IAEA Report on

Assessment and Prognosis in Response to a Nuclear or Radiological Emergency

International Experts Meeting
20–24 April 2015, Vienna, Austria

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International Atomic Energy Agency

IAEA REPORT ON ASSESSMENT AND PROGNOSIS IN RESPONSE TO A NUCLEAR OR RADIOLOGICAL EMERGENCY

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INTERNATIONAL EXPERTS MEETING
VIENNA, 20–24 APRIL 2015

Organized in connection with the implementation
of the IAEA Action Plan on Nuclear Safety

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2015

Printed by the IAEA in Austria
September 2015
IAEA/IEM/IX

FOREWORD

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In response to the accident at the Fukushima Daiichi nuclear power plant, IAEA Member States unanimously adopted the Action Plan on Nuclear Safety. Under this Action Plan, the IAEA Secretariat was asked to organize International Experts Meetings to analyse all relevant technical aspects and learn the lessons from the accident. The International Experts Meetings brought together leading experts from areas such as research, industry, regulatory control and safety assessment. These meetings have made it possible for experts to share the lessons learned from the accident and identify relevant best practices, and to ensure that both are widely disseminated.

This report on Assessment and Prognosis in Response to a Nuclear or Radiological Emergency is part of a series of reports covering all the topics dealt with in the International Experts Meetings. The reports draw on information provided in the meetings as well as on insights from other relevant IAEA activities and missions. It is possible that additional information and analysis related to the accident may become available in the future.

I am grateful to all the participants in the meeting for their valuable input. I hope that this report will serve as a valuable reference for governments, technical experts, nuclear operators, the media and the general public, and that it will help to strengthen emergency preparedness for a nuclear or radiological emergency.

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1. INTRODUCTION

Following the accident at TEPCO's Fukushima Daiichi nuclear power plant (the Fukushima Daiichi accident), the IAEA Director General convened the IAEA Ministerial Conference on Nuclear Safety in June 2011 to direct the process of learning and acting upon lessons to strengthen nuclear safety, emergency preparedness and radiation protection of people and the environment worldwide. The Conference adopted a Ministerial Declaration on Nuclear Safety, which, inter alia, requested the Director General to prepare a draft Action Plan.[1] The draft Action Plan on Nuclear Safety (the Action Plan) was approved by the Board of Governors at its September 2011 meeting.[2] On 22 September 2011, the IAEA General Conference unanimously endorsed the Action Plan, the purpose of which is to define a programme of work to strengthen the global nuclear safety framework.

The Action Plan includes 12 main actions; one of the actions is focused on communication and information dissemination, and includes six sub-actions, one of which mandates the IAEA Secretariat to "organize international experts meetings to analyse all relevant technical aspects and learn the lessons from the Fukushima Daiichi nuclear power station accident"[3].

The IAEA Secretariat organized an International Experts Meeting (IEM) on Assessment and Prognosis in Response to a Nuclear or Radiological Emergency, held from 20 to 24 April 2015, at IAEA Headquarters in Vienna. The meeting was attended by over 200 participants from 70 Member States and five international organizations. The participants represented governmental, regulatory, operating, research and educational bodies, Competent Authorities under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, technical support organizations and international organizations. This IEM, the ninth in the series of IEMs, was organized in response to an IAEA General Conference resolution[4] that requested the IAEA Secretariat "to continue organizing international experts' meetings on lessons learned from the Fukushima Daiichi accident,

[1] Declaration by the IAEA Ministerial Conference on Nuclear Safety in Vienna on 20 June 2011, INFCIRC/821, IAEA, Vienna (2011), para. 23.

[2] Draft IAEA Action Plan on Nuclear Safety, Report by the Director General, GOV/2011/59-GC(55)/14, IAEA, Vienna (2011).

[3] Ibid., p. 6.

[4] Measures to Strengthen International Cooperation in Nuclear, Radiation, Transport and Waste Safety, Resolution GC(58)/RES/10, IAEA, Vienna (2014).

including to address the issue of accident analysis and prognosis with the focus on possible gaps".

The overall objective of this IEM was to provide a forum for experts from Member States and international organizations to discuss issues, challenges and solutions related to the assessment and prognosis process in response to a nuclear or radiological emergency. The IEM focused on sharing information, knowledge and experience in national and international assessment and prognosis capabilities, as well as on the operational arrangements for implementation of the IAEA's assessment and prognosis process. The meeting built on and complemented discussions at earlier IEMs[5] that touched upon many of the same issues within the context of their topics.

The specific objectives of the IEM were:

— To share national experience in assessment and prognosis;
— To discuss constraints, limitations and uncertainties associated with assessment and prognosis;
— To discuss the implications of assessment and prognosis for determining public protective actions and communication strategies;
— To share the progress made in the operational implementation of the IAEA's assessment and prognosis process in close cooperation with Member States;
— To identify and discuss areas to strengthen existing assessment and prognosis tools and capabilities;
— To discuss future prospects in the development of tools and capabilities for assessment and prognosis and in implementation of assessment and prognosis at the international level.

The large number of experts participating in the IEM underlined the importance that the international nuclear community places on assessment and prognosis during a nuclear or radiological emergency. The IEM featured expert presentations from keynote speakers and panellists, and provided opportunities for discussion, during which the participants shared their experience and identified lessons learned. A Chairperson's Summary of the meeting was produced (see Annex A).

[5] The International Experts Meeting on Enhancing Transparency and Communication Effectiveness in the Event of a Nuclear or Radiological Emergency, held 18–22 June 2012, in Vienna, Austria, and the International Experts Meeting on Strengthening Research and Development Effectiveness in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, held 16–20 February 2015, in Vienna, Austria.

1.1. BACKGROUND

The Fukushima Daiichi accident underscored the importance of having in place robust arrangements to effectively respond to a nuclear or radiological emergency. The Action Plan expanded the IAEA Secretariat's response role in an emergency at a nuclear power plant to cover the need "to provide Member States, international organizations and the general public with timely, clear, factually correct, objective and easily understandable information during a nuclear emergency on its potential consequences, including analysis of available information and prognosis of possible scenarios based on evidence, scientific knowledge and the capabilities of Member States."[6] The IAEA General Conference further clarified[7] that the IAEA Secretariat's response role in such a context would cover all nuclear and radiological emergencies. The IAEA Secretariat's response role would not, however, replace or duplicate the mandatory national responsibilities to respond to emergencies and to protect the public and the environment from ionizing radiation.

In the light of the Action Plan, many activities in relation to this expanded response role of the IAEA have been undertaken by the Secretariat in close collaboration with Member States. The topic of assessment and prognosis was also presented in an earlier IAEA report in this series.[8]

1.2. OBJECTIVE AND SCOPE

The objective of this report is to highlight the lessons learned from the IEM on the topic of the assessment and prognosis process and to identify potential further developments in this area. The report summarizes the insights gained from presentations by keynote speakers and invited speakers, posters, panellist discussions and contributions by participants during the meeting. These insights are supplemented by experience from other relevant IAEA activities being carried out in the framework of the Action Plan.

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[6] Draft IAEA Action Plan on Nuclear Safety, Report by the Director General, GOV/2011/59-GC(55)/14, IAEA, Vienna (2011), p. 6.

[7] Measures to Strengthen International Cooperation in Nuclear, Radiation, Transport and Waste Safety, Resolution, GC(57)/RES/9, IAEA, Vienna (2013).

[8] INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on Preparedness and Response for a Nuclear or Radiological Emergency in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, IAEA, Vienna (2013).

The report summarizes the discussions and conclusions of the IEM, which identify key areas where the assessment and prognosis process could be further developed and strengthened worldwide. It is expected to contribute to the ongoing efforts to improve assessment and prognosis capabilities and to encourage the establishment of a unified information exchange process, which would benefit those authorities in Member States performing assessment and prognosis by allowing them to obtain technical information, share insights, compare results and synchronize public messaging during a nuclear or radiological emergency. The report presents the experts' views on steps needed to support the IAEA in defining the objectives, process and limitations with regard to analysis of available information and prognosis of the possible consequences of a nuclear or radiological emergency.

2. OVERVIEW OF ASSESSMENT AND PROGNOSIS

Lessons Learned: There is a need for a common understanding of the assessment and prognosis process and for harmonization of the associated methodologies to ensure the production of consistent and reliable information for decision makers and the public.

The objectives of the actions taken in response to a nuclear or radiological emergency[9] are:

— To regain control of the situation and to mitigate consequences;
— To save lives;

[9] PREPARATORY COMMISSION FOR THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY ORGANIZATION, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL CIVIL AVIATION ORGANIZATION, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, INTERPOL, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, WORLD METEOROLOGICAL ORGANIZATION, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7, IAEA, Vienna (in preparation).

— To avoid or minimize severe deterministic effects[10];
— To render first aid, provide critical medical treatment and manage the treatment of radiation injuries;
— To reduce the risk of stochastic effects[11];
— To keep the public informed and to maintain public trust;
— To mitigate, to the extent practicable, non-radiological consequences;
— To protect, to the extent practicable, property and the environment;
— To prepare, to the extent practicable, for the resumption of normal social and economic activity.

Achieving these objectives requires informed decision making based on a sound understanding of the emergency situation and the ability to predict further developments. The assessment and prognosis process is an important part of the strategy for realizing these objectives.

In a nuclear or radiological emergency, effective communication is essential to support decision makers in understanding the situation and to ensure that they have sufficient actionable information to enable them to protect people and the environment. The challenges associated with the assessment and prognosis process can compromise effective communication. One of these challenges relates to the approach adopted for assessment and prognosis, which can range from simple means of assessment to sophisticated computer based approaches. The differences in the complexity of these approaches can generate divergent results. In addition, possible limitations of available technical data during an emergency may add to the uncertainties associated with any assessment or prognosis.

Communication with the public in a nuclear or radiological emergency is improved when information and advice on, for example, protective action recommendations are harmonized. Consequently, the development of an assessment and prognosis methodology requires the involvement of all relevant stakeholders. To that end, the IAEA Secretariat and Member States have been developing predetermined sets of key technical parameters for nuclear power plants (dynamic data) and fixed characteristics of nuclear power plants

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[10] A deterministic effect is a health effect of radiation for which generally a threshold level of dose exists above which the severity of the effect is greater for a higher dose.

[11] A stochastic effect is a radiation induced health effect, the probability of occurrence of which is greater for a higher radiation dose and the severity of which (if it occurs) is independent of dose.

(static data)[12] that would be sufficient for a third party[13] to perform general assessments. The IAEA Secretariat has taken considerable steps to enhance the capabilities of the IAEA's Incident and Emergency System and the IAEA's Incident and Emergency Centre[14] to the extent necessary to fulfil the expanded response role.

During a nuclear emergency, the IAEA Secretariat's arrangements and capabilities, in conjunction with those of Member States, are used in the assessment and prognosis process. The assessment process involves an evaluation of the planned and implemented protective actions and other response actions by the 'Accident State'[15] to determine whether they are in broad compliance with relevant IAEA safety standards. The process does not replace nor duplicate any national responsibility to respond to the emergency and protect the public from ionizing radiation. The prognosis process takes the form of a bounding estimate of how an emergency may progress, based on current IAEA guidance.

