

IAEA REPORT ON  
CAPACITY BUILDING FOR  
NUCLEAR SAFETY

The following States are Members of the International Atomic Energy Agency:

AFGHANISTAN	GERMANY	OMAN
ALBANIA	GHANA	PAKISTAN
ALGERIA	GREECE	PALAU
ANGOLA	GUATEMALA	PANAMA
ARGENTINA	GUYANA	PAPUA NEW GUINEA
ARMENIA	HAITI	PARAGUAY
AUSTRALIA	HOLY SEE	PERU
AUSTRIA	HONDURAS	PHILIPPINES
AZERBAIJAN	HUNGARY	POLAND
BAHAMAS	ICELAND	PORTUGAL
BAHRAIN	INDIA	QATAR
BANGLADESH	INDONESIA	REPUBLIC OF MOLDOVA
BELARUS	IRAN, ISLAMIC REPUBLIC OF	ROMANIA
BELGIUM	IRAQ	RUSSIAN FEDERATION
BELIZE	IRELAND	RWANDA
BENIN	ISRAEL	SAN MARINO
BOLIVIA, PLURINATIONAL STATE OF	ITALY	SAUDI ARABIA
BOSNIA AND HERZEGOVINA	JAMAICA	SENEGAL
BOTSWANA	JAPAN	SERBIA
BRAZIL	JORDAN	SEYCHELLES
BRUNEI DARUSSALAM	KAZAKHSTAN	SIERRA LEONE
BULGARIA	KENYA	SINGAPORE
BURKINA FASO	KOREA, REPUBLIC OF	SLOVAKIA
BURUNDI	KUWAIT	SLOVENIA
CAMBODIA	KYRGYZSTAN	SOUTH AFRICA
CAMEROON	LAO PEOPLE'S DEMOCRATIC REPUBLIC	SPAIN
CANADA	LATVIA	SRI LANKA
CENTRAL AFRICAN REPUBLIC	LEBANON	SUDAN
CHAD	LESOTHO	SWAZILAND
CHILE	LIBERIA	SWEDEN
CHINA	LIBYA	SWITZERLAND
COLOMBIA	LIECHTENSTEIN	SYRIAN ARAB REPUBLIC
CONGO	LITHUANIA	TAJIKISTAN
COSTA RICA	LUXEMBOURG	THAILAND
CÔTE D'IVOIRE	MADAGASCAR	THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
CROATIA	MALAWI	TOGO
CUBA	MALAYSIA	TRINIDAD AND TOBAGO
CYPRUS	MALI	TUNISIA
CZECH REPUBLIC	MALTA	TURKEY
DEMOCRATIC REPUBLIC OF THE CONGO	MARSHALL ISLANDS	UGANDA
DENMARK	MAURITANIA	UKRAINE
DJIBOUTI	MAURITIUS	UNITED ARAB EMIRATES
DOMINICA	MEXICO	UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
DOMINICAN REPUBLIC	MONACO	UNITED REPUBLIC OF TANZANIA
ECUADOR	MONGOLIA	UNITED STATES OF AMERICA
EGYPT	MONTENEGRO	URUGUAY
EL SALVADOR	MOROCCO	UZBEKISTAN
ERITREA	MOZAMBIQUE	VENEZUELA, BOLIVARIAN REPUBLIC OF
ESTONIA	MYANMAR	VIET NAM
ETHIOPIA	NAMIBIA	YEMEN
FIJI	NEPAL	ZAMBIA
FINLAND	NETHERLANDS	ZIMBABWE
FRANCE	NEW ZEALAND	
GABON	NICARAGUA	
GEORGIA	NIGER	
	NIGERIA	
	NORWAY	

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

IAEA REPORT ON  
CAPACITY BUILDING FOR  
NUCLEAR SAFETY

INTERNATIONAL ATOMIC ENERGY AGENCY  
VIENNA, 2015

## COPYRIGHT NOTICE

All IAEA scientific and technical publications are protected by the terms of the Universal Copyright Convention as adopted in 1952 (Berne) and as revised in 1972 (Paris). The copyright has since been extended by the World Intellectual Property Organization (Geneva) to include electronic and virtual intellectual property. Permission to use whole or parts of texts contained in IAEA publications in printed or electronic form must be obtained and is usually subject to royalty agreements. Proposals for non-commercial reproductions and translations are welcomed and considered on a case-by-case basis. Enquiries should be addressed to the IAEA Publishing Section at:

Marketing and Sales Unit, Publishing Section  
International Atomic Energy Agency  
Vienna International Centre  
PO Box 100  
1400 Vienna, Austria  
fax: +43 1 2600 29302  
tel.: +43 1 2600 22417  
email: [sales.publications@iaea.org](mailto:sales.publications@iaea.org)  
<http://www.iaea.org/books>

© IAEA, 2015

Printed by the IAEA in Austria  
September 2015  
IAEA/REP/CAP

# **FOREWORD**

**By Denis Flory**  
**Deputy Director General**  
**Department of Nuclear Safety and Security**

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 to learn the lessons from the Fukushima Daiichi accident.

Capacity building is an area that is represented in many of the actions of the Action Plan, and includes education and training, human resource development and knowledge management. In 2014, the IAEA Secretariat organized the International Conference on Human Resource Development for Nuclear Power Programmes: Building and Sustaining Capacity, which brought together leading experts from areas such as industry, regulatory control, technical support, research and development, and academia. The conference, held in Vienna, Austria, provided a forum for the experts to share lessons learned, including those related to the accident, and to identify relevant best practices.

This IAEA Report on Capacity Building for Nuclear Safety is part of a series of reports on the lessons learned from the Fukushima Daiichi accident. It draws on the information provided at the 2014 Conference, on insights from relevant IAEA Secretariat activities undertaken since 2011 and on information provided in relevant International Experts Meetings. It is possible that additional information and analysis related to the accident may become available in the future, and will need to be considered.

I am grateful to the participants in the conference and in all the other meetings and activities who contributed their valuable input. I hope that this report will serve as a valuable information tool and reference for governments, regulatory bodies, technical support organizations, nuclear operators, the media and the general public, and that it will contribute to further capacity building for nuclear safety.

## EDITORIAL NOTE

*The presentations on the attached CD-ROM (including the figures, tables and references) have not been reviewed by the editorial staff of the IAEA. The views expressed remain the responsibility of the named authors or participants. In addition, the views are not necessarily those of the governments of the nominating Member States or of the nominating organizations.*

*This report does not address questions of responsibility, legal or otherwise, for acts or omissions on the part of any person.*

*Although great care has been taken to maintain the accuracy of information contained in this publication, neither the IAEA nor its Member States assume any responsibility for consequences which may arise from its use.*

*The use of particular designations of countries or territories does not imply any judgement by the publisher, the IAEA, as to the legal status of such countries or territories, of their authorities and institutions or of the delimitation of their boundaries.*

*The mention of names of specific companies or products (whether or not indicated as registered) does not imply any intention to infringe proprietary rights, nor should it be construed as an endorsement or recommendation on the part of the IAEA.*

*The authors are responsible for having obtained the necessary permission for the IAEA to reproduce, translate or use material from sources already protected by copyrights.*

*Material prepared by authors who are in contractual relation with governments is copyrighted by the IAEA, as publisher, only to the extent permitted by the appropriate national regulations.*

*This publication has been prepared from the original material as submitted by the authors. The views expressed do not necessarily reflect those of the IAEA, the governments of the nominating Member States or the nominating organizations.*

*The IAEA has no responsibility for the persistence or accuracy of URLs for external or third party Internet web sites referred to in this book and does not guarantee that any content on such web sites is, or will remain, accurate or appropriate.*

*The depiction and use of boundaries, geographical names and related data shown on maps do not necessarily imply official endorsement or acceptance by the IAEA.*

# CONTENTS

1.	INTRODUCTION .....	1
1.1.	Background .....	2
1.2.	Objective .....	4
2.	DISCUSSIONS AT THE INTERNATIONAL CONFERENCE ON HUMAN RESOURCE DEVELOPMENT FOR NUCLEAR POWER PROGRAMMES .....	5
2.1.	Background .....	5
2.2.	Insights from the conference .....	6
3.	INSIGHTS FROM THE IAEA PEER REVIEW SERVICES .....	8
4.	INSIGHTS FROM OTHER INTERNATIONAL EXPERTS MEETINGS .....	11
5.	LESSONS LEARNED .....	13
5.1.	General .....	13
5.2.	Education and training .....	15
5.3.	Human resource development .....	16
5.4.	Knowledge management .....	17
5.5.	Knowledge networks .....	19
6.	SUMMARY AND CONCLUSIONS .....	20
ANNEX A:	CHAIRPERSON'S SUMMARY .....	23
ANNEX B:	SUMMARY OF RELATED IAEA ACTIVITIES DISCUSSED AT THE CONFERENCE .....	28
ANNEX C:	CONTENTS OF THE ATTACHED CD-ROM .....	32





