informing the public and sharing with the embassies, consulates, and neighbouring countries was identified as an important factor. Established channels such as those at IAEA based on the conventions on Assistance and Early Notification and through professional international partnerships (agreements and memoranda of understanding) were identified, along with co-ordinated centres or systems that would be established during an emergency according to plans. Translation/multilingual services were identified as necessary resources in order to inform visiting foreign nationals. Validation and verification of all information prior to its use in briefing materials was identified as a good method for minimising the release of bad or conflicting information. The types of information to be shared included radiological impacts/consequences; protective measures; incident and its consequences; affected areas; restrictions imposed; countermeasures; progress and response; radiation data related to food and the environment; agriculture, fishery, animal product controls; pet, poultry, livestock controls; personnel access control; government assistance; radiation consequences; information of protective measures and locations; changes in public transportation arrangements; instructions on self-help; and decontamination processes.

Organisations and processes were identified for safety and security response and, as expected, it was recognised that the organisational structure varies from country to country with a different degree of integration between safety and security response. In most cases, population control and crime scene area access was handled by law enforcement or local first responders. For most countries, cordoning off areas was used as a method of securing property and goods. Cordoning off the areas of detonation also served to protect the area for crime scene investigation. Some countries noted that crime scene investigation would take place prior to decontamination to protect forensic

evidence; whereas one country mentioned that population safety would always come first over crime scene investigation. In addition, some countries' discussions of the length of time necessary for the investigation indicated that investigation would occur only during the crisis phase, whereas another country stated it would take up to a few weeks after the event. Once the crime scene is released, the law enforcement protection of the cordoned-off area and its contents is typically turned over to the local authorities. In some countries the police are still responsible for cordoning-off areas to maintain safety after the criminal investigations are over. Hiring private security companies to provide continued enforcement of the cordoned-off area was a solution identified by one country.

In the event of local government or critical infrastructure impacts, a few countries addressed the issue of needing national support, city-district co-operation, and alternate locations for providing services. In some cases, access to the cordoned areas was given to some officials and emergency responders, whereas other countries gave no access to evacuated areas. Lifesaving activity was identified as an exception to access control protocols. Emergency worker access was based on radiation levels, protective clothing, and/or escorts (primarily related to security restrictions). Not all countries have procedures in place for exceptions to access control restrictions.

The management of abandoned and contaminated personal property was discussed. Some countries indicated that personal property might need to be decontaminated and handed back to the owners. Processes discussed regarding decontamination and release of personal property included collecting the property, making a record (including photos) of the items, storing, sampling and monitoring, decontaminating, returning or compensating/reimbursing for property that could not be decontaminated, owners being responsible for personal property, and disposing of contaminated property.

6.1. Lessons learnt

Good practices and opportunities for improvement were identified as a part of the reviewers' assessment. The reviewers were tasked with identifying these practices whether they were from a single country exercise or reported by many countries as common experiences; the good practices identified were as listed below.

6.1.1. Good practices

- Pre-prepared templates could be used for quick access and consistent reporting.
- A team was appointed to be responsible for preparing the information to be disseminated to foreigners (information translated in selected languages).
- Pre-established arrangements were in place for access to cordoned-off areas.
- Organisational structure or protocols were in place so that police forces from different areas (regional, national, international) can assist one another.

6.1.2. Improvement opportunities

- Establish processes, including good recordkeeping, to handle inquest, public inquiry, and long-term scrutiny.
- Establish a co-ordinated crisis communication system/one common spokesperson.
- Establish a process for communicating radiation risk, including how units and numbers will be presented.
- Clarify and include in plans/procedures distinctions between the security of public and private properties.

- Educate workers and the public about radiation risks.
- Develop procedures to allow crime scene investigators to collect and work with collected evidence that is contaminated with radioactive material.
- Develop procedures for access control, including exceptions to access, of restricted areas.
- Implement legislation and develop procedures for handling government disruptions.
- Clarify responsibilities for costs related to the clean-up of private properties.
- Develop processes and procedures for getting contaminated material offsite (transportation infrastructure).
- Develop processes for ensuring police authority decisions and governmental officials' needs to open/keep open cities do not conflict.
- Develop safety criteria for the protection of historic buildings and monuments (structural damage due to blast, imminent danger to security force, etc.).
- Clarify the legal aspects of prohibiting entry to the restricted area.

7. Information sharing, communication and notification

Information and the means by which it is shared, co-ordinated and used are critical for successful response to all phases of an emergency. Information needs to be correct, truthful, and timely; it needs to be provided in a way that avoids confusion or putting people at additional risk; and it needs to cover the basic needs of the audience, including technical experts and decision-makers. It was noted that if people understand the risks they are more inclined to accept the advice provided.