At the International Experts Meeting:

Some experts considered that the understanding of assessment and prognosis was often not completely clear to all parties and that, depending on the objectives of the organization conducting the assessment and prognosis activities, the results may be very different.

To help put the definition of assessment and prognosis into proper perspective in terms of the IAEA's expanded response role in this area, the following definition was provided by the IAEA Deputy Director General and Head of the Department of Nuclear Safety and Security during the IEM[16]:

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[12] See Section 5 for a more detailed discussion of static and dynamic data.

[13] For the purposes of this report, the term 'third party' refers to any State or organization that is neither the 'Accident State' nor the IAEA.

[14] The Incident and Emergency System covers emergency preparedness and response arrangements and capabilities for nuclear or radiological emergencies, and consists of a warning point (24 hour communication centre), an on-call system (initial response) and an on-duty system (full response capability). The Incident and Emergency Centre serves as the focal point for emergency preparedness and response, and as the custodian of the Incident and Emergency System.

[15] The 'Accident State' is defined as the State in which the nuclear or radiological accident has occurred. This term is used throughout this report.

[16] See: FLORY, D., paper presented at the International Experts Meeting on Assessment and Prognosis in Response to a Nuclear or Radiological Emergency, Vienna, 2015; available on the attached CD-ROM.

> “The assessment and prognosis process builds on the existing international emergency preparedness and response framework and is based on the IAEA Secretariat’s capabilities, complemented by Member States’ capabilities through the IAEA Response and Assistance Network (RANET) and other arrangements. During an emergency at a nuclear power plant, our arrangements and capabilities, our guidance and tools, our expert human resources, in conjunction with the capabilities of various Member States, will be used in the assessment of possible consequences and prognosis of likely emergency progression.
>
> “The IAEA assessment is an evaluation of the planned and implemented protective actions and other response actions by an ‘Accident State’ to determine whether they are in broad compliance with relevant IAEA safety standards. The IAEA assessment does not replace neither duplicate any national responsibility to respond and protect the public, instead, it is internationally focused and based on IAEA safety standards and guidance.
>
> “Within this expanded role, a prognosis is a bounding estimate of how an emergency may progress. This will be accomplished using IAEA guidance and tools.”

The definition was further clarified during a keynote presentation by the Head of the IAEA Incident and Emergency Centre that included information on the goals, process, constraints, limitations, challenges and deliverables, and on what remained to be done.

The objectives and details of the IAEA assessment and prognosis process were shared by the IAEA Secretariat during the meeting. The principal objective of an assessment and prognosis during a nuclear or radiological emergency is to assess where and what protective and/or other response actions need to be taken by the ‘Accident State’ and to provide advice, if needed. The assessment and prognosis process builds on the existing international emergency preparedness and response (EPR) framework and is based on the IAEA Secretariat’s capabilities, complemented by Member State capabilities through the IAEA’s Response and Assistance Network (RANET) and other arrangements. In an emergency, the IAEA Secretariat will perform an assessment and prognosis based on information received from the ‘Accident State’, using its own resources and capabilities, augmented by pre-identified advanced assessment capabilities in Member States. The IAEA Secretariat will provide these Member States with input data received from the ‘Accident State’ requesting assessment of the situation and prognosis of likely progression. It is expected that Member States with pre-identified advanced assessment capabilities will register their capabilities in RANET in the preparedness stage.

The experts considered that the IAEA Secretariat was best placed to take the leading role in harmonizing the assessment and prognosis methodologies and in synchronizing the transfer of technical information to interested States or parties during a nuclear or radiological emergency. The IAEA Secretariat could act as a conduit for all Member States looking for information and could ensure that any such requests for information are made in a coordinated manner to the 'Accident State'. This would require significant efforts during the preparedness phase, both to develop the methodologies for information exchange and to provide Member States with training and build capacity to understand the IAEA assessment and prognosis methodology. Harmonization and implementation of recommended protective actions such as establishing the size of the evacuation zone and the use of operational intervention levels[17] between States will facilitate timely and clear communication with the public.

There was understanding among the experts that the assessment and prognosis process was a challenging task requiring advanced analytical capabilities and detailed information. The experts recognized the need to develop clear objectives in order to clearly define the purpose of an assessment or prognosis prior to selecting the approaches and tools to be used. Once the objectives are agreed, developing the methodologies to achieve these objectives will require the involvement of all relevant stakeholders, from those providing information to those receiving the final results of the assessment and prognosis process.

During the IEM, some common themes emerged regarding challenges to the assessment and prognosis process, including:

— Choosing the optimal approach for any organization from the wide variety of approaches to assessment and prognosis;
— Determining what data are required during both the preparedness and the response phases;
— Using potentially unreliable data owing to unknown uncertainties;
— Clearly communicating the impact of uncertainties to decision makers and the public;
— Translating technical data and concepts into plain language for informing the public;

[17] An operational intervention level is a type of action level that is used immediately and directly (without further assessment) to determine the appropriate protective actions on the basis of an environmental measurement.

— Dealing with competing requirements for providing timely information to the public confirming their safety and providing sufficient technical data for assessment and prognosis;
— Maintaining organizational staffing and expertise levels through appropriate training;
— Harmonizing messages provided to the public while assessment statements are being developed by other institutes and organizations during an emergency;
— Explaining to the public that the response actions adequately provide for their safety, despite possible differences in the response actions taken by different Member States.

3. ASSESSMENT AND PROGNOSIS STRATEGIES

Lessons Learned: Possible uncertainties in the results of the assessment and prognosis process cannot be avoided. These uncertainties can be significantly influenced by the strategy adopted for the process. The uncertainties need to be evaluated and taken into account, and clearly communicated to decision makers and the public.

In general terms, nuclear and radiological emergencies differ in their potential radiological consequences. Nuclear emergencies generally lead to low radiation doses affecting a large number of people over a wide area, whereas radiological emergencies generally lead to high radiation doses affecting only a few people. Given these general characteristics, different assessment and prognosis strategies may need to be developed and adopted to adequately respond to each emergency and to appropriately estimate health risks following different types of events.

The process of assessment and prognosis will always have some associated uncertainties. These may include uncertainties arising from the assumptions and models used in the process as well as uncertainties associated with the available data. These uncertainties need to be evaluated and taken into account in the decision making process and clearly communicated to decision makers and the public. During the early stages of an emergency, the available data may be uncertain or unreliable. It may still be possible to perform an assessment and prognosis using reasonable assumptions that can then be refined when more reliable information becomes available. However, the use of any conservative assumptions and the implications for the results need to be clearly expressed and communicated to any audience reviewing the message so that they understand its limitations.

Decisions on urgent protective actions in a nuclear emergency need to be made based on the conditions at the nuclear power plant in order to be prompt and effective.[18] However, the public will seek answers to questions such as "Where is the contamination going?", "Am I safe?" and "How long will things be contaminated?" Some of these questions can be answered by environmental radioactivity measurements; however, the responses to other questions can only be determined using models to predict the transport of radioactivity through the environment. Measurements are important for both improving the accuracy of the assessment models and validating the models' results.

Environmental transport models can range from simple to highly complex computer based models. Computer based environmental radionuclide transport modelling tools for use in nuclear or radiological emergencies typically consist of a number of interacting modules that may include:

- A data module that requires information on the 'source term'[19], as well as meteorological, radiological and environmental data;
- A module that calculates the dispersion of radioactivity in the environment;
- A module that calculates the deposition of radioactivity on the ground;
- A module that presents key output parameters such as radioactive contamination levels, radiation dose rates, radiation doses and potential health effects;
- A module that allows for sensitivity analysis and can be used for estimating errors and uncertainties.

At the International Experts Meeting:

The experts discussed the different methodologies and strategies currently used in Member States to provide advice and information to decision makers and the public during a nuclear or radiological emergency. They made the distinction between the approaches taken during nuclear emergencies and those taken during radiological emergencies. During a nuclear emergency, monitoring of the

[18] INTERNATIONAL ATOMIC ENERGY AGENCY, Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP Public Protective Actions 2013, IAEA, Vienna (2013).

[19] The 'source term' is the amount and isotopic composition of material released (or postulated to be released) from a facility.

fundamental safety functions[20] and the availability of real-time nuclear power plant parameter monitoring are important for understanding the on-site situation. The experts recognized that information from probabilistic safety assessments (PSAs) for nuclear power plants could be useful for assessment and/or prognosis during an emergency, but that due consideration needed to be given to the limitations of the data and models used in the PSA process.

For radiological emergencies, the strategy for assessment and/or prognosis requires a combination of complementary methods such as dose reconstruction and dose measurements. In such emergencies, radiation doses may be incurred in the first days of the emergency, when information and dose measurements may be limited.

Many organizations may provide an assessment and/or prognosis during a nuclear emergency beyond their national borders, either on their own initiative or because they are requested to do so by the relevant authorities. The Fukushima Daiichi accident showed that there is a need at the international level for a mechanism to harmonize results of such assessments in order to ensure that consistent messages are disseminated. The experts considered that the IAEA Secretariat could play an important role in this harmonization process, while recognizing that emergency preparedness and response in Member States was a national responsibility (see Annex B). In order to achieve the objective of providing timely, clear, factually correct and easily understandable information on the potential consequences of an emergency, including analysis of available information and prognosis of possible scenarios, the capabilities of the IAEA Secretariat and Member States will need to be used to their fullest extent through RANET and other relevant agreements.

The experts discussed the use of environmental modelling for prediction and long term assessment to support communication with the public during and after the emergency. There was general consensus that the effective use of modelling tools requires a high level of training and expertise, and that such tools should not be used as 'black boxes'[21]. There was broad understanding among experts that use of such tools was best suited for the preparedness phase and that prompt public protective actions in the response phase of an emergency needed to be made based on observable conditions at a nuclear power plant and

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[20] The fundamental safety functions for a nuclear power plant are: (i) control of reactivity; (ii) removal of heat from the reactor and from the fuel store; and (iii) confinement of radioactive material.

[21] A 'black box' in this sense is a complex computational tool used by an untrained or inexperienced user who may not understand the limitations of the models used in the tool and thus may generate inappropriate outputs during an emergency.

off-site monitoring data. It was recognized that environmental modelling tools can support the activities of off-site monitoring teams.

Assessment techniques were presented and discussed during the meeting. The majority of these techniques involved modelling of dispersions within the atmospheric and marine environments. Many Member States and international organizations such as the World Meteorological Organization have the capability to use sophisticated dispersion models, and the availability of high quality meteorological data is critical to the predictive accuracy of these models. The use of such tools in the assessment and prognosis process requires careful consideration when used for practices such as guiding prioritization of environmental monitoring resources, as models used in these tools may potentially to misrepresent the situation.

The IAEA Secretariat presented the International Radiation Monitoring Information System (IRMIS) at the IEM. This system was created to facilitate the sharing of radiological monitoring data during a nuclear or radiological emergency. One of the overarching goals of IRMIS is to provide timely information to the public during a nuclear or radiological emergency on the current environmental radiological situation. The system uses the International Radiological Information Exchange (IRIX) format[22], and the web site facilitates visualization and evaluation of data during an emergency. IRMIS will eventually be integrated into the IAEA's Unified System for Information Exchange in Incidents and Emergencies (USIE) for communicating with Member States. IRMIS is able to handle data from vehicle mounted, aerial and fixed radiation monitoring points within a single user interface.