# 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. Subsequently, the Conference adopted a Ministerial Declaration on Nuclear Safety, which requested the Director General to prepare a draft Action Plan<sup>1</sup>. The draft Action Plan on Nuclear Safety (the Action Plan) was approved by the Board of Governors at its September 2011 meeting.<sup>2</sup> 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”.<sup>3</sup>

Another action focuses on strengthening and maintaining capacity building, including two sub-actions:

“Member States with nuclear power programmes and those planning to embark on such a programme to strengthen, develop, maintain and implement their capacity building programs, including education, training and exercises at the national, regional and international levels; to continuously ensure sufficient and competent human resources necessary to assume their responsibility for safe, responsible and sustainable use of nuclear technologies...”<sup>4</sup>

“Member States with nuclear power programmes and those planning to embark on such a programme, to incorporate lessons learned from the accident into their nuclear power programme infrastructure...”<sup>4</sup>

---

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

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

<sup>3</sup> *Ibid.*, p. 6.

<sup>4</sup> *Ibid.*, p. 5.

Given that there has not been a specific International Experts Meeting (IEM) on the subject of strengthening and maintaining capacity building, this report considers the discussions and the outcomes of the conferences and meetings that addressed this subject following the Fukushima Daiichi accident. The aim is to share with Member States the most significant lessons learned to date regarding strengthening and maintaining capacity building in the light of the Fukushima Daiichi accident.

This report considers the discussions and the conclusions of the International Conference on Human Resource Development for Nuclear Power Programmes (the 2014 Conference), held on 12–16 May 2014, the insights gained from IAEA peer review and support services relating to capacity building for nuclear safety, and the discussions at relevant IEMs on this topic. The report is expected to contribute to the ongoing efforts to assist Member States in strengthening capacity building for nuclear safety and constitutes an integral part of implementation of the Action Plan. The report is part of a series of IAEA reports from IEMs that summarize the lessons learned from the Fukushima Daiichi accident.

## 1.1. BACKGROUND

Following the Fukushima Daiichi accident, the international community addressed, among other things, the issue of strengthening capacity building for nuclear safety. In the Declaration by the IAEA Ministerial Conference on Nuclear Safety in Vienna on 20 June 2011, the Ministers of the IAEA Member States underlined the need for States operating nuclear power programmes and the IAEA to promote capacity building, including education and training for both regulators and operators.

Capacity building is a major first step in the process of ensuring a sustainable supply of competent human resources capable of applying nuclear technologies in a safe, responsible and sustainable manner. The building of competence for all parties with responsibilities for the safety of nuclear facilities is a requirement of the IAEA safety standards.<sup>5</sup>

---

<sup>5</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, Governmental, Legal and Regulatory Framework for Safety, IAEA Safety Standards Series No. GSR Part 1, IAEA, Vienna (2010).

The importance of human resources was highlighted by the International Nuclear Safety Group (INSAG)<sup>6</sup>, which recognized that education in nuclear science and technology needs to be stabilized in order to maintain sufficient human resources in sciences and engineering relating to nuclear safety. In addition, the Contracting Parties to the Convention on Nuclear Safety are committed to taking the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety related activities in or for each nuclear installation, throughout its life.

INSAG also noted that for Member States embarking on a nuclear power programme:

“The responsibility for safety requires that the new entrant operator establish and maintain the necessary competencies of both staff and management for safe operations. This entails providing adequate training and effective knowledge management, establishing the culture and methodologies to maintain safety under all conditions, and verifying that all activities and processes are safe.”<sup>7</sup>

Capacity building has been defined<sup>8</sup> as a systematic and integrated approach to develop and continuously improve the governmental, organizational and individual competencies and capabilities necessary for achieving a safe, secure and sustainable nuclear power programme. The lessons learned that are presented in this report relate to the four essential elements of the umbrella approach (see Fig. 1) for capacity building, which include:

- Education and training;
- Human resource development;
- Knowledge management;
- Knowledge networks.

---

<sup>6</sup> INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Maintaining Knowledge, Training and Infrastructure for Research and Development in Nuclear Safety, INSAG-16, IAEA, Vienna (2003).

<sup>7</sup> INTERNATIONAL NUCLEAR SAFETY GROUP, Licensing the First Nuclear Power Plant, INSAG-26, IAEA, Vienna (2012).

<sup>8</sup> MALLICK, S., MOLLOY, B., “Capacity Building”, CN-215, paper presented at IAEA Int. Conf. on Human Resour. Dev. for Nucl. Power Programmes Vienna, 2014.



FIG. 1. Capacity building, the umbrella approach.

In 2012, the IAEA Secretariat and an advisory group of Member States developed an integrated strategy for education and training in nuclear safety for the period 2013–2020 to strengthen support for capacity building in Member States. The IAEA Secretariat’s capacity building programmes cover all areas related to nuclear safety including safe operation, emergency preparedness and response, infrastructure development and regulatory effectiveness.

## 1.2. OBJECTIVE

The objective of this report is to highlight the relevant lessons learned in the light of the Fukushima Daiichi accident for strengthening capacity building for nuclear safety in Member States. This report was prepared by the IAEA Secretariat and is intended to serve as a reference for government officials, technical experts, diplomats, the media and the general public. It is expected that the report will contribute to Member States’ efforts in building and sustaining capacity for nuclear safety.

## **2. DISCUSSIONS AT THE INTERNATIONAL CONFERENCE ON HUMAN RESOURCE DEVELOPMENT FOR NUCLEAR POWER PROGRAMMES**

### **2.1. BACKGROUND**

The IAEA organized two international conferences, in 2007<sup>9</sup> and 2010<sup>10</sup> that addressed the issues of human resource development and knowledge management. These conferences emphasized the importance of the role of the national government, educational institutions, industry and international organizations toward meeting the challenge of strengthening capacity building through adequate human resource development.<sup>11</sup> A major outcome of the 2010 Conference was the recognition of the need for local, national and international cooperation for human resource development for nuclear power programmes.

The 2014 Conference was attended by around 300 experts and senior officials from 65 Member States and 5 international organizations. The objectives of the conference included:

- To review global progress in human resource development, education and training, knowledge management and knowledge networks;
- To emphasize the importance of capacity building at the national and organizational levels for achieving safe, secure and sustainable nuclear power programmes;
- To exchange information on international, national and organizational approaches, programmes and experience gained to date.

---

<sup>9</sup> The International Conference on Knowledge Management in Nuclear Facilities was held from 18 to 21 June 2007 in Vienna.

<sup>10</sup> The International Conference on Human Resource Development for Introducing and Expanding Nuclear Power Programmes was held from 14 to 18 March 2010 in Abu Dhabi.

<sup>11</sup> Human Resource Development for Introducing and Expanding Nuclear Power Programmes (Proc. Int. Conf. Abu Dhabi, 2010), IAEA, Vienna (2012).

The Chairperson's summary of the conference along with all conference papers and presentations can be found in the Annexes to this report and on the conference web site<sup>12</sup> and on the attached CD-ROM.

## 2.2. INSIGHTS FROM THE CONFERENCE

The highlights of the technical presentations, conclusions and recommendations discussed at the 2014 Conference as they relate to capacity building are presented below.

Conference participants recognized that capacity building programmes need to cover the full scope of nuclear activities. These programmes require the active involvement of government, regulatory bodies, industry, academia, research and development organizations and technical and scientific support organizations (TSOs). Capacity building in Member States is being addressed on many levels:

- The individual level: Individual capacity building is the development of the knowledge and skills of individuals to enable them to fulfil specific responsibilities in specific organizations.
- The organizational level: The key organizations for capacity building include government ministries, nuclear energy programme implementing organizations, regulatory bodies, operating organizations, technical and scientific support organizations, and education and training institutions.
- The national level: The role of government is crucial to the development of integrated and comprehensive national approaches to capacity building.
- The international level: Globalization of the nuclear industry has led to a number of international cooperative programmes in the area of networks on nuclear education, training, knowledge management, safety and security.

The 2014 Conference recognized that there are many factors affecting capacity building activities in Member States depending on the status or maturity of the nuclear power programme. Those Member States embarking on new nuclear power programmes need to establish and develop capacity. Member States with expanding programmes need to respond to the need for additional human resources, while Member States with mature programmes need to ensure a stable capacity of human resources.