The information, communication, and notification sharing processes identified during the INEX-4 exercises are discussed below. Some related good practices and improvement opportunities are also highlighted.

7.1. Information and communications

Within the scope of INEX-4, information about the emergency was communicated to people living in, working in, or travelling through the affected area, the general public and neighbouring countries. Notification practices and in-place emergency communication processes varied across countries, as did the application of various communication methods/tools. Countries typically identified the organisation(s) responsible for ongoing communications to keep the public informed. Communication processes often reflected the implementation of rigorous contingency arrangements, methods used to reassure the public, systems to inform the public about the status of displaced persons, and awareness of the international nature of communities. Consideration of political aspects when formulating messages was not consistent (ranging from always carefully considered to not considered at all).

Methods identified for emergency information and communication exchange included news, press conferences and releases, TV, radio, loudspeakers, internet, information and call centres, national answering phone service, website, e-mail, and a special delivery system. In some cases, messages had pre-identified phase-specific information for the event status and protective actions. In another case a question and answer format was identified for sharing information about the situation and public health and other information. In other cases, communication strategy and press releases were developed during the exercise. Delivery of the information was co-ordinated, typically through a single source. The need for multilingual information was identified.

Additional information and communication systems were identified to assist displaced persons. Those systems included regular updates and briefings to the public by local authorities, and the use of megaphones, electronic siren loudspeakers, help lines/hotlines, dedicated phone lines, and teletext. The need to protect personal data was identified in relation to publishing affected persons locations.

7.2. International assistance and co-ordination

The process of accepting offers of assistance from the international community was discussed. In general, the assistance offered would be evaluated and, if determined necessary, would be accepted using established frameworks (Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, bilateral agreements, etc.). In addition, considerations for requesting international assistance were discussed and

the established frameworks were primarily used for accepting offers of assistance. Requested assistance included experts in surface decontamination; different decontamination agents and the treatment of these decontamination products, e.g., water; dose reconstruction; monitoring teams; medical personnel; and remediation expertise.

Decisions to consult with and/or inform other countries about protective action implementation were discussed. In general, basic protective action information would be shared using many of the same frameworks listed above. In some cases, neighbouring countries would have access to radiological information through a password-protected web platform. One country stated that because protective actions are considered an early phase activity, there would be little to no likelihood for consultation. Guidance documents (such as IAEA, ICRP and EC) were identified as resources. Implications for the international community included the need to issue a proclamation to foreign visitors to check radiation contamination and to accomplish decontamination; a restriction on export of goods produced in the affected area; transportation disruptions between countries; and impacts on embassies and consulates.

7.3. Lessons learnt

Good practices and opportunities for improvement were identified as a part of the reviewers' assessment. The reviewers were tasked with identifying these practices whether they were from a single country exercise or reported by many countries as common experiences; the good practices identified were as listed below.

7.3.1. Good practices

- Exercise players provided the affected population with information pertaining to its protection as promptly as possible.
- Many of the larger corporations have contingency plans in place so they can continue operating from alternative premises.
- Positive public perception of risk and communication of risk may even be more effective than the "hard science" data (numbers are less convincing than the public's trust in the person delivering the information).
- It helps to have established "crisis" information teams that are able to provide a surge capacity, have spokesperson training, and have the ability to translate technical briefs into layperson language that is easy for the public to understand.
- To instil public trust and confidence, the information policy must be transparent, timely and exhaustive.
- Risk maps of affected areas were provided along with the information.
- Bilateral contacts were established with several cities.

7.3.2. Improvement opportunities

- Establish a co-ordinated information/communication system, including identification of roles and responsibilities, for radiological emergencies and terrorist situations.
- Translate highly technical information into messages that can be understood by the general public.
- Establish processes to ensure emergency information can be shared in multiple languages.

- Design a system to cope with the flood of queries that would ensue after a RDD attack.
- Ensure bilateral agreements include response to radiological emergencies, not just natural disasters.
- Develop a clear emergency response communications strategy for effective resource management.
- Consider/plan for impacts on international interests from questions regarding the safety of foreign delegations visiting the country.
- Ensure measuring the public reaction to information products using modern technology.
- Consider acts of terrorism, such as an RDD explosion, when developing security-related information-sharing protocols.
- Consider psychological and media implications no matter how low the actual effects might be.

8. Radiological management

Radiological management addresses protection from radiation, including information directly related to the radiological aspects of the INEX-4 scenario. Most countries used radiological modelling software for characterisation of the radiological situations and their impacts and to provide maps to participants and decision makers. Radiological management takes into account radiation monitoring and assessment needs, decontamination activities, and waste management, as discussed in the following sections, along with the criteria and basis for actions. Some good practices and improvement opportunities are also highlighted.