The experts discussed the use of environmental modelling tools for determining the potential impact of a nuclear or radiological emergency on food and agriculture. However, the uncertainties associated with the source term in the early stages of an emergency suggest that the usefulness of such tools would be limited. The importance of environmental monitoring and measurements in making informed public protective action decisions was emphasized, as was the usefulness of modelling techniques to assist in managing the strategy for environmental monitoring.

The experts also recognized the need to give due consideration to the interface between nuclear safety and nuclear security in relation to preparedness and response for nuclear and radiological emergencies, irrespective of the cause of the emergency and the implications for assessment and prognosis strategies (for further information, see Annex C). To achieve the common goal of protecting

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[22] IRIX is the standard for facilitating exchange of radiological information and data between organizations during an emergency.

workers, the public and the environment from ionizing radiation, emergency plans must be compatible and consistent with contingency plans and security plans. Many Member States have introduced coordinated response mechanisms; however, this approach has not been universally adopted. The experts considered that Member States would benefit from the development of IAEA guidance providing a framework for a coordinated response mechanism, based on best practices from Member States that have adopted and carried out exercises on this approach.

Furthermore, the experts considered that guidelines for adequate training and exercises, such those as provided in IAEA guidance on emergency preparedness and response[23], were necessary to ensure emergency response effectiveness, including for emergencies triggered by nuclear security events. The experts discussed how the IAEA Secretariat could contribute to strengthening global security arrangements by expanding existing guidance in its Emergency Preparedness and Response Series[24] on conducting emergency response exercises that incorporate events such as insider threats and cyber security threats. In addition, the experts considered that scenarios involving complex emergencies triggered by nuclear security scenarios, such as concomitant insider and cyber security threats, required development.

4. SHARING ASSESSMENT AND PROGNOSIS OUTPUTS WITH DECISION MAKERS AND THE PUBLIC

Lessons Learned: While the provision of consistent and harmonized information is essential for effective communication with decision makers and the public, the sharing of data and information is not sufficient to achieve the objectives of assessment and prognosis. The necessary technical expertise to interpret results and add proper perspective to the conclusions needs to be available. Continued training on the assessment and prognosis process for decision makers is required.

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[23] INTERNATIONAL ATOMIC ENERGY AGENCY, Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, EPR-Exercise 2005, IAEA, Vienna (2005).

[24] INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency (Updating IAEA-TECDOC-953), EPR-Method 2003, IAEA, Vienna (2005). See also footnote 23.

Communicating effectively with decision makers and the public during a nuclear or radiological emergency is key to successful emergency management. A robust communication strategy needs to address three main requirements[25]:

— The roles, responsibilities and coordination of the various stakeholders involved in communication have to be clearly defined.
— The information used in communications needs to be transparent, timely, objective, factual, relevant, accurate, clear and credible.
— Processes need to be established that result in regular and efficient dissemination of information to both national and international stakeholders.

The assessment and prognosis process needs to take account of these requirements and to consider the nature of the information to be shared with decision makers and the public. In general, there are two types of information that need to be communicated in an emergency: lay information for the public and non-nuclear experts, and technical information for the national and international nuclear community, including international agencies, regulatory bodies and individual nuclear experts. While much of the focus will understandably be on public communications, an overall communication strategy should include formal provisions for the rapid dissemination of technical information as well.

The use of plain language in statements for the public and non-nuclear experts that put the health issues associated with an emergency into perspective needs to be an important element of the communication strategy. Any communication strategy will require training of all involved personnel in the methods of tailoring information to the target audience as well as in the assessment and prognosis process.

An effective communication strategy for nuclear or radiological emergencies will need to take account of all stakeholders that may be involved in communications, including governments, regulatory bodies, operators, international organizations, designers, technical organizations, independent nuclear experts and the public. Ensuring that roles and responsibilities are well defined and that detailed plans for communication are established is essential for a successful response. Emergency communication strategies need to accommodate the rapid development and clearance of information that is to be disseminated.

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[25] INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on Enhancing Transparency and Communication Effectiveness in the Event of a Nuclear or Radiological Emergency, IAEA, Vienna (2012).

Effective communication ensures that decision makers understand the situation and have sufficient useful information to allow them to make informed decisions that protect people and the environment from ionizing radiation. Decision makers require rapid assessments of radiological data to make decisions on protective actions. Timely environmental monitoring data must be collected and presented in an accessible format for analysis to provide the critical technical products to decision makers. To achieve more rapid responses, unified messaging and more efficient coordination, it is essential that, during the preparedness phase, all decision makers, operators and government authorities agree on a common communication strategy.

The public and media's perception of an emergency and of the relevant response organizations is a key factor in the success of public communications. Not only do communicators need to transmit technical, safety related information, but equally important, while doing so they must be able to maintain public confidence. This will require that understandable, concise and factual information be delivered frequently by authoritative sources through coordinated and harmonized messages. Common communication strategies and the harmonization of decision making criteria and training, especially at the regional level, on assessment and prognosis tools, procedures and processes are needed.

Harmonization of information and messages is crucial. Third party international organizations such as those sponsoring the Joint Radiation Emergency Management Plan of the International Organizations[26] should regularly practise their arrangements so as not to place an additional burden on the 'Accident State' or create the potential for public mistrust. Resources and mechanisms to provide accurate, coordinated, timely and accessible information should be established and practised. However, the process of sharing data and information will not be sufficient to achieve the objectives of assessment and prognosis. Technical expertise spanning many disciplines will always be needed to interpret and add a balanced perspective to the results. Further work needs to be done to improve capacity and to ensure that expert-to-expert relationships exist at the preparedness stage.

At the International Experts Meeting:

The experts discussed how best to deliver and share the results of an assessment and prognosis process with the public and decision makers in a manner that is clear, timely, factual, objective and easily understandable.

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[26] INTERNATIONAL ATOMIC ENERGY AGENCY, Joint Radiation Emergency Management Plan of the International Organizations, EPR-JPLAN 2013, IAEA, Vienna (2013).

Many of the approaches to assessment and prognosis presented by the experts appeared to rely on sophisticated computer based capabilities. While these approaches were originally created and implemented at a national or regional level, the experts shared the understanding that harmonization of approaches and implementation on a global scale would create a robust and harmonized communication scheme.

The experts considered that strategies for communication in an emergency needed to be based on close collaboration between the 'Accident State' and the IAEA Secretariat in order to ensure consistency in public statements. Information needs to be factual, and coordination and consultation are important so that there is agreement, to the extent possible, on the content of any messages to be shared with the public.

The experts discussed several available computer based assessment methods, such as methods for the assessment of radiation doses to the public[27], and noted the international exercises that had been carried out to compare their results. One of the main outcomes of these comparison exercises was an understanding of the impact of the level of expertise of the user on the results and their interpretation. The experts considered that participation in these exercises would lead to improvements in the assessment methodologies and experience in their use. This, in turn, would increase the likelihood of reliable and consistent assessments by national and international organizations. The experts emphasized that user forums for computer based assessment methodologies across a wide range of technical disciplines would be beneficial for harmonizing the international response to an emergency. The experts also noted that emergency communication plans needed to be tested and exercises needed to be organized to verify their effectiveness.

All approaches to assessment and prognosis will have limitations that need to be well understood and reflected in the interpretation of any assessment. The experts discussed issues associated with the use of sophisticated computer based methodologies at times when there may be only limited information available, such as during the early phases of an emergency.[28] The experts highlighted the benefit of decision making based on predefined nuclear power plant

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[27] For example, the Radiological Assessment System for Consequence AnaLysis (RASCAL) system, the Real-time On-line Decision Support System for Nuclear Emergency Management (RODOS) and others.

[28] HIRANO, M., "The new framework for emergency preparedness and response in Japan", paper presented at the International Experts Meeting on Assessment and Prognosis in Response to a Nuclear or Radiological Emergency, Vienna (2015); available on the attached CD-ROM and on-line at: http://www-pub.iaea.org/iaeameetings/IEM9p/Opening/Hirano.pdf.

conditions in such circumstances, as an approach that is in line with the IAEA safety standards.

The data requirements and timescales for assessments undertaken in the emergency phase, the transition phase and the recovery phase differ.[29] The urgency with which response decisions are required is likely to preclude the availability of full information, and the time focus is predominantly short term. Retrospective assessment of exposures for input to dose reconstruction requires a wider spread of data, both spatially and temporally, and includes a combination of information from measurements and modelling.

Additionally, a wide range of technical disciplines are necessary to address emergency management needs. Frequent training, practising and exercising of all the tools and protocols used for assessment and prognosis are necessary during the preparedness stage.

The IAEA's response role under the international EPR framework[30] includes:

— Prompt notification and exchange of official (authenticated and verified) information to Member States and international organizations;
— Provision of assistance, upon request;
— Provision and/or coordination of public information that is timely, accurate, clear, objective and easily understandable during a nuclear emergency;
— Coordination of the response activities within the international organizations;
— Assessment and prognosis.

This is a very complex role that requires a great deal of coordination and practice in order to ensure harmonization of international efforts in an effective and efficient manner.

It was highlighted that responsibility for emergency preparedness and response for nuclear or radiological emergencies rests with the State, as does the protection of human life, health, property and the environment.[31] The State is responsible for ensuring that EPR arrangements are in place at the national, local and operating organization/facility levels. Where appropriate, the State

[29] See footnote 9 on p. 4.

[30] The international EPR framework is based on legal instruments, primarily the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; the IAEA safety standards; and agreements and arrangements made by and between IAEA Member States, the IAEA Secretariat and relevant international organizations to maintain the preparedness to respond to any nuclear or radiological emergency irrespective of its cause. More information is available at: http://www-ns.iaea.org/tech-areas/emergency/international-response-system.asp.

[31] See footnote 9 on p. 4.

is also responsible for ensuring coordination of national EPR arrangements with the relevant international arrangements to which the State has acceded or is otherwise a party, such as through bilateral and/or multinational agreements.

Consultation and sharing of information on protective actions and other response actions among States in an emergency help to ensure that actions are taken consistently. In addition, a clear and understandable explanation of the technical basis of decisions on protective actions and other response actions is crucial in order to increase public understanding and acceptance at both the national and the international levels. Internationally focused efforts to support the harmonization of response actions would be useful to avoid situations where bordering countries or other Member States are recommending actions that conflict with the response actions of the 'Accident State'. These instances need to be carefully managed, and considerable effort should be given to resolving differences or creating a system to explain these differences without unduly concerning the public.

5. TECHNICAL DATA REQUIRED FOR CONDUCTING ASSESSMENT AND PROGNOSIS

Lessons Learned: Assessment and prognosis require the sharing of static and dynamic technical data during the preparedness phase and during an emergency. Agreement among all stakeholders is needed during the preparedness phase on what data will be shared during an emergency and how they will be shared.

Performing an assessment and prognosis during a nuclear or radiological emergency can be difficult and technically challenging and will have associated inherent limitations and uncertainties. Because of potential difficulties in gathering technical data during an emergency, the assessment and prognosis may be delayed, as required data may be unavailable, especially in the initial stages of an emergency. These potential delays or unavailability of data need to be taken into account in the development of an assessment and prognosis strategy. The IAEA Secretariat and Member States are developing a predetermined set of key plant assessment parameters (static and dynamic data, as referred to above) and common situational awareness criteria based on meteorological data and radiological measurements, sometimes termed 'vital ground truth data', to allow for the performance of meaningful assessments.