---

<sup>12</sup> See <http://www-pub.iaea.org/iaecameetings/46084/International-Conference-on-Human-Resource-Development-for-Introducing-and-Expanding-Nuclear-Power-Programmes-Building-and-Sustaining-Capacity>.

The Conference participants emphasized that human resources are the backbone of every nuclear power programme and require a significant variety of skills and training. The conference highlighted the key role governments have in integrating education and training programmes into an overall strategy for building and maintaining capacity. Such an overall strategy needs to involve all relevant stakeholders<sup>13</sup> and cover the medium or long term to ensure intergenerational knowledge transfer.

The results of national human resource requirements analysis contribute to the effectiveness of strategies to develop and strengthen capacity building, and are extremely useful for estimating education and training needs in the short and medium term. A number of participants reported on the progress of systematic analyses of human resource needs, which are being conducted for new and mature nuclear programmes at the national and regional levels.

Several good examples of managing and improving education and training systems were presented, including training needs analysis and the systematic approach to training<sup>14</sup>. The systematic approach to training comprises five interrelated phases including:

- Analysis of training needs;
- Design of training programmes;
- Development of training material;
- Implementation of training;
- Evaluation of training effectiveness.

Given that nuclear power programmes can span many generations, the 2014 Conference emphasized the importance of addressing knowledge management over the life cycle of a nuclear power plant from design through construction, commissioning, operation and decommissioning or closure. Proper knowledge management is vital for operating organizations, regulatory bodies, and design and construction organizations for countries with mature nuclear programmes as well as for newcomer countries. The importance of international support for capacity building efforts in newcomer countries was highlighted.

The participants noted that networks have proven to be a key mechanism to support knowledge management and capacity building and have helped to foster harmonization and cooperation among stakeholders. A number

---

<sup>13</sup> Stakeholders include governments, regulators, operators, research and development design organizations and academia.

<sup>14</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, Experience in the Use of Systematic Approach to Training (SAT) for Nuclear Power Plant Personnel, IAEA-TECDOC-1057, IAEA, Vienna (1998).

of successful existing and new networks that work at the organizational, national and international levels were presented during the conference.

### **3. INSIGHTS FROM THE IAEA PEER REVIEW SERVICES**

The insights from a number of IAEA peer review and assessment services that focused on capacity building or one of its components, such as education and training, human resource development, knowledge management or knowledge networks, are presented in the following.

The Education and Training Appraisal (EduTA) service was introduced in 2005 to provide an assessment of the national legal and regulatory infrastructure related to education and training in radiation protection and the safety of radiation sources. To date, EduTA has been used in 17 missions to 14 Member States. This service has shown that not all Member States have a national strategy for education and training for radiation protection and safety. The service highlighted the importance of involving all relevant stakeholders, particularly the regulatory body, in establishing requirements for education and training in radiation protection and safety. Criteria and procedures for the recognition and designation of qualified experts and radiation protection officers need to be clearly established by the regulatory body or other governmental authorities. Information on national infrastructures and capabilities for education and training in radiation protection and safety from EduTA missions need to be disseminated for the benefit of all Member States to support their efforts to develop and strengthen their education and training infrastructure.

The Education and Training Review Service (ETReS) was established in 2012 to assist Member States in developing and maintaining a sustainable and adequate education and training programme in nuclear safety. The ETReS complements the EduTA service. To date, the ETReS has been used in three Member States. Experience with this service has highlighted the importance of systematic analyses of education and training needs for capacity building for nuclear safety. The systematic approach to training is important to a number of organizations, including operators, regulatory bodies, TSOs and research and development organizations. The analysis of education and training gaps needs to be comprehensive and needs to involve all relevant stakeholders in order to minimize gaps in education and training programmes and in human resources. To that end, a national integrated human resource development plan needs to be developed, regularly evaluated and updated.



The Integrated Regulatory Review Service (IRRS) is designed to strengthen and enhance the effectiveness of the national regulatory infrastructure of Member States for nuclear, radiation, radioactive waste and transport safety and security. The first IRRS missions were conducted in 2006 and more than 50 initial and follow-up IRRS missions have been carried out worldwide to date. The service has highlighted the importance of a national policy and strategy for nuclear safety that includes provisions for ensuring that the necessary capacity is developed and competence is maintained. The systematic approach to training needs to be used for the development of regulatory body staff, and formal qualification programmes should ideally be in place along with a regulatory inspector refresher training programme. A systematic competence needs assessment, as supported by the Systematic Assessment of Regulatory Competence Needs (SARCoN), is important in order to improve regulatory competence building programmes.

The SARCoN methodology<sup>15,16,17</sup> has been used by Member States since 2005. To date, the IAEA Secretariat has provided SARCoN training seminars in over 20 Member States, including more than ten embarking countries. Strategies for capacity building need to be supported by adequate education and training programmes as well as management systems and knowledge management programmes. Such strategies need to be developed systematically based on the identification of needs followed by the design, development, implementation and final evaluation of activities. The self-assessment approach of SARCoN supports capacity building, promotes ownership and facilitates follow-up actions, while ensuring that national priorities are taken into account.

Other related IAEA services and reviews that have a component related to capacity building for nuclear safety include the Operational Safety Review Team (OSART) programme, and the Emergency Preparedness Review (EPREV) and the Integrated Nuclear Infrastructure Review (INIR) services.

The OSART programme was established to assist Member States in enhancing safe operation of nuclear power plants<sup>18</sup>. More than 180 OSART

---

<sup>15</sup> Systematic Assessment of Regulatory Competence Needs for Regulatory Bodies of Nuclear Facilities SARCoN Guidelines, available at: [http://www-ns.iaea.org/downloads/ni/training/sarcon/sarcon\\_rev14\\_ade6.pdf](http://www-ns.iaea.org/downloads/ni/training/sarcon/sarcon_rev14_ade6.pdf).

<sup>16</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, Managing Regulatory Body Competence, Safety Reports Series No. 79, IAEA, Vienna (2013).

<sup>17</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, Methodology for the Systematic Assessment of the Regulatory Competence Needs (SARCoN) for Regulatory Bodies of Nuclear Installations, IAEA-TECDOC-1757, IAEA, Vienna (2015).

<sup>18</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, OSART Mission Highlights 2010–2012: Operational Safety Practices in Nuclear Power Plants, available at: <http://www-ns.iaea.org/downloads/ni/s-reviews/osart/osart-mission-highlights%202010-2012.pdf>.

missions to nuclear power plants and corporate organizations have been performed to date. These missions have highlighted the need to systematically and periodically evaluate the effectiveness of training programmes and the training methods used for continuous improvement of the operational safety of nuclear power plants. Nuclear power plant staff need to be given the opportunity for refresher training, and nuclear power plant simulator facilities need to reflect the current status of the specific plant in order to achieve the desired training results.

EPREV missions have been conducted in Member States since 1999 to review national emergency preparedness and response arrangements and capabilities. The missions have shown that, to achieve globally harmonized capabilities and responses to emergencies, there is a continuing need for greater awareness of the international safety standards and compatibility requirements for all Member States, both those with and without nuclear power programmes. Regional and interregional education and training programmes are needed on assessment and decision making during an emergency to promote a harmonized and consistent global response. There is a need for better educational programmes in both public and risk communications to adequately communicate health risks during nuclear emergencies. There is also a need for knowledge networks to provide a platform for emergency preparedness professionals to share their knowledge and experience on capacity building.

The Integrated Nuclear Infrastructure Review (INIR) supports Member States embarking on nuclear power programmes in the preparatory phase leading to the introduction of a first nuclear power plant. The main objective of an INIR mission is to assist the Member State in determining its infrastructure status and to identify further development needs. By 2015, 15 INIR missions had been conducted in 10 Member States.

The INIR missions have shown the importance of clearly specifying the scope and timeline of a national nuclear power programme so that capacity building programmes can be based on sound predictions of future needs. The roles and responsibilities of the different organizations involved in capacity building programmes need to be clearly identified, and effective national coordination of capacity building activities is required to ensure that the necessary resources are available when they are needed by the nuclear power programme.

INIR missions have also highlighted the need to clearly distinguish education activities that are usually a governmental issue, such as a national education plan, from human resource development, of which the latter builds on an initial educational background and is provided by individual organizations such as the nuclear energy programme implementing organization, the regulatory body, or nuclear power plant owners or operators. Capacity building for the regulatory body or TSOs can be a major challenge for embarking countries. These organizations manage their own development either nationally or through

bilateral arrangements. Capacity building for the operating organization is typically provided by the nuclear power plant vendor.