8.1. Monitoring and assessment

Participating countries identified the organisations responsible for monitoring and assessment of radiation. Management of monitoring teams was identified as an area of improvement for one country. In general, after the initial phase of the event the monitoring teams/personnel were integrated into the continuing phases as their dose levels allowed.

The exercise participants were given contamination information in the form of maps, charts, pictures, reports, and verbal descriptions to aid in their response to the exercise scenario. Radiological dispersion modelling and related software, such as HPAC5, LandScan, NAME III, HOTSPOT, CIPREGIS, IXP, ARGOS, RODOS, GIS, NARAC, or JRODOS, was identified for use in developing the contamination data and related information. Some countries experienced difficulties with obtaining and using radiological characterisation products, and with the lack of decision-maker familiarity with them. Characterisation of the radiation contamination was based on the level of contamination in terms of the activity and dose rates present in an area. The level of contamination was determined, in most cases, by on-the-ground first responders or radiological workers using portable detectors. In other cases onsite detection and sampling (direct readings, regional and road contamination, aerosol activity, smears/swabs, environmental sampling and analysis) were used to determine the level of contamination. International guidelines issued by ICRP, IAEA, OECD/NEA, NATO, and other national guidelines were identified as resources for monitoring and assessment strategies. In some cases, radiological information was made available to external organisations. It was also noted that an international system of data collection and evaluation should be used to ensure good data quality and interpretation. Information and instructions regarding monitoring were disseminated using established communication channels.

To control the spread of contamination, areas around the event scene were cordoned off and decontamination check points were established. Decontamination control points were also established for evacuees and the public. Some countries also addressed the need to consider extending the cordoned-off area due to inadvertent spread of contamination. Loss of contamination control was identified as affecting a hospital and being present outside a cordoned-off area. Long-term monitoring of these cordoned-off areas is needed for ongoing hazard analysis and risk assessment, and was to be carried out until recovery levels were achieved. In order to have a swift return to normality, specific priority monitoring and long-term monitoring were given to critical infrastructure areas such as drinking water, transportation networks, utilities, sewage, and hospitals.

8.2. Decontamination

Contamination of heating, ventilation, and air conditioning systems in office buildings were dealt with by decontamination or replacement and disposal at designated radiological waste facilities. A focus on preventing contamination of pumping stations was identified by one country. In the event of the contamination of city water-pumping stations, some countries would reroute drinking water or use a closed-loop supply. Storage and disposal of the contaminated water was also observed to be an issue, as well as the need to have follow-up control and monitoring. Procurement of and payment for rented, subsequently contaminated, private industry equipment was discussed, but not all countries would use private equipment.

8.3. Lessons learnt

Good practices and opportunities for improvement were identified as a part of the reviewers' assessment. The reviewers were tasked with identifying these practices whether they were from a single country exercise or reported by many countries as common experiences; the good practices identified were as listed below.

8.3.1. Good practices

- A set of standard operating procedures and a Technical Guidance Document was produced to assist in the production of sampling plans and for undertaking sampling and analysis.
- Neighbouring countries could access all the information they need via the established central electronic situation display.
- A limited number of high-volume air samplers located across the country could provide reassurance that radioactive materials had not dispersed to other countries.
- Several federal departments have agreements with their international partners to share information about specific topics.
- A monitoring station was set up outside the national airport for departing travellers.

8.3.2. Improvement opportunities

- Establish better atmospheric dispersion modelling capabilities for urban environment.
- Establish better data communication processes/systems between provincial and federal groups.
- Define what and when military support capabilities would be available to support emergency response.
- Establish an international system of data collection, evaluation, and presentation materials/format for radiological monitoring information that will be provided to decision-makers.
- Establish a unified approach to sharing additional information at the international level.
- Strengthen contamination control processes/procedures.
- Establish/strengthen processes for managing monitoring teams, including controlling dose limits as they relate to labour periods.
- Develop/strengthen procedures for handling contaminated water-pumping facilities.
- Develop rules/procedures for the recovery phase.

9. Planning and recovery

This section considers the planning requirements for recovery and the mitigating actions such as decontamination, clean-up, and recovery management, including sheltering and relocation activities, and stakeholder involvement. From the questionnaires received from participant countries, it should be noted that not all countries addressed these elements of the INEX-4 exercise in depth and in some cases they were specifically excluded from the exercise play. Where indicated the criteria used and the basis for mitigating actions that would be required are identified. An assessment of the responses to the challenges posed and the experience reported by the participant countries has allowed some good practices and further improvement opportunities to be highlighted.