At the International Experts Meeting:

The experts highlighted the challenges associated with data availability at the onset of an emergency. It is expected that there will be difficulties obtaining information and parameters to support an in depth prognosis during the early phases of an emergency without the sharing of some information prior to the emergency. Many of the parameters that are needed for a detailed technical assessment and prognosis are known in advance, such as the type of nuclear power plant, the operating characteristics and the composition of the fuel. The nuclear power plant operator and designer and the national regulatory body are in a position to have comprehensive technical design information. However, this information may not be readily available to others at the onset of an emergency. In order to provide an overview of the data required for assessment and prognosis, the experts made the important distinction between static and dynamic technical data.

‘Static data’ are related to the design features of nuclear power plants, such as the containment volume and the containment design pressure, and can be shared in advance of an emergency. This will allow those performing the assessment and prognosis to start with the basic nuclear power plant design inputs. ‘Dynamic technical data’, on the other hand, refer to the type of data that may only be available during an emergency and are generally temporal in nature. This type of data includes the current status of fundamental safety functions and the critical equipment to fulfil them, as well as ‘source term’ data in the case of radioactive releases. This information needs to be shared in a timely manner during the emergency.

To allow for consistent and quality prognosis, guidance and procedures should be put in place for determining which dynamic parameters will need to be shared in an emergency and how they will be shared. While the information needed to support prognosis during emergency conditions is difficult to predict, it needs to be identified in advance and shared in a timely manner. Timeliness of sharing will facilitate the evaluation of critical safety functions and enable the rapidly changing circumstances during an emergency to be taken into account. When defining what kinds of dynamic data should be provided to the IAEA by an ‘Accident State’, consideration should be given to the minimum information required to produce a meaningful assessment of a situation for understanding the conditions for both the on-site and off-site impacts.

Other types of data will need to be shared nationally and with the IAEA Secretariat during an emergency, depending on the event. These could include geospatial data, measurement uncertainty or products created during an assessment or prognosis process initiated by a third party. Organizations participating or otherwise having a role in the response need to be prepared to share and receive this type of data within their information systems. Previous experience has demonstrated that sharing of too much data can lead to important data, such as the status of critical safety functions, being overlooked. Plans and procedures need to be developed to ensure that the most important and critical data are given priority within any information handling system, or request for or provision of information. In the preparedness phase, organizations should ensure that they are developing an information handling process for use in the response that is compatible with those of all stakeholders in line with international guidance, where available.

The experts discussed the tools currently under development for providing information and technical data to the IAEA in advance of an emergency. However, further IAEA engagement with Member States is needed to better define the information to be provided and maintained in advance of an emergency. Member States should also be continuously informed of the objectives of the assessments by the IAEA and non-impacted Member States. Procedures and specific agreements would help communication and manage expectations.

The experts agreed that mechanisms such as RANET might provide a path to activate previously identified technically advanced assessment and prognosis capabilities available in Member States. The experts considered that continued engagement of the IAEA Secretariat with Member States would help further define a process with supporting procedures to facilitate prognostic evaluations outside the ‘Accident State’.

6. ASSESSMENT AND PROGNOSIS AT THE INTERNATIONAL LEVEL

Lessons Learned: The Fukushima Daiichi accident highlighted the need for a single focal point with an authoritative, global view of the results of assessments and prognoses at the international level, to avoid the generation and dissemination of conflicting information.

During the response to the Fukushima Daiichi accident, many Member States conducted their own independent assessment and prognosis. However, there was no clear international mechanism for disseminating the key information on which these assessments and prognoses could be performed. As a result, in some cases the public and various government organizations were receiving different messages.

The absence of the technical information needed for Member States to perform assessments and the lack of an authoritative, global view of the results sometimes led to the generation of inconsistent and at times conflicting information.[32] This in turn led to the expansion of the IAEA's mandate during a nuclear or radiological emergency. It was clear that tools to provide a common operating picture and joint messaging could be used to improve both transparency and confidence in information provided by authorities during an emergency.

The IAEA Secretariat already had the capability[33] to assess a nuclear or radiological emergency. During the response to the Fukushima Daiichi accident, the IAEA Secretariat evaluated the available information, which formed the basis of the briefings of the representatives of the Member States' Permanent Missions in Vienna and the media. The expanded role of the IAEA Secretariat now includes a mandate for prognosis of the potential evolution of an emergency and assessment of possible consequences. The IAEA Secretariat is implementing this mandate within the IAEA's Incident and Emergency System.

The aim of an IAEA Secretariat assessment is to evaluate the planned and implemented protective actions and other response actions by the affected Member State to determine if they are in broad compliance with the relevant IAEA safety standards. The aim of the IAEA Secretariat prognosis is to estimate how an emergency may evolve. The IAEA Secretariat will broadly assess possible emergency scenarios by reviewing the available technical information using IAEA guidance and tools to obtain an indication of what is likely to happen next. For nuclear power plants, this process will include a broad examination of the emergency and its consequences with respect to potential failure of critical safety functions. By using expert knowledge, the likely evolution of the emergency will be described in broad terms.

A preliminary procedure for the harmonization of assessment and prognosis messages during a nuclear or radiological emergency is presented in Annex B; the plan is to further elaborate this procedure in future publications in the IAEA's Emergency Preparation and Response Series.

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[32] See Annex B to this report.

[33] See: INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Assessment Procedures for Determining Protective Actions during a Reactor Accident, IAEA-TECDOC-955, IAEA, Vienna (1997); INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Assessment and Response during a Radiological Emergency, IAEA-TECDOC-1162, IAEA, Vienna (2000); INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Monitoring in a Nuclear or Radiological Emergency, IAEA-TECDOC-1092, IAEA, Vienna (1999).

At the International Experts Meeting:

The activities conducted by the IAEA Secretariat to evaluate the new assessment and prognosis process within the IAEA's Incident and Emergency System were discussed at the IEM. These activities included:

— Developing objectives;
— Developing a methodology to achieve objectives;
— Developing a process;
— Creating supporting tools;
— Developing and testing internal procedures;
— Conducting internal exercises;
— Conducting external exercises with Member States;
— Continuously informing Member States of updates of the IAEA process at General Conference side events, in consultancy meetings, during the meetings of the Representatives of Competent Authorities identified under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, and through other avenues, including one-on-one discussion.

The IAEA Secretariat explained the process that will occur during a radiological or nuclear emergency, including the following actions:

— The IAEA response team will review the incoming technical information (including on-site conditions and off-site monitoring data) and, if necessary, clarify aspects of the information provided with (or request missing information from) the contact point in the 'Accident State'. Based on this review, the team will evaluate whether the planned or implemented protective actions and other response actions taken by the 'Accident State' are broadly consistent with the IAEA safety standards applicable for the situation.
— If necessary, the IAEA will contact one or more of the Member States that volunteered to support this process via RANET in the preparedness phase, provide available information and request support through the sharing of their assessment with the IAEA.
— Once an assessment has been elaborated, the IAEA will share the results with the 'Accident State' to obtain agreement on the conclusions and to discuss any differences.

— With the agreement of the ‘Accident State’, the IAEA will disseminate the assessment conclusions. If a common understanding and consistent message cannot be reached within a reasonable time, the IAEA Director General will decide, as appropriate, on the next steps.

In addition, the IAEA will need to perform the following tasks:

— Develop a ‘reasonably’ bounding estimation of the potential progression and the associated radiation exposure pathways, based on available information, evidence and scientific knowledge;
— Evaluate relevant information to assess whether the public is safe and will continue to be safe, and, if not, identify protective and/or other response actions that should be considered;
— Evaluate relevant information to assess if facility workers and emergency workers are safe and will continue to be safe, and, if not, identify additional actions that should be considered;
— Identify actions that should be considered to protect international trade and interests;
— Assess whether the public protection strategy being implemented, recommended or discussed is effective, and, if not, identify actions that should be considered by Member States, international organizations and the IAEA Secretariat;
— Alert those Member States in which response actions may need to be considered;
— Continue the ongoing assessment and prognosis based on the progression of the emergency.

An expert from Mexico presented the experience of interfacing with the IAEA Secretariat during an actual radiological emergency that occurred in December 2013.[34] The expert noted the value of the assessment of the event performed by the IAEA Secretariat and the positive impact this had on the media reporting that took place during the emergency. Messages from the IAEA Secretariat — such as “the Mexican authorities and the IAEA believe the general public is safe and will remain safe” and “[the IAEA] believes the actions taken in response to the discovery of the source are appropriate and follow Agency guidance for this type of event” — were harmonized with those of the relevant Mexican authorities and served to reduce public uncertainty regarding their safety.

[34] For more information see: https://www.iaea.org/newscenter/news/mexico-informs-iaea-theft-dangerous-radioactive-source.

The seven emergency response exercises conducted with Member States over the preceding 18 months in which assessment and prognosis was performed were presented at the IEM. Experts from Canada, Finland, Hungary and Mexico shared their insights on their experience of interfacing with the IAEA Secretariat during these exercises. The experts considered that active participation in exercises was crucial for counterparts in Member States to be better prepared to accommodate the IAEA Secretariat's assessment and prognosis process. In particular, the challenges to channels of communication that may arise when large volumes of technical information are requested were highlighted.

The need for an international mechanism to harmonize global communication efforts during a nuclear or radiological emergency was emphasized by the experts during discussions. The experts considered that the assessment and prognosis process would need to:

- Provide a global focal point for the technical data required by other Member State technical organizations to carry out their assessment and prognosis activities;
- Provide a global focal point for follow-up requests for additional information from the 'Accident State' and to avoid duplicate requests for the same information being sent by several parties in parallel;
- Provide a mechanism to relieve the 'Accident State' of the significant strain on its communication system from many organizations attempting to directly contact an operating emergency centre for technical information;
- Provide an open forum for technical audiences to share and discuss the outcome of their assessments and prognosis before it is shared with the public in order to facilitate discussions and resolution of differences.

The experts agreed that the IAEA Secretariat was best placed to provide a forum for the harmonization of assessment and prognosis efforts, and to act as the global focal point for authoritative information from the 'Accident State' during a nuclear or radiological emergency.

7. CONCLUSIONS

The experts discussed a wide range of issues during the IEM. The following are some of the key points highlighted during the meeting as well as a suggested path forward to benefit from this IEM.

Assessment and prognosis

The assessment and prognosis process for a nuclear emergency requires advanced capabilities and significant knowledge of the facilities and technology involved. The relevant authorities within the Member State are best placed to provide a detailed assessment and prognosis of the on-site and off-site situations. However, those authorities are not required, or may not be able, to share such a prognosis with the international community during an emergency. Consequently, there is a need for a globally focused assessment and prognosis process.

There are important differences between nuclear and radiological emergencies that may affect the assessment and prognosis process. Experience has shown that, in general, nuclear emergencies lead to low doses affecting many people, whereas radiological emergencies lead to high doses affecting a few people. However, many of the tools developed for nuclear emergencies can be applied for radiological emergencies as well.