In 2005, the IAEA introduced assistance missions ('assist missions') through Knowledge Management Assist Visits (KMAVs) for nuclear industry operating organizations. These missions cover knowledge management policy, strategy and culture, human resources, training and human performance, document management and IT solutions as well as external collaboration. To date, 26 KMAV missions have been conducted to 17 Member States. Experience from these missions has shown that nuclear safety knowledge management needs to be included in an organization's management system so that it is consistently embedded in business processes across the organization. The KMAV missions have also highlighted that nuclear safety related topics need to be incorporated into the education and training curricula for nuclear engineers and for other technical and non-technical disciplines of relevance to nuclear facilities or activities. A sound understanding of topics related to nuclear safety needs to be embedded in the whole nuclear workforce.

#### **4. INSIGHTS FROM OTHER INTERNATIONAL EXPERTS MEETINGS**

While the need to strengthen and maintain capacity building is specifically highlighted in the Action Plan, the elements of capacity building relate to a number of other actions. The importance of capacity building activities in strengthening nuclear safety was identified at a number of IEMs; the relevant lessons learned and observations of the experts are summarized in the following.

Regulatory bodies<sup>19</sup> need to be independent and competent and need to have strong legislative authority and adequate human and financial resources. Achieving and sustaining these characteristics is the responsibility of national governments.

---

<sup>19</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on Strengthening Nuclear Regulatory Effectiveness in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, IAEA, Vienna (2013), available at: <https://www.iaea.org/sites/default/files/reffectiveness0913.pdf>.

Capacity building efforts to effectively meet the needs of recovery actions that follow a nuclear or radiological accident,<sup>20</sup> or to deal with nuclear legacy facilities can be costly and take a long time. These efforts require the mobilization of sufficient and competent personnel and resources for extended periods of time. Member States making the transition to large scale decommissioning of nuclear power plants face many challenges in maintaining a stable and skilled workforce.

Research and development<sup>21</sup> activities are important for the identification of gaps in scientific and technical capacity including knowledge, research, expertise, and education and training. Research and development can be used to identify the needs for infrastructure development and ongoing capacity building activities at the national, regional or international levels.

All Member States would benefit from a programme of capacity building in radiation protection. An accident similar in scale to the Fukushima Daiichi accident would pose a significant challenge to the radiation protection capabilities of many Member States, including States without a nuclear power plant.<sup>22</sup> Consequently, well trained people and adequate equipment are needed to respond to a nuclear or radiological accident and its aftermath. The decommissioning and remediation activities following the Fukushima Daiichi accident will last several decades, and radiation protection expertise is one of the key skills required for the implementation of these activities.

The importance of training, particularly related to response capabilities, was a common lesson learned that was highlighted at a number of IEMs.

The continuous training of staff in severe accident mitigation capabilities is essential to improve the overall response capability of both staff at the nuclear power plant and the experts in support centres.<sup>23</sup>

---

<sup>20</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on Decommissioning and Remediation after a Nuclear Accident, IAEA, Vienna (2013), available at: <https://www.iaea.org/sites/default/files/decommissioning0913.pdf>.

<sup>21</sup> IAEA Report on Strengthening the Effectiveness of Research and Development in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, IAEA, Vienna (2015).

<sup>22</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on the International Experts Meeting on Radiation Protection after the Fukushima Daiichi Accident: Promoting Confidence and Understanding, IAEA, Vienna (2014), available at: <http://www.iaea.org/sites/default/files/radprotection0914.pdf>.

<sup>23</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on the International Experts Meeting on Reactor and Spent Fuel Safety in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, IAEA, Vienna (2012), available at: <https://www.iaea.org/sites/default/files/spentfuelsafety2012.pdf>.

Human and organizational factors<sup>24</sup> play a significant role in the identification of specific training for nuclear power plant operating personnel. The Fukushima Daiichi accident highlighted the need to better understand and implement an integrated, or systemic, approach to safety so as to ensure proper preparation and training of those who will be dealing with an unexpected nuclear or radiological event. A review of major accidents yields insights into the human and organizational factors involved in their occurrence. Some of these factors relate to failures in training to deal with the unexpected.

Dedicated training is also essential for those responsible for communicating with the public and the media in the event of a nuclear or radiological emergency.<sup>25</sup> Spokespeople, public information officers, executives and experts must be included in the preparedness phase. In addition, the establishment of a systematic, effective and regular training programme is necessary for all national and local responders to an emergency (from national experts to security guards). Continuous education and training, including the involvement of stakeholders, are essential to creating and maintaining emergency preparedness and awareness.

## 5. LESSONS LEARNED

The lessons learned presented below are summarized within the framework of the four pillars of capacity building and are preceded by some general cross-cutting lessons.

### 5.1. GENERAL

Human resource capability and knowledge are essential for a safe, secure and sustainable nuclear power programme and require dedicated programmes at the global, national and organizational levels.

---

<sup>24</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on the International Experts Meeting on Human and Organizational Factors in Nuclear Safety in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, IAEA, Vienna (2014), available at: <https://www.iaea.org/sites/default/files/humanfactors0914.pdf>.

<sup>25</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Report on the International Experts Meeting on Enhancing Transparency and Communication Effectiveness in the Event of a Nuclear or Radiological Emergency, IAEA, Vienna (2012), available at: <https://www.iaea.org/sites/default/files/enhancetransparency180612.pdf>.

Nuclear safety requirements underscore the importance of capacity building, as the abilities of all nuclear operators, regulators and other relevant organizations require sufficient numbers of competent staff. The safety requirements established in Governmental, Legal and Regulatory Framework for Safety (IAEA Safety Standards Series No. GSR Part 1)<sup>26</sup> require that at the national level, “[t]he government shall make provision for building and maintaining the competence of all parties having responsibilities in relation to the safety of facilities and activities.” GSR Part 1 also requires that “[a]s an essential element of the national policy and strategy for safety, the necessary professional training for maintaining the competence of a sufficient number of suitably qualified and experienced staff shall be made available.”

In addition, the operating organization is to ensure that all activities that may affect safety are performed by suitably qualified and competent persons, and a regulatory body is to be established and maintained with the competence and the resources necessary to fulfil its statutory obligations.<sup>27</sup>

To meet these needs, capacity building for nuclear safety needs to be promoted through activities at the individual, organizational, national and global levels. Activities need to be designed to take advantage of the strengths of each of these levels. Each of the four pillars of capacity building requires a targeted programme that addresses nuclear safety needs.

The life cycle of a nuclear power plant usually spans more than one generation and government support is essential to develop a nationally coordinated strategy for capacity building that encompasses all relevant stakeholders.

Capacity building for nuclear safety needs to be supported by governments and through a national strategy to ensure that all stakeholders are involved during the full life cycle of a nuclear power programme. National strategies can help to identify the gaps in capacity building efforts at the national level, and can also help to contribute to higher level objectives, such as a strong safety culture, safety leadership and transparency.

---

<sup>26</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, Governmental, Legal and Regulatory Framework for Safety, IAEA Safety Standards Series No. GSR Part 1, IAEA, Vienna (2010).

<sup>27</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Commissioning and Operation, IAEA Safety Standards Series No. SSR-2/2, IAEA, Vienna (2011). INTERNATIONAL ATOMIC ENERGY AGENCY, Governmental, Legal and Regulatory Framework for Safety, IAEA Safety Standards Series No. GSR Part 1, IAEA, Vienna (2010).

The IAEA peer review services and their associated self-assessments, such as SARCoN or ETReS, allow for the identification of capacity building needs and provide a means of monitoring progress in building and sustaining capacity in nuclear safety.

Peer review services are an important mechanism for exchanging information and experience to strengthen nuclear safety in a harmonized and transparent manner, both at the organizational and national levels. There is a need for enhanced sharing of peer review mission findings for the benefit of all Member States as a means to provide an improved knowledge base for capacity building efforts.

The self-assessments that are associated with IAEA peer reviews are important tools as they increase ownership and facilitate follow-up actions, while ensuring that national priorities are taken into account.

Member States need to consider hosting peer reviews or conducting self-assessments, sharing results in a transparent manner and ensuring that appropriate follow-up actions are implemented.

## 5.2. EDUCATION AND TRAINING

Education and training infrastructure and processes are fundamental to the capacity building strategy of Member States, as they provide a structure to develop the capacity of those individuals involved in the application of nuclear technologies. Education and training provide the basis for human resource development, knowledge management and knowledge networking.