9.1. Decontamination and waste management

The decontamination and generic clean-up issues related to allowing people back into areas from which they were excluded were identified as being both technical in nature coupled with over-arching political implications and economic considerations. Decontamination practices and the residual dose rate levels that were deemed acceptable for releasing affected areas were discussed and included the following:

- not using specifically identified criteria (developed for RDD in an urban environment);
- using international dose limit recommendations;
- using established national dose limits;
- bringing the affected area back to "green field" status.

Some specific values mentioned by the INEX-4 participant countries were as follows:

- a limit of 10 mSv/1 month period (from irradiation & ingestion pathways);
- residual dose from all pathways <1 mSv/year;
- dose rates in the decontaminated area should not give significant contribution to dose received from the natural background (up to 0.3 μGy/h above the background level);
- below 4 Bq/cm^2; residual dose of 0.1 mSv/y;
- use the reference level recommendation value for protective actions, which is 20 ~ 100 mSv effective dose; effective annual dose limit (1 mSv); and effective dose 1 mSv/year.

Decontamination techniques and clean-up activities that were considered by the participants included:

- washing (with water);
- vacuuming;
- sweeping and scraping;

- changing filters;
- removing soil and vegetation;
- covering surfaces;
- removing explosion wastes;
- decontaminating personnel.

It was mentioned that decontamination methods would be based on experience from previous events that resulted in wide-spread contamination, and an example quoted was the Litvinenko poisoning incident in 2006. In addition, the decontamination arrangements would be developed based on the environmental monitoring and hazard assessment of the existing situation. However, it was noted that there may be occasions where the technical basis for the decontamination techniques may have been made but the political considerations involved may override the technical case.

Decontamination costs for publicly-owned buildings and property were generally identified as being the responsibility of the local and/or the federal government but there was a clear distinction that the owners/proprietors of privately-owned buildings and property were generally identified as having this responsibility. It was noted that in many of the participant countries that standard insurance policies were unlikely to cover the claims for decontamination and clean-up for private individuals and companies.

Participating countries identified many competing factors that would drive the clean-up levels and mitigating actions to be established during the transition phase. Dose reduction was considered the primary factor identified along with others such as long-term reputation, health risks, costs, management of waste, public tolerance, socioeconomic importance, stakeholders, technology, and political decisions. A common feature was that the decision-making processes were typically conducted by appointed committees or councils that were made responsible for final decisions. Unsurprisingly, no specific cost value was identified for clean-up, but it was noted that the cost impacts would be likely to overwhelm the resources of the local authorities and payments for terrorist-related events would be unlikely to be covered by insurance or country funding rules. In some cases, it was noted that the clean-up costs would be weighed against the residual value of the contaminated items and that decisions could be made not to decontaminate some items.

In general, it was clear that all INEX-4 participants determined that there would be a large quantity of waste materials. Event-related waste types were identified as:

- explosive remnants and debris;
- radioactive;
- vehicles;
- household;
- office equipment;
- building and property debris;
- soils;
- market commodities;
- water and materials used for decontamination;
- environmental samples.

Many countries referenced the use of computer-based software tools that would be used to provide estimates of waste volumes. Scenario specific calculations and pre-

existing information were identified as requirements for estimating waste quantities using these tools.

Protocols that clearly allocate the responsible organisations and processes required for securing, handling, and disposing of emergency-related contaminated materials were also identified. Participants provided descriptions of the waste facilities that would be used included existing facilities, temporary sites, engineered solutions, and natural barrier sites. In some cases, countries noted that the plans for the management of radioactive waste would need to be developed on an 'ad hoc' basis owing to the restrictions of the urban geography or other location-specific factors. Arrangements for the handling and disposal of emergency-related contaminated materials varied across the responses received from INEX-4 participants. In some cases there were no specific changes to existing technical arrangements while in other cases the need for special solutions for handling and storage was identified. Several methods for managing contaminated runoff water were identified, including:

- sampling and monitoring;
- surveying;
- capture;
- dilution;
- use of a retaining walls/bunds;
- run-off into rivers or other natural water courses, e.g. fiord.

9.2. Recovery management procedures and stakeholder involvement

The organisations involved and processes required for terminating the emergency response phase and transitioning to recovery were discussed during the exercise and reported by the participating countries. It was noted that not all countries have pre-defined criteria for terminating the emergency response. It was recognised that technical aspects, economic considerations and political factors were identified as key requirements in the decision-making process to terminate the response and move into the transition to recovery. The reduction of radioactivity to levels below those specified by national regulations and the withdrawal of protective measures and on-going clean-up activities were discussed with regard to the transition to long-term recovery. It was also recognised that a systematic and co-ordinated clean-up was necessary in order not to re-contaminate cleaned areas.