The range of possible scenarios that result in a radiological emergency[35] makes assessment and prognosis a particularly challenging task that requires diverse approaches commensurate with an organization's planning basis and risk assessment. This requires any organization performing such tasks to: develop clear objectives; establish an appropriate methodology to achieve those objectives with supporting tools; and implement, practise and continuously improve their developed methodology. A common understanding of the assessment and prognosis procedure used by an organization and the associated objectives is critical to working together during an emergency to harmonize public messages.

Assessment and prognosis activities conducted in the early phases of an emergency should be primarily focused on determining any immediate impact on public protective actions so that they can be immediately implemented, rather than on establishing long term emergency progression. More advanced comprehensive assessments may be performed later on, once the emergency has stabilized and detailed measurements have been performed.

Radiological emergencies involving other associated hazards such as chemical hazards — for example, uranium hexafluoride — present additional challenges for assessment and public communication. Plans and procedures need to be developed to handle assessment and prognosis during these types of emergencies.

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[35] See: INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-Method 2003, IAEA, Vienna (2003), appendix 7.

Decisions on urgent protective actions and their implementation in the early stages of a nuclear emergency need to be made based on conditions at the nuclear power plant in order to be prompt and effective. Although measurements are very useful for conducting a dose assessment during an emergency, it is unlikely that sufficient information and results will be available to provide a detailed dose assessment early in the response, and actual monitoring will always be required to confirm that proper actions have been put into place.

Environmental modelling techniques can be used to support decision making for protection of the public and resource coordination during an emergency. However, these techniques, such as atmospheric dispersion, can require a significant amount of high quality data. Furthermore, research and development is needed for guidance on appropriate methodologies for presenting forecasts from atmospheric dispersion modelling during an emergency without distracting from actual measurements.

Capacity building

Training for emergency preparedness and response is critical to maintaining a supply of experts able to conduct activities associated with assessment and prognosis. There is a need for training, at the regional level, on assessment and prognosis tools, procedures and processes in order to support harmonization of protective action strategies among Member States.

Capacity building for the assessment and prognosis process starts in the preparedness phase with the development of capabilities for appropriate hazard assessment. This is followed by development of the emergency planning basis and the ability to convert this into a protection strategy that is consistent and harmonized with the strategies of other States at the global level. Additional international guidance is needed in this area.

Safety and security

The arrangements for nuclear safety and those for nuclear security share the same objective of protecting people and the environment from ionizing radiation. However, a nuclear or radiological emergency triggered by a nuclear security event requires significant efforts to ensure that the nuclear safety and nuclear security interface is well planned and practised.

There is a need for more international exercises covering nuclear and radiological emergencies to practise assessment and prognosis, including emergency scenarios triggered by nuclear security events. Such exercises would help to identify areas for improvement in the safety and security interface. There is a need to develop exercise guidance on the response to emergencies triggered by nuclear security events.

Communication

Communication with the public needs to be in plain language that is understandable to a wide audience. When explaining public safety, it can be useful to include the terms ‘safe’ and ‘not safe’ in communications, where possible. There is a need for global harmonization of public protection strategies to support the credibility of statements regarding the public’s being ‘safe’ or ‘not safe’. The potential for the contamination of food will be a public concern even if assessments and measurements indicate otherwise. Transparent presentation of food safety information is essential in building and maintaining public trust.

Guidance on how the international harmonization of messages during an emergency will be performed and how technical data will be shared would be very useful for the international community. The development of this guidance could be led by the IAEA Secretariat with the support of Member States.

Sharing of information during the preparedness phase will save considerable efforts early on in an emergency. This information could be shared in the Emergency Preparedness and Response Information Management System (EPRIMS) and its Reactor Technical Information database.

Clear communication of uncertainties and the limitations of any assessments is needed during an emergency. Clearly communicating technically difficult concepts such as ‘uncertainty’ in assessments is a challenge. Efforts to improve and standardize the language used in this area would support all parties receiving assessment and prognosis outputs. Coordination, harmonization and mutual understanding of the basis of the public protective action decisions of all parties during an emergency are essential.

The experience gained during exercises and during radiological emergencies[36] has shown that the IAEA Secretariat’s assessment and prognosis process provides a valuable opportunity for an ‘Accident State’ to harmonize its messages with those of the international community.

Future activities

The IAEA Secretariat, acting as the global focal point during a nuclear or radiological emergency, should facilitate the sharing of the detailed technical information needed for organizations from other Member States to conduct

[36] See footnote 33 on p. 21.

assessment and prognosis. It should also provide a mechanism for organizations from Member States to have the opportunity to harmonize their messages during an emergency before they are released to the public.

Harmonization and benchmarking of the tools used during an emergency should take place during the preparedness phase. This should include tools that will be used to assess the situation during the transition to an existing exposure situation. Many Member States would benefit if an international intercomparison exercise were organized in this topic area.

Annex A

CHAIRPERSON’S SUMMARY[1]

International Experts Meeting on Assessment and Prognosis in Response to a Nuclear or Radiological Emergency 20–24 April 2015, Vienna

INTRODUCTION

This is the ninth International Experts Meeting (IEM) organized under the IAEA Action Plan on Nuclear Safety. The purpose of the meeting is to discuss issues, challenges and solutions related to the assessment and prognosis process in response to a nuclear or radiological emergency. The meeting builds upon and complements earlier IEMs that touched upon many of the same issues within the context of their topics.

The importance of the subject matter, which addresses both technical issues and the effectiveness of communications efforts, is underlined by the fact that the IEM has attracted over 200 participants from 70 Member States and five international organizations. In addition, the organizers have used the meeting as an opportunity to involve as many young professionals as possible as part of the IAEA’s programme of capacity building. The IEM provided a unique opportunity to bring to bear a wide range of expertise and diverse viewpoints on assessment and prognosis issues.

A particular focus of the IEM is the expanded role of the IAEA in assessment and prognosis during nuclear or radiological emergencies. Prior to 2011, the role of the IAEA covered four aspects of nuclear and radiological response: (1) notification and exchange of official information though officially designated contact points; (2) provision of timely, clear and understandable public information; (3) provision and facilitation of international assistance upon request; and (4) coordination of interagency response. The IAEA’s role did not include the provision of a prognosis of the potential evolution of the event or assessment of its possible consequences.

[1] The opinions expressed in this summary — and any recommendations made — are those of the Chairperson and do not necessarily represent the views of the IAEA, its Member States or other cooperating organizations.

The collective experience in responding to the Fukushima Daiichi nuclear power plant accident showed that many different messages were reaching the public and various Governments, and that there was no clear international mechanism for either harmonization of messages or dissemination of key information upon which assessments and prognoses could be performed. There was also no source for a global authoritative view of the results of assessments and prognoses. The availability of and access to information, often from third parties, as well as the availability of assessment tools in emergency organizations around the world, provided information to the public far beyond the 'Accident State' or areas of direct radiological impact. This information was not always consistent. Tools to provide a common operating picture and joint messaging can improve both transparency and confidence in information provided by appropriate/established authorities.

As part of the IAEA Action Plan on Nuclear Safety, and subsequent General Conference resolutions, Member States have charged the IAEA to "provide Member States, international organizations and the general public with timely, clear, factually correct, objective and easily understandable information during a nuclear emergency…based on evidence, scientific knowledge and the capabilities of Member States." The IAEA work is designed to complement, not duplicate or replace long-standing national responsibilities to respond to emergencies and protect the public. Member States also intended the work of the IAEA to take advantage of the existing capabilities of some Member States.

DISCUSSION ISSUES

Assessment and prognosis terminology

The IEM brought together a wide range of expert practitioners from the field of assessment and prognosis, and discussions at the meeting indicated a correspondingly wide range of meaning and uses for the terms. The IAEA presented its intended use of the term assessment as an evaluation of the planned and implemented protective actions and other response actions to determine if they are in broad compliance with the IAEA safety standards. The IAEA presented its use of the term prognosis as a bounding estimate of how the emergency may progress. A common definition is important to set the stage for IAEA engagement with Member States and to provide clear expectations to all involved parties.

The discussions at the meeting also highlighted that the objectives of assessment and prognosis, and the types of needed assessment and prognosis, change during the course of a response to an emergency and also with respect to the type of an emergency. For example, in the early phases of a response, assessment of nuclear power plant conditions relies upon pre-existing operator training and knowledge of safety systems and plant behaviour, and associated emergency action levels. If a General Emergency condition is predicted, immediate close-in evacuation is often the indicated protective action, and the Emergency Director of the operator can make a fully informed recommendation to authorities based only on plant status (without dose assessment or monitoring results). In the early phase of an emergency, prognoses and protective actions need to be frequently reviewed and updated as plant conditions change.

The use of preventative measures, mitigation strategies, and emergency preparedness and response actions all bear upon accident progression, and combine to ensure defence in depth of public protection. The data needed for assessment and prognosis for emergency response are different from the data needed for mitigation (such as severe accident management guidelines). The IAEA assessment and prognosis efforts are focused on data required to support off-site emergency activities (e.g. protective actions). Inherent conservatisms in approach, and the uncertainties in analyses, need to be put into context for decision makers as well as the public.

In the later phases of a response, after the emergency phase is over, assessment of long term health and environmental needs becomes important. Such a situation is under way with ongoing evaluations in the Chernobyl area and by the Fukushima Health Management Survey, which will provide valuable insights to inform the design of future assessment activities related to public health actions. Additional considerations come into play for such situations, such as the movement of contamination into previously unaffected areas due to seasonal flooding, river transport, etc. Long term assessment and prognosis with combined environmental modelling, sampling and computational tools can be very valuable to plan optimal recovery and decontamination activities.

The objectives of assessment and prognosis will differ for the ‘Accident State’, neighbouring States and unaffected States, and among international organizations. More work is warranted to identify, understand and explain any instances where the IAEA’s definitions of assessment and prognosis, presented above, may not be consistent with all of these objectives. It is a reality that many countries and organizations will likely conduct their own assessments and prognoses if a significant accident occurs. The IAEA is uniquely positioned to help harmonize efforts and give voice to the global community in a manner that assists the ‘Accident State’ authorities. Joint exercises, as part of preparedness activities, provide an opportunity to explore these interfaces and objectives.

Use of information technology and treatment of uncertainties

A recurring theme of the IEM was the expected difficulty of reconciling results from multiple assessment sources — whether from different users with the same models, or from different models for 'source term', plume development, meteorology, deposition and concentration-dose conversion.

Probabilistic safety assessment (PSA) is often used for pre-accident assessment, and its use during an emergency needs to take full consideration of its limitations. There is a high variance of results of PSA, and PSAs are dependent upon system assumptions that may not be valid for a degraded facility. Users of codes need to be trained not only in the code but also in the underlying technical issues associated with the type of facility and accident. Providing PSA information to decision makers can detract from the protection of the public. Simple explanations are all that is needed for most decisions (for example, whether the food is safe, or not safe, to eat).

There are significant capabilities (codes and databases) available to perform a credible prognosis and assessment of all phases of a nuclear emergency. The sustainability and practicality of those platforms, and their ability to handle and reduce large sets of collected data while providing the level of simplicity needed for emergency management will be a growing challenge. The pace of change in information technology tools is very high and can outpace the training of users. Additionally, a wide range of technical disciplines are necessary to address emergency management needs. Frequent use of the applicable codes is beneficial during the preparedness stage and through exercises.