A systematic approach to training, including quality assurance and continuous improvement, needs to be a component of the management system of all organizations relevant for nuclear safety.

Nuclear power plant operating organizations are required to ensure that all activities that may affect safety are performed by suitably qualified and competent personnel. A suitable training programme is to be established and maintained for the training of personnel which is to include provision for periodic confirmation of the competence of personnel and for refresher training on a regular basis. The content of each programme is to be based on a systematic approach. The training programmes are to be assessed and improved by means of periodic review.<sup>28</sup>

---

<sup>28</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, *Safety of Nuclear Power Plants: Commissioning and Operation*, IAEA Safety Standards Series No. SSR-2/2, IAEA, Vienna (2011).

The systematic approach to training needs to be embedded in the organization's management system, which allows for continuous improvement and the ability to address issues such as quality management, staff development and lifelong learning. While some qualifications included in the systematic approach to training need to be formalized and codified, others, such as team cooperation and gender or cultural awareness, need to be promoted as soft skills. In both cases, regulatory oversight of the development and implementation of the systematic approach to training is important.

Technical experts may have specific needs in terms of continuous learning, and require a tailored systematic approach to training programmes. These needs can be met through specific skills development plans, drills and exercises, particularly for areas where prompt decision making is needed to implement emergency response actions and accident mitigation measures.

A harmonized understanding of nuclear safety education and training, skills, and competence standards is instrumental to building a sustainable and strong safety culture, to which experts from a wide range of disciplines, both technical and non-technical, can make important contributions. This understanding can also facilitate the transfer of staff and knowledge between organizations or Member States. This can contribute to individual career development based on established qualification schemes, and contributes to nuclear safety worldwide.

Systematically conducted human resource needs analyses are useful to identify capacity building needs in the short and medium term as well as to assess and evaluate the effectiveness of current efforts.

Safety issues need to be incorporated into the training not only for nuclear engineering, but also for other related technical and non-technical disciplines so that the nuclear workforce, as a whole, has a sound understanding of safety issues. Experts from non-technical disciplines, such as the behavioural sciences, can significantly contribute to understanding the interaction of human, organizational and technical factors and how they contribute to nuclear safety.

### 5.3. HUMAN RESOURCE DEVELOPMENT

Human resource development is a means to ensure that sufficient competent human resources are available for the activities that may affect safety. This includes the adoption of a structured approach for the development of an effective workforce at the national and organizational levels. This approach will enable Member States to estimate the human resource needs for a nuclear power programme, assess the existing capability, identify competency gaps, if any, and plan and implement activities to fill these gaps.



Increased emphasis needs to be placed on medium and long term planning of capacity building and human resource development, particularly for those Member States embarking on a nuclear power programme.

An integrated national human resource development plan needs to be developed and regularly updated. The national government plays an important role in initiating or leading the development of such a national plan. The plan needs to include the current and expected human resource demand for the different qualification levels and technical areas and be based on the overall plan for the national nuclear power programme.

For Member States embarking on a nuclear power programme, a clear understanding of the programme timeline and the implications for human resource needs is essential. This understanding will allow the provision of sufficient qualified and competent staff at the right time. In addition, greater attention needs to be directed to the capacity building needs of regulatory bodies and TSOs.

It is important to clearly define and distinguish the roles of the government and other relevant organizations for human resource development and education and training. While education is primarily a national governmental responsibility, individual organizations maintain human resource development plans and recruitment programmes, which, in turn, are fed by the national human resource pool.

The migration of the workforce between Member States has increased and needs to be taken into account in any national or organizational planning. Monitoring national workforce migration and organizational staff recruitment trends, and consolidating the findings at the national level can contribute to appropriately address these increases in migration.

#### 5.4. KNOWLEDGE MANAGEMENT

Knowledge management is essential for effective implementation of capacity building programmes. It combines the people, processes and technology aspects of knowledge under one integrated approach. Knowledge management deals with capturing, structuring, retaining and transmitting knowledge and requires an understanding of the concepts of organizational knowledge and individual knowledge. The transfer of knowledge can be of crucial importance for nuclear safety; for example, it is essential for knowledge to be transferred from a vendor country to a Member State embarking on a nuclear power programme. Knowledge transfer across generations is necessary for countries with mature nuclear power programmes and with an ageing workforce.

Medium and long term knowledge management planning is needed to effectively manage knowledge transfer to future generations. The life cycle of a nuclear power plant can span several decades and many generations; consequently, knowledge transfer to future generations is needed from normal operation through to decommissioning of nuclear power plants. Intergenerational transfer of knowledge, experience and skills is important to inform the education and training programmes for subsequent generations.

In addition, the activities undertaken to recover from a nuclear power plant accident, as well as to deal with nuclear legacy situations, will also require knowledge management and knowledge transfer over a period of decades. These activities need the mobilization of knowledgeable and experienced national and international personnel for extended periods of time. Sustaining these efforts for decades is a challenge that requires medium and long term knowledge management planning.

Nuclear safety knowledge needs to be managed proactively through programmes at the national and organizational levels, particularly programmes for regulatory bodies and TSOs.

At the national level, knowledge management requires the inclusion of all relevant stakeholders. The processes for the creation, preservation and sharing of knowledge need to be aligned with the nuclear power programme timelines to ensure the right knowledge is available at the right time. These processes need to be sustainable and need to take into consideration any anticipated technological and societal changes.

At the organizational level, the availability of nuclear safety knowledge is crucial for both operating organizations and regulatory bodies. Nuclear safety knowledge needs to be managed by every relevant organization, and the knowledge management process needs to be embedded into the management system.

Although the responsibility for safety rests primarily with the operating organization, governments and regulatory bodies also have an important responsibility to establish standards and the regulatory framework to protect people and the environment from the harmful effects of ionizing radiation. Knowledge management is essential for regulatory bodies to effectively fulfil their functions. IAEA safety standards require that a process be established to develop and maintain the necessary competence and skills of staff of the regulatory body, as an element of knowledge management.<sup>29</sup>

---

<sup>29</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, Governmental, Legal and Regulatory Framework for Safety, IAEA Safety Standards Series No. GSR Part 1, IAEA, Vienna (2010).

## 5.5. KNOWLEDGE NETWORKS

Knowledge networks can be composed of networks of people or organizations that are linked by a common infrastructure for coordination or collaboration. Knowledge networks have been established to manage the knowledge and experience in an organization and to promote the pooling, analysis and sharing of knowledge at the national, regional and international levels. Knowledge networks allow for continuous improvements in nuclear safety related knowledge.

Knowledge networks are an effective mechanism to share knowledge, pool resources and develop a harmonized understanding of nuclear safety. Connecting all networks and initiatives under the Global Nuclear Safety and Security Network (GNSSN)<sup>30</sup> needs to be an important objective of future work.

Capacity building for nuclear safety can be supported through increased networking to share lessons learned, to expand the knowledge base and to increase transparency. Regional and global knowledge networks can also be instrumental for building a harmonized understanding of safety culture as an overarching objective.

Global networks such as the GNSSN have been instrumental in promoting a global nuclear safety and security framework and in connecting, under one umbrella, the activities of the various participating global, regional and national networks and initiatives. Member States should consider fostering and strengthening their participation in this initiative.

Knowledge networks require a technical infrastructure to share knowledge in a structured manner. National platforms with a shared information and communication technology infrastructure, such as the national safety knowledge platforms under the GNSSN, have proven to be good tools that can be used widely. A shared infrastructure, such as this, can be a powerful tool to support national, regional and global cooperation and capacity building for nuclear safety.

Knowledge networks can help share the available knowledge nationally, regionally or globally, and can thereby reduce costs. For example, systematically implemented ETReS reviews at the national level, supported by regional cooperation mechanisms and knowledge networks, can help share training resources among participating national institutions in the region and can provide enhancements for existing training courses.

---

<sup>30</sup> A complete overview of the GNSSN is available at: <http://gnssn.iaea.org/More/Home.aspx>.

Dissemination of nuclear safety knowledge is important in order to improve and enhance public information and outreach, and can be facilitated through nuclear safety knowledge and education networks.

Knowledge networks are useful mechanisms for reaching out to society and building bridges between the nuclear sector and the public. Capacity building programmes need to include public outreach and interaction with the community so that basic nuclear knowledge becomes available to, and is shared by, a broader societal group. This can also help to reduce boundaries between nuclear and non-nuclear professions and to build a stable scientific and technical human resource reservoir for nuclear professions.