Long-term recovery issues included many of the topics reported on earlier in this document such as:

- public health;
- socioeconomic impacts;
- environmental monitoring;
- decontamination.

Additional considerations were also identified, as follows:

- radioactive waste costs related to collection and storage;
- fear and anxiety of evacuees associated with moving back into their homes;
- fear of workers involved in the recovery actions concerning their own safety;
- on-going air monitoring activities such as fixed monitoring stations;

- plans, and responsible organisations;
- exclusion zones for areas that cannot be decontaminated.

In some cases, national task forces, committees, and stakeholders were identified to support long-term recovery. Local stakeholders would be briefed on the situation, their concerns would be addressed, and their involvement was recognised as an important political element of final decision-making. The key groups and committees that needed to be established for long-term recovery were identified as crisis management, contaminated water treatment, public information, and technical working teams. They were identified as being either established or convened in an "ad hoc" manner. Functional requirements of the group and committee management included processes for resolving disagreements such as discussion, adjudication, mediation, and the use of designated people or other groups charged with making the final decision.

During the INEX-4 exercises, the discussion of sheltering requirements included how to handle over-crowded shelters and relocation of guests and foreign travellers. Opening additional shelters, learning from previous events (Litvinenko poisoning incident and Goiânia radiological accident), re-uniting families and relatives, identifying organisations responsible for managing shelters and relocation, requesting additional support, and registering and monitoring evacuees were all identified by the participants as sheltering-related actions. Other actions identified for the relocation of guests and foreign travellers included:

- finding suitable alternative accommodation;
- performing early and later phase monitoring of guests/visitors;
- providing briefings to all embassies and consulates;
- providing an assessment of contamination to foreign nationals;
- making arrangements for foreign visitors to leave the country;
- determining how to handle the loss/destruction of documents/passports;
- translation of emergency information for foreign visitors.

The issues regarding long-term re-location and re-housing and other "way of life" issues were also discussed by some countries. It was noted that specific plans were not prepared in advance in most cases, but the processes and likely requirements were discussed. The key issues identified included the accommodation needs and its limitations, the reluctance of people to return, the disposal of animals, pets and livestock, and the use of pre-existing plans for conventional emergencies.

The decision to demolish contaminated structurally sound buildings was, in most cases, acknowledged to be the property owner's responsibility. The processes for disposal of contaminated belongings included the need for instructions to the public to submit their belongings at a specified location, a system of registering the personal belongings, a system for disposing of contaminated articles, use of established waste management procedures, and a defined level of contamination for disposal.

Commercial organisations and other businesses that were affected by the incident both within and outside the contaminated area could need the following:

- decontamination assistance or re-assurance monitoring;
- a media campaign to urge people to return to work;
- significant stakeholder collaboration;

- along with pre-existing national policies or the development of them on an "ad hoc" basis for handling damage/losses because, in most cases, there is a lack of insurance coverage for terrorist attacks.

Only one INEX-4 participant country identified that an insurance organisation is in place for terrorist events.

It was generally noted that in the long-term financial costs were the primary focus. Cost-related discussions included the role of government (local, regional, national and international), private low-interest loans, relief contributions, and the fact that it will take a long time to fully resolve cost issues.

9.3. Lessons learnt

Good practices and opportunities for improvement for the transition to recovery phase were identified as a part of the INEX-4 exercise assessment. The key findings from the questionnaires are listed below.

9.3.1. Good practices

- Locality-specific data, made available from the city (area, etc.) were used for modelling/calculating the projected contaminated levels and volume of materials from the affected area.
- Radiation protection instructions were provided to workers handling the waste.
- Deployment of task force(s) was considered to ensure co-ordination when emergency situations/organisations are terminated.
- A database of stakeholders was established that includes expertise/function, technical equipment, capacities, pre-prepared agreements, etc.
- Trained volunteers, authorised to perform specific activities, were used.
- Information and education campaigns were discussed and implemented.
- Businesses and city institutions had established contingency arrangements.
- Fixed-point monitoring stations were in place across the country.
- Personnel monitoring facility was set up outside the national airport for departing travellers.
- Develop "clean" certificates to provide to the authorities.
- A small number of whole body monitors were set up and operated to provide reassurance to the public and the emergency workers.

9.3.2. Improvement opportunities

- Develop plans/procedures/processes for items identified as not being currently in place, such as operational intervention levels; legal criteria; pre-defined numerical values for urban area, building, and environment decontamination levels ("how clean is clean?" concept); guidelines, policies, or legislation governing compensation for costs related to deliberate acts of terrorism (including insurance company responsibilities); tools for estimating the amount of contaminated materials and related costs; animal welfare procedures; stakeholder involvement and training for response to radiological events; a mass casualty plan related to contaminated victims; management of significant amounts of contaminated wastes; and criteria for ending the emergency situation.