The IEM presenters described several codes, and noted international efforts to compare code results, expand availability of 'source terms' and increase access to meteorological data. There are projects being run internationally to compare dose assessment codes including RASCAL, RODOS and others. The code user's input assumptions are a major factor in the differences in code outputs. Such cooperative efforts at the international level improve the codes, help train users and build capacity, and increase the likelihood of reliable and consistent accident prognosis by separate entities. Further training and user forums for code use, which pull in multiple technical disciplines, would be very beneficial for the international response community.

The level of complexity of assessment and prognosis should be commensurate with the potential radiological health impacts of the given event. A graded approach is applied in performing assessment and prognosis. Most large-scale emergencies will need a sophisticated assessment and prognosis. Many organizations have the capability to pull in expertise (technical support organizations, vendors, atmospheric modelling centres) as assessment and prognosis activities increase in complexity.

Harmonization of approaches and international guidance

IAEA safety standards and guidance documents (for example, IAEA Safety Standards Series No. GSR Part 7) takes into account the ICRP recommendations (specifically ICRP 103) but are not always identical. International, regional and national level documents (for example, the Nordic Flagbook and EPA-400 Protective Action Guidelines in the United States of America) can also have differences. Different standards or dosimetry techniques used either in different areas or by different agencies for the same areas, could make public safety messaging inconsistent and difficult. This underscores the importance of the IAEA's efforts to coordinate with the 'Accident State' prior to release of information in an emergency. Similarly, neighbouring countries may want to have pre-established arrangements to coordinate emergency management messaging.

It was highlighted that public protection strategies implemented in response to an emergency will always be a national level responsibility. However, internationally focused efforts to support the harmonization of response actions would be useful to avoid or explain situations where neighbouring countries (or even countries far from the 'Accident State') are recommending actions that conflict with the response actions of the 'Accident State'.

Protocols and tools to exchange information during emergencies

Regardless of the geographical location of an accident, it is reasonable to expect that organizations with advanced assessment and prognosis capabilities, or particularly relevant technical expertise, will be performing such activities. Recognizing this reality, a preplanned approach for these organizations to obtain key information to support assessment needs will help to manage reconciliation of differences and facilitate appropriate communications.

The IAEA can provide reliable information and data, supplied by the 'Accident State', to other Member States. This will reduce the impact of multiple information requests upon the 'Accident State'. The IAEA should ensure their assessment and prognosis programme supports this objective. Guidance on reconciling differences, and protocols for 'source term' estimation, will help ensure that the parties that cooperate in such sharing arrangements are viewed as trusted sources of information.

To accomplish this expanded role, the IAEA would need to work with Member States to develop a predetermined set of key plant assessment parameters (dynamic data) and common situational awareness criteria (vital ground truth data) sufficient for a third party State to perform a high level assessment. Some regions mentioned efforts, such as one by the Heads of the European

Radiological Protection Competent Authorities (HERCA) and Western European Nuclear Regulators Association (WENRA), to collect information and data in a standardized format. The Emergency Preparedness and Response Information Management System (EPRIMS) has been established by the IAEA to develop these capabilities, but it is not complete or populated at this time. The IAEA has made efforts to leverage other sources of internal IAEA information and regional information to reduce the burden on Member States to populate EPRIMS.

The types of information and parameters needed to support a prognosis are more difficult to predefine than the parameters for assessment. Mechanisms such as the Response Assistance Network (RANET) may provide a path to leverage advanced capabilities or to access situation-specific information on short notice. Continued IAEA engagement with Member States is planned and will help further define a process to support prognostic evaluations outside the 'Accident State'.

Radiological emergencies resulting from a nuclear security event

Protection of the public is the common, overarching goal of safety and security activities. However, the interfaces between nuclear safety and nuclear security have been evolving. Several recent emergency preparedness exercises in Member States have explored the role of security considerations and provided valuable insights on the nuclear safety and nuclear security interface, and how contingency planning can work in concert with emergency planning. In general, more entities (particularly government assets) are involved for nuclear security events, which have short timescales, and consequently there are different coordination, interface and command-and-control issues. These can significantly affect joint prioritization and decision making activities otherwise assigned to emergency response officials. Individual Member States have developed requirements and guidance, and there is some applicable IAEA guidance. Security-driven response activities can introduce special information sharing considerations, can affect the ability of the emergency response field teams to perform actions in a timely manner, can change the nature of possible off-site protective actions, can often bring in different government response assets and authorities than accident-driven events, and can introduce new disciplines such as attribution via nuclear forensic techniques. The ongoing development of the system of nuclear security guidance by the IAEA, and continued exercises to explore the nuclear safety and nuclear security interface, will broaden the sharing of lessons on how this will affect emergency preparedness and response activities.

Capacity building and informing Member States

Capacity building for Member States in the area of assessment and prognosis is an important issue. The harmonization of international messaging to the public can be achieved if all Member States are fully knowledgeable of the global assessment and prognosis process, expected outputs and the capabilities which are available through the IAEA. For Member States without assessment and prognosis capabilities for nuclear or radiological emergencies, it would be useful to enhance their arrangements through capacity building so that they are better able to understand assessment and prognosis outputs produced not only by the IAEA but by other Member States.

Exercises

In discussing the above issues, the participants in the IEM discussed the need to increase the frequency and opportunities to exercise the international response. This would allow all organizations that would be expected to respond to a nuclear or radiological emergency, both the 'Accident State' and the remaining international community, to practise the established data exchange framework and create the necessary synergy among the international community. Regular exercises with the whole community would assist in developing a more complete understanding of the impacts the international community would have on the 'Accident State', what support the international community has to offer, would identify any gaps and overlaps in international guidance and doctrine, would provide a more accurate picture of the full international response capabilities, and would determine any advancements necessary to achieve a more harmonized collective international response.

To ensure continuity and consistency is applied to international response strategy, it is important to exercise a variety of response scenarios, to include nuclear power plant safety and security events, nuclear materials and fuel facilities based events. Exercising a diverse range of nuclear and radiological emergency scenarios will promote consistency, and will also enable the community to draw distinctions between the different types of events and determine how these differences affect the established data and exchange protocols, and allow the international community to apply any consistent customization, if appropriate. Opportunities to widen the number and types of exercise participation should be sought. This will allow partnerships to develop, at the preparedness stage, between organizations that will be tasked to respond to an emergency.

NEXT STEPS

From a review of the current global nature of the nuclear and radiological industries, the availability of information and tools, and the expectations of officials in Member States and the public, it is clear that, like in 2011, many organizations will be performing their own assessments and prognoses of a significant nuclear or radiological emergency that occurs anywhere. Providing these organizations with a common operating picture, opportunities to interact with each other and tools to ensure unity of effort is in the best interest of the national and international emergency management community.

Efforts need to continue to provide a common understanding of the objectives of assessment by the IAEA and third party (non-impacted) Member States, and to communicate those objectives. These objectives should recognize and not impinge upon the roles and responsibilities of the 'Accident State' and potentially impacted States, with respect to the activities they engage in to protect their public. Where different standards are referenced (such as protective actions), the harmonization of messaging becomes particularly important for public understanding.

Currently, tools to provide information and technical data to the IAEA and to third party Member States through the IAEA in advance of an accident are under development. Having timely and accurate input information is essential for quality, clarity and consistency of assessments. More IAEA and Member State engagement is needed on the types of information to be provided and maintained. These engagements should be informed by the objectives of the assessments by the IAEA and non-impacted Member States. Procedures and specific agreements would help communications and manage expectations.

To support consistent and quality prognosis being performed by multiple organizations, guidance and procedures should be put in place stating what type of and how information related to dynamic parameters will be shared in an emergency. Information to support prognosis during emergency conditions is hard to predict and share in advance, but it needs to be timely, needs to be sufficient to evaluate critical safety functions at a high level, and needs to account for the rapidly unfolding nature of many emergencies.

Wherever two or more organizations plan to conduct assessment and prognosis of the same event and provide information to affected audiences (governments, media, private entities and the public), resources and mechanisms to provide accurate, coordinated, timely and accessible information should be established and practised. The importance of harmonized messaging was underscored by the accident at the Fukushima Daiichi nuclear power plant in 2011.

Sharing data and information will not be sufficient to achieve the objectives of assessment and prognosis. Technical expertise spanning many disciplines will always be needed to interpret and add perspective to results. Work needs to be done, for example through wider exercise participation, to improve capacity, to leverage expertise and to ensure expert-to-expert relationships exist at the preparedness stage.

Exercise programmes will be critical for setting clear expectations and establishing strong relationships between counterparts. Additional opportunities for cooperation during exercises should be sought, including opportunities for broader participation (ideally, reflecting those that would take on roles in a real event). This should include emergencies triggered by nuclear security events to explore interfaces between contingency planning and emergency planning. It would be worthwhile to have an 'unaffected' Member State participate in an exercise and seek assessment and prognosis information from the IAEA.

Robert J. Lewis

Annex B

HARMONIZATION OF INTERNATIONAL ASSESSMENT AND PROGNOSIS MESSAGES DURING A NUCLEAR OR RADIOLOGICAL EMERGENCY

BACKGROUND

The international emergency preparedness and response (EPR) framework for nuclear and radiological emergencies is defined by the Convention on Early Notification of a Nuclear Accident (the Early Notification Convention)[1], the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (the Assistance Convention)[2] and IAEA safety standards. These documents are supplemented by a number of mechanisms established by the IAEA's Policy-Making Organs and the meetings of Competent Authorities under the Early Notification and Assistance Conventions, inter-agency agreements and a number of practical arrangements[3] maintained and coordinated by the IAEA's Incident and Emergency Centre (IEC).

Prior to endorsement of the IAEA Action Plan on Nuclear Safety (the Action Plan), in September 2011, the IAEA Secretariat's central response role included: prompt notification of the emergency to Member States and international organizations; exchange and/or provision of official (authenticated and verified) information to Member States and international organizations; provision of international assistance, upon the request of the State concerned; coordination of the interagency response; and provision and/or coordination of timely, accurate and appropriate public information.

The Action Plan expanded the IAEA Secretariat's response role in an emergency at a nuclear power plant to cover the need "to provide Member States, international organizations and the general public with timely, clear, factually

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1 See: http://www.iaea.org/Publications/Documents/Conventions/cenna.html.

2 See: http://www.iaea.org/Publications/Documents/Conventions/cacnare.html.

3 See: INTERNATIONAL ATOMIC ENERGY AGENCY, Operations Manual for Incident and Emergency Communication, EPR-IEComm 2012, IAEA, Vienna (2012); INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Response and Assistance Network, EPR-RANET 2013, IAEA, Vienna (2013); INTERNATIONAL ATOMIC ENERGY AGENCY, Joint Radiation Emergency Management Plan of the International Organizations, EPR-JPLAN 2013, IAEA, Vienna (2013).

correct, objective and easily understandable information during a nuclear emergency on its potential consequences, including analysis of available information and prognosis of possible scenarios based on evidence, scientific knowledge and the capabilities of Member States."

During an emergency at a nuclear power plant or other nuclear facility, the IAEA Secretariat's arrangements and capabilities, including its guidance, tools and expert human resources, will be used in the assessment of possible consequences and prognosis of likely emergency progression, in conjunction with the capabilities of various Member States through the IAEA's Response and Assistance Network (RANET) and/or other arrangements. The IEC has already taken specific actions[4] to fulfil the IAEA Secretariat's expanded response role.