Public perception and confidence depend on the availability and communication of information. The regulator is often considered the main trusted source of information. Regulatory bodies need to enhance communication, transparency and sharing of regulatory knowledge and experience with interested parties such as industry and the general public.

Existing regional nuclear safety knowledge networks, such as the Asian Nuclear Safety Network, the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies, the Arab Network of Nuclear Regulators and the Forum of Nuclear Regulatory Bodies in Africa, can be used as models of efficient and effective nuclear safety knowledge management mechanisms to share nuclear safety information, good practices and practical experience. They can also provide for a capacity building framework and enhance sustainable national and regional nuclear safety infrastructures. Existing regional nuclear education networks, such as the Asian Network for Education in Nuclear Technology, the Latin American Network for Education in Nuclear Technology and the AFRA Network for Education Science and Technology are equally important mechanisms in this context.

## **6. SUMMARY AND CONCLUSIONS**

The Action Plan, unanimously adopted by Member States following the Fukushima Daiichi accident, identified capacity building as one of the key areas for strengthening nuclear safety. This IAEA Report on capacity building for nuclear safety draws on the discussions of the 2014 Conference as well as on experience from IAEA peer review services. The report summarizes the lessons learned in each of the essential elements of capacity building, namely, education and training, human resource development, knowledge management and knowledge networks.

Both nuclear power plant operating organizations and regulatory bodies require suitably qualified and experienced staff. The life cycle of nuclear facilities usually spans more than one generation, and an overarching lesson is that human resource capacity and knowledge management are essential for nuclear safety and require ongoing programmes at the organizational, national and global levels over the long term. National governments play a key role in supporting the development of a nationally coordinated strategy for capacity building that encompasses all relevant stakeholders.

National strategies can also help promote higher level objectives, such as strong safety culture, safety leadership and transparency. The national government is to make provisions for building and maintaining the competence of human resources. National governments can be instrumental in developing a harmonized understanding of nuclear safety education and training to which experts from a wide range of disciplines, both technical and non-technical, can make important contributions.

The challenges of capacity building differ depending on whether a Member State is embarking, maintaining or expanding a nuclear power programme or undertaking decommissioning of nuclear power plants.

The IAEA peer review services and associated self-assessments provide a good means of monitoring progress and identifying gaps and areas for further work and improvements in capacity building. Member States should consider hosting such peer reviews or conducting self-assessments, sharing results in a transparent manner and ensuring appropriate follow-up on recommendations.

A systematic approach to training needs to be integrated into the management systems of all organizations relevant to nuclear safety. Safety issues need to be incorporated into the curricula of higher education and training, not only for nuclear engineering, but also for related technical and non-technical subjects. In addition, expertise from non-nuclear disciplines can provide valuable insights into the interaction of human, organizational and technical factors and how they can contribute to nuclear safety.

Nuclear safety knowledge needs to be managed through programmes at both the national and the organizational levels, including regulatory bodies and TSOs. Nuclear regulators need to maintain the necessary nuclear safety knowledge to carry out their legal function as regulator, both in terms of having independent knowledge themselves and making informed decisions regarding the appropriate knowledge of operators.

Knowledge networks are an effective mechanism to share knowledge, to pool resources and to develop a harmonized understanding of nuclear safety culture and leadership. One important objective of future work needs to be the connection of all networks and initiatives under one single umbrella, such as the

GNSSN. Knowledge networks are also useful mechanisms that can help reach out to society and build bridges between the nuclear sector and the public.

## Annex A

### CHAIRPERSON'S SUMMARY<sup>1</sup>

#### **International Conference on Human Resource Development for Nuclear Power Programmes**

Thank you for participating in this conference and remaining until the end. I would like to begin my closing remarks by looking back four years. The 2010 Conference on Human Resource Development for Introducing and Expanding Nuclear Power Programmes highlighted the importance of human resources, the need to broaden nuclear curricula, emphasized governmental and societal support, requested more cooperation in building human resources and proposed a follow-up conference to be held to monitor progress.

In response, the IAEA organized this conference we are about to conclude. It has focused on capacity building, human resource development, attracting the next generation, education and training, nuclear knowledge management and knowledge networks. I am pleased to say that the conference was very successful. It was attended by more than 300 participants from 65 Member States and 5 international organizations, a very good turnout, and an increase from the 2010 Conference. Participation was also very broad and covered all types of countries: newcomers, countries with expanding nuclear power programmes and 'mature' countries. It also covered all types of institutions: from industry to regulators to academia. This is clear evidence that capacity building and human resource development continues to be of high interest to many Member States.

Let us now review the work we have done in the course of the last five days.

The first insight is that the drivers for capacity building are manifold: countries with new programmes need to build up new capacity, countries with expanding programmes need to recruit additional workforce and countries with mature programmes need to ensure stable capacity and turnover. In addition, nuclear safety and security requirements provide strong drivers, and the importance of capacity building was rightly underlined in the IAEA Action Plan on Nuclear Safety.

---

<sup>1</sup> 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.

A second insight is that in terms of nuclear activities, the world has changed since the 2010 Conference. New nuclear power programmes have started in several countries, we see a continuing globalization in nuclear power, we expect the decommissioning of additional plants in countries with phase-out policies and the Fukushima accident has led to additional safety enhancement.

I am pleased that an impressive number of activities in Member States that address these challenges were presented, and that the IAEA has responded to these developments as well with a host of activities. In all areas we heard about this week — nuclear energy, nuclear safety and nuclear security — the IAEA has active programmes that support capacity building in Member States. New IAEA services and guidance have been developed, for example, the Capacity Building Self-Assessment Methodology. New networks have been established for nuclear education and training and nuclear safety and security. Other IAEA services continue to play an important role, for example, the expanding catalogue of training and e-learning courses. The IAEA's technical cooperation programme will remain essential in this area.

Against this background, and while we will continue to need to learn from each other, we are now in a phase of implementing capacity building programmes based on proven mechanisms.

A third important insight is that capacity building programmes need to cover the full scope of the nuclear programme. They should encompass fuel, power and waste facilities; consider government, regulators, industry, academia and research; include all academic subjects needed; and cover nuclear programme management and outreach into society at large.

As a fourth insight, we heard this week that capacity building is a real need and is being addressed on many levels, all of which need to be considered:

- On the individual level, development of staff and lifelong learning are important. New multidisciplinary curricula complement the traditional engineering curricula, and training schemes supplement university education.
- On the corporate level, we see a growing culture of corporate knowledge management and recruitment programmes. The nuclear sector at present offers a very supportive environment for the younger generation and new employees.
- On the national level, we heard about the importance of an integrated and comprehensive national approach for capacity building. The role of governments is crucial for such an approach.



- On the global level, the globalization of the nuclear industry is mirrored by an increased internationalization of university programmes, recruitment and professional careers. A growing number of international cooperative programmes, for example, in the area of networks in nuclear education, safety and security, were presented.

As a fifth insight, I would like to comment on progress made in reducing boundaries between nuclear and non-nuclear professions. Professionals outside the nuclear sector increasingly benefit from having basic knowledge of nuclear technology, safety and security, for example in governmental organizations, trade unions, commerce and local authorities, achieved and supported by training offers, proactive outreach and communication. Nuclear professionals, in turn, often have additional qualifications in non-nuclear subjects, such as law, economics, management, social sciences, communication and public administration, and we heard good examples of new or multidisciplinary curricula that support this trend. In addition to these challenges on the level of professionals, a greater general understanding by the public of nuclear technologies was deemed desirable.

From the five sessions we followed in the course of the past five days, we made the following important findings:

- Human resource needs analyses are now conducted more systematically both by mature and new nuclear programmes and sometime even at a regional level, e.g. in Europe. These analyses are extremely useful to education and training efforts in the short and medium term. Human resources are the backbone of every nuclear energy programme, and a significant variety of personnel in terms of skills and training are required.
- Progress in human resource development has been made by considering both vocational training and academic education; by considering interfaces between technical, safety and security issues; by recognizing the importance of non-nuclear knowledge and by reaching out to society.
- We heard several good examples of managing and improving the education and training pipelines. We looked at training needs analysis, the systematic approach to training process, national programmes and international support to newcomer countries. Key conclusions were that education and training is strengthening across all levels of the skills pyramid with good blending of theory, practical and hands-on experience.