- Develop procedures for the preparation and use of "clean" certificates to be provided to the public for their possession to be released by the authorities.
- Plan for the replacement of documents/passports in case of their loss or destruction.
- Ensure a clear understanding of how emergency activities interface between local, regional, national, and international authorities in response to a terrorist RDD (policies, plans and procedures).
- Address public concerns regarding radioactivity in the environment and how to communicate emergency information in a way that promotes trust and understanding, including psychosocial aspects.
- Develop a well-defined system of prioritising actions in the face of local or other pressures.
- Develop emergency procurement processes (private vs. government, renting, internationally) for obtaining additional resources (equipment, dosimeters, laboratory services, etc.).

10. Termination of actions/countermeasures

This section considers the requirements for termination of protective actions and countermeasures. From the questionnaires received from participant countries, it should be noted that all countries addressed these elements of the INEX-4 exercise in depth.

The INEX-4 participants reported that organisations with the responsibility for advising on the withdrawal of protective actions and countermeasures (and under the specific national guidance) were identified. In most cases, the withdrawal of protective actions was based on pre-defined criteria, including dose levels needing to fall within the applicable national regulatory or legislative guidelines. Protective actions could also be terminated based on emergency response measures being met, and, in some cases, because protective measures could cause more harm than the actual risk. Only one country identified "returning [the affected area] to a green field" as a goal for its protective actions. Another country identified, the as low as reasonably achievable (ALARA) principle for clean-up activities.

The communications requirements between national and local governments and affected stakeholders regarding the termination of the emergency response and the withdrawal of protective actions include a number of approaches, such as making stakeholders a part of the decision-making process and using previously established communications systems and mechanisms. Subjects identified for communication by the authorities to stakeholders and affected individuals included:

- the shelter and relocation process, including reduction of evacuation and shelter-in-place zones;
- alternate means of conducting school classes;
- potential health impacts;
- ensuring safe food and water supplies;
- handling contaminated or potentially contaminated goods, materials, waste, etc.;
- potential health impacts;
- compensation.

Compensation claims and costs that were discussed by the INEX-4 participants included food, feed and agricultural control; medical services; radiation health effects; evacuation and relocation; decontamination; and costs defined by national policy. It was noted that costs and the tracking of costs related to the Chernobyl accident were not undertaken until later in the event using procedures that had been developed for normal situations.

Discussions regarding the maintenance of documentation and emergency records indicated that all countries recognised that essentially all emergency-related records should be kept for long periods. Types of emergency-related documentation to be captured and archived included:

- radiological and other surveys and measurements;
- financial records;

- resources used and workers involved;
- medical records;
- criminal investigation reports;
- information on emergency response and recovery measures related to RDDs;
- plans, maps, geographical information systems;
- details of legal entities involved in rescue and protective actions;
- recordings of video conferences;
- log books.

Only one country identified an especially designed crisis communication web space for archiving incident response documentation.

10.1. Lessons learnt

Good practices and opportunities for improvement for the termination of protective actions and countermeasures were identified as a part of the INEX-4 exercise assessment. The key findings are listed below.

10.1.1. Good practices

- Approaches to termination and withdrawal of various protective actions were included in national planning guidance.
- All public administration sectors were given a task to explore all the financial and economic consequences of an RDD event in an urban environment.

10.1.2. Improvement opportunities

- Establish clear channels of communication and information routes between authorities and the private sector.
- Establish well-defined guidelines, policies, or legislation governing compensation for costs for acts of terrorism.
- Improve information management procedures for control and archiving of records for these kinds of events.

11. Conclusions

Participating countries welcomed the opportunity offered by the OECD/NEA and the INEX-4 series to exercise their nuclear and radiological preparedness and their response capabilities. Many countries also recognised that these exercises in the nuclear and radiological field are useful for their national emergency preparedness and response capabilities in general.

The themes that emerged from the information gathered, assessed, and presented in the previous sections are listed below. These themes could act as a potential focus for a future international workshop organised by the WPNEM. Each theme and the associated general questions (representing a sample of the discussion points assembled from questionnaire responses) are presented in a bulleted list format for quick reference and consideration. In many cases, the issues are cross-cutting and may be reflected under more than one theme. While many of the questions below are similar to those in the evaluation questionnaire, they are nonetheless designed to invoke further thought and action. They are not all inclusive, however, and should not be considered applicable to all countries across all situations.

In addition to the general themes, one country proposed the following question for future action and consideration.