The IAEA Secretariat fulfils its response role through the IAEA's Incident and Emergency System and the IEC. The IEC is the IAEA Secretariat's focal point for emergency preparedness and response, and the custodian of the Incident and Emergency System.

Harmonized messaging during a nuclear or radiological emergency

During a nuclear or radiological emergency, there may be many different institutions within Member States providing internal and external viewpoints related to how the emergency will develop and its potential consequences. It was evident during the response to the Fukushima Daiichi accident that many voices with divergent viewpoints speaking at once during an emergency can cause public confusion, and that this confusion may have an impact on the perception of people in decision making roles. The importance of providing consistent messages to the public during an emergency is a valuable lesson learned from the response.

During the IEM it was suggested that the IAEA's expanded response role during a nuclear or radiological emergency would be enhanced if the IAEA Secretariat were to facilitate harmonization of Member State assessment and prognosis results with those of the 'Accident State', other Member States and the IAEA. This would achieve a consistent message for public communication and promote synergy at the international level. Currently, the IAEA has within

[4] The IEC has incorporated specific arrangements in the IAEA's Response Plan for Incidents and Emergencies (REPLIE), in its operating documents and in RANET.

its assessment and prognosis process a specific step for harmonizing its message with those of the ‘Accident State’ and any directly supporting Member States.[5]

As the global focal point during a nuclear or radiological emergency, the IAEA is in a unique position to both facilitate the provision of technical data to the technical institutes performing assessment and prognosis within Member States and coordinate requests for additional technical data from the ‘Accident State’. During this process, the IAEA can provide a global forum where results can be shared, messages discussed, and a globally harmonized message achieved before being released to the public.

Providing messages to the public is a clear responsibility of many organizations at the national level during a nuclear or radiological incident or emergency. Such a harmonization mechanism would not replace any national level responsibility for keeping the public informed. Rather, such a harmonization process would allow national organizations to have knowledge of technical statements made by other organizations. The availability of other institutes’ messages would allow any messages being prepared to be considered within the global context. This would facilitate the provision of coordinated and accurate information.

Harmonized messaging process

In its current response role of providing an assessment and prognosis during a nuclear or radiological incident or emergency, the IAEA will interface with the ‘Accident State’ to harmonize those messages to the public that contain assessment and prognosis results. Following the established process[6], the IAEA will also include Member States that are directly supporting this process. Using the existing procedure, the IAEA could also include those Member States that are not directly supporting the IAEA but are performing an assessment or prognosis that will be released to the public.

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[5] INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on Preparedness and Response for a Nuclear or Radiological Emergency in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, IAEA, Vienna (2013).

[6] See: BUGLOVA, E., “Role of the IAEA in assessment or prognosis during a nuclear or radiological emergency”, paper presented at the International Experts Meeting on Assessment and Prognosis in Response to a Nuclear or Radiological Emergency, Vienna (2015); available on the attached CD-ROM and on-line at:
http://www-pub.iaea.org/iaeameetings/IEM9p/Session6/1Buglova.pdf.

Adapting the existing process would require minor changes to accommodate the following actions during an emergency using the existing emergency communication channels:

— The IAEA receives from the 'Accident State' an agreed upon set of technical information[7], relevant for understanding issues important for a global perspective, which is provided to Member States.
— Member State organizations review the technical information and identify any additional follow-up information that is needed, and provide a request for information to the IAEA (within an appropriate time frame, e.g. one hour).
— The IAEA consolidates all requests for technical information and contacts 'Accident State' authorities for follow-up (eliminating any redundant requests or requests where the follow-up information is already known).
— 'Accident State' authorities provide the follow-up information (if possible) to the IAEA, which distributes it to all.
— Within an appropriate time frame (e.g. six hours), the IAEA coordinates a forum where assessment and prognosis results from all organizations can be discussed (e.g. video teleconference, telephone conference), to be led by the IAEA and the 'Accident State' authorities.

During the preparedness phase, the IAEA works with the Member State Competent Authorities to identify those organizations that will be participating in the process and that will contribute to refining the procedures.[8] The provision of additional information — such as static technical data that have been made available to the IAEA — to those organizations identified as participating in the process could be encouraged. The IAEA will continue to organize international

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[7] This is consistent with General Conference resolution GC(58)/RES/10, which "Encourages the Secretariat and Member States operating nuclear power plants to work together with a view to developing arrangements for the timely sharing of relevant technical parameters during an emergency to support the assessment and prognosis processes conducted by the Secretariat and other Member States". See: Measures to Strengthen International Cooperation in Nuclear, Radiation, Transport and Waste Safety, Resolution GC(58)/RES/10, IAEA, Vienna (2014), para. 104.

[8] This is consistent with General Conference resolution GC(58)/RES/10, which "Requests the Secretariat to work with Member States to develop arrangements for assessments, prognosis and communication, making effective use of Member State capabilities that could be used during an emergency, and encourages Member States to inform, and periodically update, the Secretariat and other Member States of their capabilities" (ibid., para. 103).

exercises such as ConvEx-2c/d/e or ConvEx-3 exercises[9] to enable Member States to practise the process and identify areas for improvement.

By having the IAEA act as the focal point for this key technical data, this process would remove from the 'Accident State' the burden of providing such information to other countries. This would provide an organized process consolidating additional requests for follow-up technical information, thus reducing the demands on the resources and communication system of the 'Accident State'. Finally, this coordinated forum would provide an opportunity for participants to share and harmonize assessment and prognosis messages before their distribution to the public.

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[9] For further information on the ConvEx series of exercises organized by the IAEA, see: INTERNATIONAL ATOMIC ENERGY AGENCY, Operations Manual for Incident and Emergency Communication, EPR-IEComm 2012, IAEA, Vienna (2012).

Annex C

THE INTERFACE BETWEEN SAFETY AND SECURITY DURING A NUCLEAR OR RADIOLOGICAL EMERGENCY

During the IEM, the interface between nuclear and radiation safety and nuclear security was discussed with great interest by the participants. The IAEA Action Plan on Nuclear Safety addresses the requirement for a “timely, transparent and adequate response to nuclear emergencies”, which includes those evolving from nuclear security events. The IAEA publications Fundamental Safety Principles (the Safety Fundamentals)[1] and Objective and Essential Elements of a State’s Nuclear Security Regime (the Nuclear Security Fundamentals)[2] contain similar statements on the need to design and implement safety and security measures in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security. This emphasizes the need for coordination and consistency between nuclear or radiological emergency response plans and contingency plans for nuclear security events, with the purpose being to achieve the common goal of protecting human life and health and the environment from ionizing radiation hazards.

The IAEA safety standards in the area of emergency preparedness and response apply for any nuclear or radiological emergency, irrespective of its cause, and thus are applicable for preparedness and response for an emergency triggered by a nuclear security event. As a consequence, these safety standards and supporting technical guidance address and elaborate necessary arrangements for response to a nuclear or radiological emergency triggered by a nuclear security event, with the aim of allowing for coordination and integration of the emergency response with the response measures taken to address the circumstances surrounding the nuclear security event. Publications within the IAEA Nuclear Security Series address and provide guidance on the latter response measures.

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[1] EUROPEAN ATOMIC ENERGY COMMUNITY, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Objective and Essential Elements of a State’s Nuclear Security Regime, IAEA Nuclear Security Series No. 20, IAEA, Vienna (2013).

In discussions during the IEM, it was noted that while guidance in the nuclear and radiological emergency preparedness and response area was currently well advanced, the nuclear security guidance and considerations in the nuclear security community were considerably newer. Many aspects related to nuclear security and related response measures are currently under active development. Raising awareness among the nuclear and radiological emergency preparedness and response community and the nuclear security community of overlapping, complementary and mutually supportive guidance is an important issue. This is particularly true when responding to an emergency triggered by nuclear security event that has the potential to impact both areas. Building trust, understanding the roles and responsibilities of different responders, and developing a common understanding of how they can achieve their response goals should be seen as a step toward broadening the coordination and cooperation between these communities.

The discussions at the IEM emphasized the following areas of interface between nuclear and radiation safety and nuclear security in relation to preparedness and response for a nuclear or radiological emergency triggered by a nuclear security event:

— If not carefully considered, the emergency arrangements in place and established nuclear security systems may potentially conflict. Ideally, systems will exist in a non-conflicting manner and be as supportive as possible of the mutual goals. For example, although physical protection systems are a very important aspect of nuclear security, their implementation in a nuclear facility should involve consideration of how emergency workers will carry out their emergency response actions. Equally important, emergency workers need to follow the necessary nuclear security measures during their response.
— Plans and procedures in both the nuclear and radiation safety and nuclear security areas need to be coordinated, to ensure that interfaces are clearly identified and that measures are taken in the development stage to avoid any negative impact in either area. For example, the sequence of response actions, respect for each set of plans and the order of procedures need to be considered during the planning phases. How plans will be coordinated through a systematic review of results of exercises and operational experience also needs to be considered.
— The handling of sensitive information that has an impact on the nuclear and radiological emergency preparedness and response area and/or the nuclear security area needs to be considered. For example, the sharing of timely, clear, factually correct, objective, easily understandable information with the public is an important element of a successful nuclear or radiological

emergency response, but there are situations where the response to a nuclear security event may be compromised if information concerning all response actions is made available to the public (such as plans and strategies to neutralize an existing threat). The potential for conflicts of this type and how they will be managed need to be identified early in the planning phase.

The use of clear terminology in nuclear and radiation safety and nuclear security documents is necessary to improve transparency and interoperability between both communities. A common understanding of the terminology in both communities would be required for harmonized and clear messages to be delivered to the public during an emergency.

During the IEM, there was understanding that the following considerations and actions taken at the international level would facilitate the joint work aimed at improving the interface between safety and security:

— *Completion of the IAEA Nuclear Security Glossary*. Completion of the IAEA Nuclear Security Glossary would greatly aid both communities by providing common terminology for communication between technical groups and for communicating consistently with the public. Completion of the IAEA Nuclear Security Glossary will need to involve harmonization with the IAEA Safety Glossary[3].
— *Development of nuclear security guidance on the response to nuclear security events*. Currently two documents are specifically considered in the IAEA nuclear security document development plan:
  - An Implementing Guide on developing a national framework for managing response to nuclear security events;
  - Technical Guidance on regaining control over nuclear and other radioactive material out of regulatory control.

  Completion of this guidance would be of great benefit to the nuclear security community. These publications will make clear references to relevant IAEA safety standards and guidance documents regarding emergency preparedness and response in the case of an emergency triggered by a nuclear security event, helping readers to understand areas of overlap. The cross-references would aim at guiding the reader to identify and develop the actual interfaces expected and needed during planning and response phases.

[3] INTERNATONAL ATOMIC ENERGY AGENCY, IAEA Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection — 2007 Edition, IAEA, Vienna (2007).

— *Further opportunities to carry out exercises for emergencies triggered by nuclear security events*. In practice, the opportunity to learn from exercises is one of the most important ways to gain new insights into both sides of the interface between nuclear and radiation safety and nuclear security. Existing guidance in IAEA publications outlines the importance of conducting such joint exercises as well as how to conduct them.[4] Additional guidance regarding the development and conduct of exercises for nuclear security events is under development. By providing guidance to Member States on conducting response exercises for nuclear security events that consider the insider threat and/or computer security threats, the IAEA can make significant contributions to global nuclear security. This guidance is expected to complement the existing guidance on nuclear and radiological emergency exercises[5].