- Strategic outreach plans are crucial for workforce development, commitment of the next generation and for building acceptance of nuclear energy. Organizations should maintain and further develop pathways ‘from education to employment’ and be ready to inspire, develop and encourage the next generation. There is also a need to engage better with the public so that dialogue with prospective future nuclear professionals becomes more attractive.
- Education and training programmes should be integrated into an overall strategy for building and maintaining capacity, supported by governments. For regulators, management of competencies is of particular importance, and the Systematic Assessment of Regulatory Competence Needs was presented as a useful tool in that regard.
- Networks have become a proven and key mechanism to support knowledge sharing and capacity building and to foster harmonization and cooperation. A large number of successful existing and new networks working at corporate, national and international levels were presented this week.
- Nuclear programmes are large scale and long term. The knowledge required for the safe, reliable and efficient operation of nuclear facilities is an asset that should be properly managed. Knowledge management should address each area of a nuclear programme from design through construction, commissioning, operation and decommissioning or closure of nuclear facilities. Proper knowledge management contributes to meeting a company’s strategic and business objectives. It is vital not only for operating, design and construction companies, but also for regulatory bodies, technical support organizations and for countries with mature nuclear programmes as well as for newcomer countries.

The IAEA is to be commended for this timely and fruitful conference, organized jointly by the Departments of Nuclear Energy and Nuclear Safety and Security. The conference concluded that capacity building is a major and important step in the process of ensuring a sustainable supply of qualified human resources for safe, secure and sustainable nuclear power programmes.

The IAEA is invited to further develop its support for capacity building, to document good practices, to continue to develop tools and guidance, to provide services and assistance and to continue to facilitate international coordination and cooperation.

Member States, in turn, are invited to join existing networks and make use of the available IAEA services, including the new capacity building self-assessment methodology.

There have been significant, practical developments since the 2010 Conference and we all look forward to the next occasion to continue our discussions, possibly at another follow-up conference four or five years from now.

My thanks go in particular to all speakers, session chairs and co-chairs and to the conference rapporteur. I also thank all participants for their valuable time, attendance and contributions.

It was your participation that made this conference a success. Thank you.

Marta Ziakova

16 May 2014

## Annex B

### SUMMARY OF RELATED IAEA ACTIVITIES DISCUSSED AT THE CONFERENCE

In the area of capacity building for nuclear safety, the IAEA is implementing a number of activities, which were reported on at the 2014 conference. The following chapter provides a brief summary of these activities.

#### B-1. NUCLEAR SAFETY

The IAEA Secretariat has developed a strategic approach to education and training in nuclear safety over the period 2013–2020, in line with and in support of the Action Plan<sup>1</sup>. Activities specifically related to supporting the efforts of Member States to strengthen the technical and managerial competencies of their regulatory bodies include:

- The development of Guidelines for Systematic Assessment of the Regulatory Competence Needs (SARCoN) to identify gaps in the competencies of regulatory bodies to perform their functions, and gaps in their related training needs. A software tool to facilitate the application of SARCoN has been made available to Member States.
- The publication of IAEA Safety Report No. 79, *Managing Regulatory Body Competence*.<sup>2</sup>
- The ongoing revisions of the textbook and workbook titled, *Regulatory Control of Nuclear Power Plants*, for the basic professional training course on nuclear safety.
- The development of packages of exemplary training material, based on IAEA safety standards and practical case studies, to support workshops and expert missions tailored to the needs of regulatory bodies of countries embarking on nuclear power programmes.
- New safety services that include the Education and Training Review Service and the Safety Assessment Advisory Programme, which use the Safety Assessment Education and Training Programme.

---

<sup>1</sup> Draft IAEA Action Plan on Nuclear Safety, Report by the Director General, GOV/2011/59-GC(SS)/14, IAEA, Vienna (2011).

<sup>2</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, *Managing Regulatory Body Competence*, Safety Reports Series No. 79, IAEA, Vienna (2013).

The approach to education and training outlined here complements the Strategic Approach to Education and Training in Radiation, Transport and Waste Safety until 2020 that was established by the IAEA, which calls upon Member States to develop national strategies for education and training in this area. The related Education and Training Appraisal service has been hosted by 14 Member States.

The IAEA has also invested efforts in strengthening capacity building in the area of emergency preparedness and response, particularly in the light of the Fukushima Daiichi accident. A recent achievement is linked to the IAEA Response and Assistance Network (RANET) and the designation of the IAEA RANET Capacity Building Centre in Fukushima Prefecture. This project commenced in December 2012, following the signing of the Practical Arrangements between the IAEA and the Ministry of Foreign Affairs of Japan under the Memorandum of Cooperation between the IAEA and the Fukushima Prefecture. Since then, a number of workshops related to nuclear and radiological emergency preparedness and response have been conducted in this centre.

## B-2. NUCLEAR SECURITY

As with safety, capacity building is critical for sustaining and advancing national nuclear security regimes. In pursuit of this goal, the IAEA has made several important advances in its nuclear security education and training programmes, including inter alia:

- The development and implementation of a comprehensive training programme offered to Member States in a variety of disciplines covering all aspects of nuclear security. Between 2010 and 2014, more than 300 national, regional and international training courses based on publications and recommendations in the IAEA Nuclear Security Series were implemented. These publications have been developed in conjunction with the Member States and represent internationally accepted standards.
- A model Master of Science academic curriculum based on IAEA Nuclear Security Series No. 12, Educational Programme in Nuclear Security<sup>3</sup>, developed jointly with a large group of international experts, and the creation in 2010 of the International Nuclear Security Education Network (INSEN). A growing number of universities and departments offer new

---

<sup>3</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, Educational Programme in Nuclear Security, IAEA Nuclear Security Series No. 12, IAEA, Vienna (2010).

programmes or courses in nuclear security using the materials developed by INSEN experts and institutions, including a consortium of European universities offering a pilot Master of Science programme which was inaugurated by the Director General in 2014. Non-European universities are following this lead.

- The establishment of the international network of Nuclear Security Training and Support Centres (NSSC), which helps to ensure sustainable nuclear security by acting as a resource base to facilitate national training. This network also provides technical support services for life cycle equipment management and scientific support services for the detection of and response to nuclear security events. Some 50 States have established such centres or have plans to do so. The IAEA coordinates the activities of the NSSC network with a view to strengthening nuclear security training and support services as a cornerstone of national, regional and international capacity building activities.

The value of this work and the importance of capacity building for nuclear security was recognized in the Ministerial Declaration adopted at the International Conference on Nuclear Security, which was organized by the IAEA and held in Vienna in 2013, as well as by IAEA Member States through IAEA General Conference resolutions and other international fora such as the 2014 Nuclear Security Summit in The Hague<sup>4</sup>.

### B-3. THE GLOBAL NUCLEAR SAFETY AND SECURITY NETWORK

One of the main functions of the IAEA under its Statute is to “foster the exchange of scientific and technical information on peaceful uses of atomic energy”. Therefore, the IAEA is committed to facilitating the exchange of information, experience and knowledge among its Member States.

While international cooperation has increased in recent years, nuclear safety and security knowledge remains scattered all over the globe. Different experiences, competencies and needs at the individual, organizational and national levels continue to exist. In addition, countries with limited technical infrastructure are embarking on nuclear power programmes. In this complex environment, the Global Nuclear Safety and Security Framework (GNSSF) represents a good and proven instrument for achieving a high level of nuclear safety and security worldwide. The Global Nuclear Safety and Security

---

<sup>4</sup> See <http://www.nss2014.com/en>.

Network (GNSSN), in this context, constitutes the heart of the GNSSF, and brings together international legal instruments with the national nuclear safety and security infrastructure. Moreover, the GNSSN supports the IAEA's nuclear safety and security programme. In line with the Action Plan, the GNSSN, as a knowledge network, supports capacity building in Member States and contributes to enhancing international cooperation and dialogue in the field of nuclear safety and security.

Over the past few years, the GNSSN has become a worldwide gateway to sharing nuclear safety and security knowledge and services to facilitate capacity building among IAEA Member States. The IAEA has brought together existing and new knowledge networks in nuclear safety and security under the GNSSN. These networks include global networks such as the International Regulatory Network, the Technical and Scientific Support Organization Forum and the Global Safety Assessment Network. The GNSSN includes regional networks such as the Asian Nuclear Safety Network, the Arab Network of Nuclear Regulators, the Forum of Nuclear Regulatory Bodies in Africa and the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies. It also includes thematic networks such as the Regulatory Cooperation Forum, the Forum for Senior Regulators of CANDU Reactors, the WWER Regulators' Forum and the Control of Sources Network. Under the GNSSN, the IAEA Incident and Emergency Centre launched the Emergency Preparedness Network (EPnet) in September 2014. This serves as a collaborative network for emergency preparedness and management professionals at all levels to share knowledge, identify common issues and exchange solutions.