Given that some countries completed their tabletop/workshop discussions after the events of the March 2011 East Japan Earthquake, it is possible that responses and interdepartmental connections may have changed drastically. Is there a method to reflect that occurrence and/or did other countries feel more prepared to respond to the March events due to the tabletop/workshop? Several Canadian department participants, for example, felt that they were better connected and knew who to call during the Japan emergency as a result of the connections established or re-established during the exercise.

Norway conducted its INEX-4 exercise as part of a larger national exercise in November 2010 with a RDD scenario in downtown Oslo. About eight months later a bomb was detonated in the same area killing eight people and destroying most of the government buildings only 800 meters away from where the INEX-4 scenario was conducted. The bomb contained no radioactive materials, but the lessons learnt from the exercise a few months earlier were considered useful in the response to a real event. This supports the view that the INEX-4 exercises not only strengthen the response capabilities to nuclear or radiological events, but contribute to strengthening the overall response capabilities of states across the spectrum of scenarios.

Plans and procedures specific to RDD in an urban environment

- What plans or procedures need to be developed or could be improved?
  - contingency plans;
  - mass casualty;
  - decision-making in the face of professional differing opinion;
  - optimisation strategies.

- How are existing international guidance/policies used/implemented?
- How are private businesses/customers factored into local emergency response actions?
- How do response emergency preparedness policies, plans, and procedures ensure that private, public, local, regional, national, and international processes are integrated?

Technical scenario

- How can the complexity of the scenario be minimised?
- What is the process for countries to adjust the basic exercise packet?
- What additional information regarding RDD and radiation effects could have been included in the exercise packet?
- How can questionnaire be made clearer/less ambiguous?
- How can scenario data be validated before it is used for an exercise?
- What background information is needed for exercises that start in later emergency phases?

Radiological management

- What exposure control processes are in place and how are they implemented?
- What contamination control processes are in place and how are they implemented?
- What processes are in place to handle public requests for verification that decontamination/clean-up has been completed?
- What decontamination values and processes/resources are in place and how are they implemented?
- How clean is clean?
- What contaminated water and sewage control processes are in place?
- What information regarding RDD and radiation effects are included in plans, procedures, training?

Safety and security

- What is the process for crime scene security, including release of the crime scene?
- What processes are in place for sheltering people, pets, and livestock?
- How is potentially contaminated forensic evidence collected and handled?
- What cordoning processes/practices, including access control, are in place and how are they implemented?

Technological resources

- How is the issue of limited radiological equipment, modelling, lab, and technical expertise handled?
- What processes/procedures are in place for integration of equipment when there are different types, different units, and different protocols?

- What data collection and assessment processes are in place?
- What technological resources are available from military sources and how is their assistance obtained?

Communications

- How are public perceptions factored into communications processes?
- What processes are in place to handle rumours and ensure the validation of information?
- What psychosocial aspects are considered in communication processes, especially as they relate to evacuation (pets, photos, family) and perceived vs. actual risks?
- What information is shared and when? With whom (locally [schools], nationally, internationally [consulates/delegations])? How is it shared?
- How is the single communicator process implemented and how does it work for providing information locally? Nationally? Internationally?
- What processes are in place to explain/educate people about radiation risks? To authorities? The public? Visitors and guests? Others?
- What processes are in place to handle the security of sensitive information or explain technical information?
- What processes are in place to handle multilingual/translation communication needs?

Costs

- How are competing resources handled (private contracting vs. government contracting)?
- What role do insurance companies play in nuclear, radiological, terrorist-related events? If they play no role, should they?
- What processes are in place for government, private, local and national payment/funding/ compensation responsibilities as they relate to a terrorist event?
- What processes are in place for international resources and how are they implemented?

Decision-making

- What information do decision-makers need to do their jobs effectively and efficiently?
- What laws/regulations (including lawyer involvement) are in place to support/provide guidance to decision-makers? For example:
  - establishment of registries;
  - historic building protection;
  - how clean is clean for radiation contamination levels to return to “normal”?
- What processes are in place for requesting/accepting international help and how do the local needs factor into the process?
- How is the recovery to normal phase handled?
  - committees;

  - experts;
  - consensus;
  - alternative opinion resolution process;
  - opening of previously closed areas (private and business).
- How well do decision-support tools align with decision-maker needs?

Stakeholders

- What processes are in place for initiating stakeholder involvement after the crisis phase in emergency response, including terrorist events? How are they identified? What training/expertise do they need?

Transition to recovery/post-accident

- What processes are in place to transition from emergency to recovery and from recovery to "normal"? How are they implemented?
- What happens when controls are lifted for re-entry? What process is in place for an orderly transition?
- How is decontamination handled when it continues to be required past the recovery phase?
- What advisory committees/people would be needed for recovery and transition to "normal"?
- What processes are in place for long-term recovery actions?
  - registries (decontamination/health/property);
  - record retention;
  - psychological impacts;
  - waste management and storage.