Action in these areas and continuation of ongoing work would allow Member States to move toward a more fully coordinated response to an emergency triggered by a nuclear security event. This will require significant efforts from both communities to develop this common understanding at the national level.

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[4] See: INTERNATIONAL ATOMIC ENERGY AGENCY, Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, EPR-Exercise 2005, IAEA, Vienna (2005).

[5] In November 2013, the IAEA conducted an international emergency response exercise (ConvEx-3 (2013)) based on a radiological emergency triggered by a nuclear security event in Morocco, with the participation of 58 IAEA Member States and nine international organizations. A report of the exercise is available at:
http://www-ns.iaea.org/downloads/iec/ConvEx-3-2013.pdf.

Annex D

CONTENTS OF THE ATTACHED CD-ROM

The following papers and presentations from the International Experts Meeting on Assessment and Prognosis in Response to a Nuclear or Radiological Emergency are available on the attached CD-ROM.

RELATED DOCUMENTS

Programme of the International Experts Meeting on Assessment and Prognosis in Response to a Nuclear or Radiological Emergency

Chairperson's Summary
R. Lewis
Nuclear Regulatory Commission, United States of America

PRESENTATIONS

Keynote Address
D. Flory
Deputy Director General, Department of Nuclear Safety and Security, International Atomic Energy Agency (IAEA)

(Keynote) New Framework for Emergency Preparedness and Response in Japan
M. Hirano
Director-General for Regulatory Standard and Research, Nuclear Regulation Authority (NRA), JAPAN

Session 1: Assessment and Prognosis during a Nuclear Emergency

(Keynote) Methodologies to Support the Prognosis of a Developing Situation and Challenges in Applying These during a Response
O. Isnard
Institute for Radiological Protection and Nuclear Safety (IRSN), FRANCE

Comparison of Approaches for Urgent Protective Actions Specified in the National Radiation Emergency Plan of Turkey and Adopted by the IAEA, HERCA-WENRA and Nordic Countries: Taking into Account Uncertainties in the Very Early Phase
G. Gokeri
Turkish Atomic Energy Authority, TURKEY

Accident Progression and Critical Issues during Reactor Accidents — An End User Perspective
R. Harter
Duane Arnold Energy Center, UNITED STATES OF AMERICA

System for Assessment and Prognosis during a Nuclear Emergency in the Czech Republic
M. Hort, K. Petrová, J. Matzner and D. Fuchsová
State Office for Nuclear Safety, CZECH REPUBLIC

Post-accident Monitoring in Pressurized Heavy Water Reactor NPPs
Inkoo Hwang and A. Lee
Korea Atomic Energy Research Institute, REPUBLIC OF KOREA

Koeberg NPP: Accident Assessment and Prognosis
L. Perryman
Eskom, SOUTH AFRICA

Emergency Preparedness and Response System for Nuclear Accidents in Argentina
I. Sadañiowski
Nuclear Regulatory Authority (ARN), ARGENTINA

Session 2: Assessment and Prognosis during a Radiological Emergency

(Keynote) The Assessment of Doses after a Radiological Release
S. Haywood
Public Health England, UNITED KINGDOM

NARAC and the International Exchange Program: Consequence Assessment Tool for Radiological Emergency Support
L. Glascoe
National Atmospheric Release Advisory Center (NARAC), UNITED STATES OF AMERICA

ARGOS: A Tool for Assessing Exposures during Radiological Emergencies
S. Hoe
Danish Emergency Management Agency (DEMA), DENMARK

Radiological Assessment and Protection of First Responders during a Radiation Emergency in EPC III and EPC IV
V. Kutkov
National Research Centre 'Kurchatov Institute', RUSSIAN FEDERATION

Monitoring and Assessment of Exposure from Unplanned Releases to the Environment: International Requirements, Guidance Documents and the Experience of Ukraine
V. Berkovskyy
Radiation Protection Institute (RPI), UKRAINE

AREVA Computer Codes for Radiological Consequence Analysis
S. Torchiani, O. Buss, S. Haussler, O. Ludwik and A. Hoefer
AREVA GmbH, GERMANY

Experience of the JCO Criticality Accident
K. Tonoike
Japan Atomic Energy Agency (JAEA), JAPAN

Session 3: Assessment of a Nuclear or Radiological Emergency Resulting from a Nuclear Security Event

(Keynote) Regulatory Measures to Ensure the Continued Effectiveness of Physical Protection Systems during a Nuclear or Radiological Emergency Caused by a Nuclear Security Event
A. Ferapontov
Federal Environmental, Industrial and Nuclear Supervision Service of Russia (Rostechnadzor), RUSSIAN FEDERATION

The Role of Nuclear Forensics Supporting Law Enforcement Investigations and Nuclear Security Vulnerability Assessments
D.K. Smith
International Atomic Energy Agency (IAEA)

Nuclear Forensics — Maintaining Chain of Custody of Evidence during a Nuclear or Radiological Emergency
K. Mayer
Joint Research Centre, EUROPEAN COMMISSION

Exercise ‘Nautilus’ and Lessons Learned from the Mixed Security and Emergency Response
I. Gorinov
Nuclear Regulatory Agency, BULGARIA

China’s Nuclear and Radiological Emergency Preparedness and Response
Zhu Zhixuan
The Permanent Mission of China to the IAEA, CHINA

The Interface of Safety and Security in the Response to a Malicious Act
E. Waller
University of Ontario Institute of Technology, CANADA

Coordinating Competing Priorities: Security, Health and Safety
H. Clark
Remote Sensing Laboratory, UNITED STATES OF AMERICA

Response Supporting System for Deterring Illicit Trafficking of Nuclear and Radioactive Materials
Sok Chul Kim
Korea Institute of Nuclear Safety, REPUBLIC OF KOREA

Session 4: Environmental Modelling and Monitoring during Nuclear and Radiological Emergencies

(Keynote) Prognosis and Assessment of the Consequences of the Fukushima Daiichi Accident Provided by the Models of the Decision Support System RODOS
M. Zheleznyak, et al.
National Academy of Sciences, UKRAINE

MODARIA Marine Transport Modelling
R. Periáñez, et al.
University of Seville, SPAIN

The Current Status of the JRodos System
C. Landman, T. Mueller, W. Raskob, D. Trybushnyi and I. Ievdin
Karlsruhe Institute of Technology (KIT), GERMANY

Time Changes in Radiocesium Concentration in Aquatic Systems Affected by the Fukushima Nuclear Power Plant Accident
Y. Onda, et al.
Center for Research in Isotopes and Environmental Dynamics, JAPAN

WMO Nuclear Emergency Response Activities in cooperation with the IAEA
G. Wotawa
World Meteorological Organization (WMO)

Environmental Measurements in an Emergency
C. Okada
Remote Sensing Laboratory, UNITED STATES OF AMERICA

Dose Reconstruction Methods and Source Term Assessment Using Data from Monitoring Networks and Mobile Teams — A German Approach
M. Bleher, U. Stöhlker and F. Gering
Federal Office for Radiation Protection (BfS), GERMANY

The Emergency Response Capabilities of the Network of Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA)
I. Osvath, A. Pitois and S. Tarjan
International Atomic Energy Agency (IAEA)

Session 5: Assessment of Food during Nuclear and Radiological Emergencies

(Keynote) Online Information System for Optimizing Decision Making in Food Safety
G. Dercon, F. Albinet, L. Adjigogov, C. Blackburn and Lee Heng
Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (IAEA)

Implementation of Information System to Respond to a Nuclear Emergency Affecting Agriculture and Food Products — Case of Morocco
A. Zouagui, et al.
Centre Nationale de l'Energie, des Sciences et des Techniques Nucléaires (CNESTEN), MOROCCO

Software Platforms for Collecting, Managing and Providing Monitoring Data for Food and Agricultural Products
H. Takemiya
Japan Atomic Energy Agency (JAEA), JAPAN

Connection between Dispersion Modelling and Remote Sensing: Methodology to Support Environmental Monitoring
E. Smejkalova, P. Carny, L. Liptak and A. Halabuk
ABmerit, SLOVAKIA

ANGLE Advanced Quantitative Gamma Spectrometry Software for Rapid and Accurate Assessment of Food, Feed, Drinking Water and Other Products during Nuclear and Radiological Emergency
S. Jovanovic and A. Dlabac
Centre for Nuclear Competence and Knowledge, University of Montenegro (UCNC), MONTENEGRO

Criteria for Decision Making Regarding Food, Milk and Drinking Water Restrictions in a Nuclear or Radiological Emergency
S. Nestoroska Madjunarova
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Session 6: Assessment and Prognosis at the International Level

(Keynote) Role of the IAEA in Assessment or Prognosis during a Nuclear or Radiological Emergency
E. Buglova
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Finland's Experience Concerning Bilateral Exercises with the IAEA
H. Aaltonen
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Member State Experience in Participation in Bilateral Exercises with the IAEA to Practice Assessment and Prognosis
G. Macsuga
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J.-F. Dodeman
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Czech–Austrian Cooperation and Data Exchange in Case of Severe Nuclear Accidents
H. Chudá, P. Hofer and N. Cernochlawek
State Office for Nuclear Safety of the Czech Republic (SÚJB), CZECH REPUBLIC, Austrian Ministry of Agriculture, Forestry, Environment and Water Management, Division of Radiation Protection (BMLFUW), AUSTRIA

Perspectives for Assessment and Prognosis Process from an NPP Exercise and a Response to a Real Event (Parts 1 and 2)
A.C. Carmona, L. Sigouin, C. Cole, F. Baciu and J. Chaput
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Session 7: The Provision and Management of Technical Data to Support Assessment and Prognosis

(Keynote) Consequence Management under the US National Response Framework
D. Van Etten
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Data Requirements during a Severe Accident
G. Johnson
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Development of a Radiological and Nuclear Emergency Dose Assessment Program in a New Nuclear Nation — A Regulator's Perspective
A. Woodruffe
Federal Authority for Nuclear Regulation (FANR), UNITED ARAB EMIRATES

Status of Assessment and Prognosis System for Nuclear Emergency Response in Korea
Seung-Young Jeong
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Development of a Platform for the Evaluation of the Source Term and the Atmospheric Dispersion of a Nuclear Facility in a Radiological Emergency Event
S. Mazidi, Bitam, B. Meftah and T.H. Fellouh
Centre de Recherche Nucléaire de Draria*, ALGERIA*

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How Important Is the Nuclear Security Team to IEA-R/RR Facility?
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N.P. Bonov
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D. Nsengiyumva, et al.
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China Institute of Atomic Energy, CHINA

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Y. López Forteza and P.F. Jerez Veguería
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A. Abaza
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D. Apriliani and Suharyanta
Nuclear Energy Regulatory Agency (BAPETEN), INDONESIA

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Nuclear Safety and Radiation Protection Authority, SIERRA LEONE

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M. Krpelanová, P. Čarný, L. Lipták and E. Smejkalová
ABmerit, SLOVAKIA

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P. Kuča and J. Koc
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