Appendix 1: Selected bibliography

INEX series documents

NEA (2011), *Practices and Experience in Stakeholder Involvement for Post-nuclear Emergency Management*, OECD, Paris.

NEA (2010), *Strategic Aspects of Nuclear and Radiological Emergency Management*, OECD, Paris.

NEA (2007), *Strategy for Developing and Conducting Nuclear Emergency Exercises*, OECD, Paris.

NEA (2007), *Experience from the Third International Nuclear Emergency Exercise (INEX3) on Consequence Management*, OECD, Paris.

NEA (2005), *INEX-2000 Exercise Evaluation Report*, OECD, Paris.

NEA (2003), *Indemnification of Damage in the Event of a Nuclear Accident*, OECD, Paris.

NEA (2003), *Short-term Countermeasures in Case of a Nuclear or Radiological Emergency, OECD*, Paris.

NEA (2001), *Experience from International Nuclear Emergency Exercises: The INEX-2 Series*, OECD, Paris.

NEA (2001), *Second International Nuclear Emergency Exercise INEX 2: Final Nuclear Energy Agency (NEA), Report of the Canadian Regional Exercise*, OECD, Paris.

NEA (2001), *Second International Nuclear Emergency Exercise INEX 2: Final Report of the Hungarian Regional Exercise*, OECD, Paris.

NEA (2000), *Monitoring and Data Management Strategies for Nuclear Emergencies*, OECD, Paris.

NEA (2000), *Second International Nuclear Emergency Exercise INEX 2: Final Report of the Finnish Regional Exercise*, OECD, Paris.

NEA (1998), *Second International Nuclear Emergency Exercise INEX 2: Final Report of the Swiss Regional Exercise*, OECD, Paris.

NEA (1998), *Nuclear Emergency Data Management*, OECD, Paris.

NEA (1997), *Agricultural Aspects of Nuclear and/or Radiological Emergency Situations*, OECD, Paris.

NEA (1995), *The Implementation of Short-term Countermeasures after a Nuclear Accident (Stable Iodine, Sheltering and Evacuation)*, OECD, Paris.

NEA (1995), *INEX 1: An international Nuclear Emergency Exercise*, OECD, Paris.

INEX-4 technical materials

NEA (2009a), "INEX 4: General Information", NEA/CRPPH/INEX(2009)6.

NEA (2009b), "INEX 4: Guidance for National Planning Committees", NEA/CRPPH/INEX(2009)7.

NEA (2009c), "INEX 4: Guidance for Exercise Players", NEA/CRPPH/INEX(2009)8.

NEA (2009d), "INEX 4: National Evaluation Questionnaire", NEA/CRPPH/INEX(2009)9.

Appendix 2: INEX-4 preparation group membership

INEX-4 exercise development/planning

Canada	AUCLAIR, Jean Patrice DUCHESNE, David
France	CAAMANO, Delphine CESSAC, Bruno MEHL-AUGET, Isabelle
Germany	GERING, Florian
Hungary	MACSUGA, Geza
Japan	FUKUMOTO, Masahiro
Norway	HOLO, Eldri Naadland UGLETVEIT, Finn
United Kingdom	GRIFFITHS, Mike
United States	BREITINGER, Mark HEINRICH, Ann MCCLELLAND, Vincent
OECD Nuclear Energy Agency	AHIER, Brian LAZO, Ted

INEX-4 summary record preparation

Canada	AHIER, Brian
Hungary	MACSUGA, Geza
Norway	UGLETVEIT, Finn
United Kingdom	GRIFFITHS, Mike (Chair)
United States	HEINRICH, Ann MCCLELLAND, Vincent MCINTURFF, Sandi
OECD Nuclear Energy Agency	KAWABATA, Masanori LAZO, Ted OKYAR, Halil Burçin

NEA PUBLICATIONS AND INFORMATION

The full catalogue of publications is available online at www.oecd-nea.org/pub.

In addition to basic information on the Agency and its work programme, the **NEA website** offers free downloads of hundreds of technical and policy-oriented reports.

An **NEA monthly electronic bulletin** is distributed free of charge to subscribers, providing updates of new results, events and publications. Sign up at www.oecd-nea.org/bulletin/.

You can also visit us on **Facebook** at www.facebook.com/OECDNuclearEnergyAgency.

Follow us on **Twitter** @OECD_NEA.

OECD/NEA PUBLISHING, 2 rue André-Pascal, 75775 PARIS CEDEX 16