The GNSSN is an inclusive concept that links, complements and brings together all existing networks and initiatives and is recognized as instrumental in harmonizing approaches and adopting best practices to achieve sustainable nuclear safety and security infrastructures. It is considered as the means to sustain the implementation of the international legal framework and focuses on assisting Member States in meeting their national responsibilities as well as their international obligations. Since 2011, over 350 capacity building regional and national activities were implemented under the GNSSN framework, gathering together more than 3500 experts from 120 Member States.

## Annex C

### CONTENTS OF THE ATTACHED CD-ROM

*The following papers and presentations from the International Conference on Human Resource Development for Nuclear Power Programmes (2014) are available on the attached CD-ROM.*

#### OPENING SESSION

Opening Remarks

*D. Flory*

Deputy Director General and Head of the Department of Nuclear Safety and Security, International Atomic Energy Agency (IAEA)

Opening Remarks

*A. Bychkov*

Deputy Director General and Head of the Department of Nuclear Energy, International Atomic Energy Agency (IAEA)

Speech on the 2010 Conference Outcomes

*H. Alkaabi*

Ambassador, Permanent Mission of the United Arab Emirates to the IAEA,  
UNITED ARAB EMIRATES

Capacity Building

*S. Mallick and B. Molloy*

International Atomic Energy Agency (IAEA)

Self-evaluation on Capacity Building in Finland: Report of the Committee for Nuclear Energy Competence in Finland

*J. Isotalo and J. Aurela*

Posiva Oy, FINLAND



## PRESENTATIONS

### Session 1A (Monday): Human Resources and Capacity Building

**(Introduction)** Capacity Building in the IAEA Action Plan on Nuclear Safety

*G. Caruso*

International Atomic Energy Agency (IAEA)

Strategic International Cooperation of Fukui Prefecture Government in Human Resource Development for Nuclear Power Programmes

*I. Nishikawa*

Governor of Fukui Prefecture, JAPAN

The Nuclear Power Institute Programs for Human Resource Development for the Nuclear Industry

*K.L. Peddicord*

Texas A&M University, USA

Human Resource Development in a Newcomer Country: Malaysia Nuclear Power Corporation's Experience as a Dedicated Nuclear Energy Programme Implementing Organization (NEPIO)

*Mohd Zamzam Jaafar*

Malaysia Nuclear Power Corporation (MNPC), MALAYSIA

Method of Competence System Estimation for the Ukrainian NPP Personnel

*M. Gushchyna*

Certification Body "RosUkrSert", UKRAINE

Japan Nuclear Safety Institute's Activities for Reflecting Lessons Learned from the Fukushima Daiichi Accident

*A. Kugo*

Japan Nuclear Safety Institute (JANSI), JAPAN

Human Capital Management Concept

*J.-C. Veyre and V. von Atzigen*

Swiss Federal Nuclear Safety Inspectorate (ENSI), SWITZERLAND

Human Resources Development for Jordan's Nuclear Energy Programme

*S. Malkawi and D. Amawi*

Jordan University of Science and Technology, JORDAN

Challenges in Building Capacity for a Nuclear Programme in the Philippines

*E.M. Bacarra*

Philippine Council for Industry, Energy and Emerging Technology, Research and Development, Department of Science and Technology (PCIEERD-DOST), PHILIPPINES

Sudan Country Profile — Human Resource Development (HRD) for the First Nuclear Power Programme

*E.H. Elneel Yousif*

Ministry of Science and Technology, SUDAN

Design and Safety Assessment Review Service (DSARS): The Safety Assessment Advisory Programme (SAAP)

*P. Hughes*

International Atomic Energy Agency (IAEA)

Capacity Building in Emergency Preparedness and Response

*P. Kenny*

International Atomic Energy Agency (IAEA)

### **Session 1B (Tuesday): Human Resources and Capacity Building**

Fostering of Innovative Talents Based on Disciplinary Construction: Human Resource Development Strategy of the Chinese Nuclear Power Industry

*Ye Yuanwei*

Shanghai Nuclear Engineering Research and Design Institute, CHINA

Human Resources Development Challenges for Nuclear Newcomers

*R. Geisser and X. Perrette*

AREVA GmbH, GERMANY and AREVA University, FRANCE

European Human Resources Observatory for the Nuclear Energy Sector

*M. Flore*

Joint Research Centre, European Commission, EU

Building Capacity through Leadership Development Programmes in the Nuclear Industry

*A. Afonin and T. Terentyeva*

Corporate Academy of the State Atomic Energy Corporation ‘Rosatom’, RUSSIAN FEDERATION

## **Session 1C (Tuesday): Human Resources and Capacity Building**

Manpower Development to Support the Indian Graduate Training School Programme of BARC and its Incorporation in the University System

*B.K. Dutta*

Bhabha Atomic Research Centre (BARC), INDIA

Human Resources Development by the Eastern European Research Reactor Initiative (EERRI)

*H. Böck, et al.*

Vienna University of Technology, AUSTRIA

Progress in Human Resources Development of the Office of Atoms for Peace, Thailand

*P. Ampornrat*

Ministry of Science and Technology, THAILAND

## **Session 2A (Tuesday): Preparing the Next Generation of Nuclear Professionals**

**(Introduction)** Capacity Building in the IAEA's Technical Cooperation Programme

*O. Acuña*

International Atomic Energy Agency (IAEA)

Plans for Competency-based Human Resources Management in KINS

*Young-Joon Choi*

Korea Institute of Nuclear Safety (KINS), REPUBLIC OF KOREA

From Education to Employment — Inspiring and Strengthening the Pathways to Secure our Nuclear Future

*L. Matthews*

EDF Energy, UK

Bridge of Generations: Project of OJSC Atomenergomash

*M. Komarova*

JSC Atomenergomash, RUSSIAN FEDERATION

European Master in Innovation in Nuclear Energy (EMINE), Developed in the Framework of the European Institute of Innovation and Technology, KICINNOENERGY

*J. Dies, et al.*

Technical University of Catalonia (UPC), SPAIN

**Session 2B (Tuesday): Preparing the Next Generation of Nuclear Professionals**

A Chance for Young Nuclear Professionals in Slovenské elektrárne, a Member of the Enel Group

*J. Zlatnansky*

Slovenské elektrárne, SLOVAKIA

Initiatives of the Belgian SCK•CEN Academy to Attract Young Talent in Nuclear Research and Technology

*M. Coeck*

Belgium Nuclear Research Centre (SCK•CEN), BELGIUM

Human Resources Requirements for New Nuclear Power Programs

*C.T. Goodnight*

Goodnight Consulting, Inc., USA

Training Courses in Support of GEN-IV Development — The Case of SVBR Technology

*A. Kondaurov, N. Zaitseva, A. Yunikova and V. Artisiuk*

Rosatom Central Institute for Continuing Education and Training (Rosam-CICE&T), RUSSIAN FEDERATION

Training Solutions to Support Embarking Countries in the Framework of Practical Arrangements with the IAEA: Lessons Learned in ROSATOM Central Institute for Continuing Education and Training

*V. Artisiuk*

Rosatom Central Institute for Continuing Education and Training (Rosam-CICE&T), RUSSIAN FEDERATION

Human Resources Development for the Rooppur Nuclear Power Programme in Bangladesh

*K. Hossain*

Bangladesh Atomic Energy Commission, BANGLADESH

Human Resources Development in Tajikistan

*U. Mirsaidov*

Nuclear and Radiation Safety Agency (NRSA), TAJIKISTAN

The Gulf Nuclear Energy Infrastructure Institute (GNEII) Four Years On

*R.J. Finch, A.H. Mohagheghi, A. Solodov, P.A. Beeley and D.R. Boyle*

Sandia National Laboratories, USA

Developing National Capacity to Initiate a Nuclear Power Programme

*M.M. Ndontchueng*

National Radiation Protection Agency (NRPA), CAMEROON

Management of Human Resources in CNCAN

*P. Ghinea and C. Goicea*

Romanian National Commission for Nuclear Activities Control (CNCAN), ROMANIA

EU Activities for Training and Tutoring of Nuclear Regulatory Authorities and Technical Support Organisations Outside the EU

*H. Pauwels, P. Daures and Y. Stockmann*

EuropeAid, European Commission, EU

Establishing Sustainable Infrastructures for Education and Training in Radiation, Transport and Waste Safety: IAEA's Approach to Support Member States

*J. Wheatley*

International Atomic Energy Agency (IAEA)

Human Resources Capacity Building as a Strategy in Strengthening Nuclear Knowledge Sustainability in the Experimental Fuel Element Installation of BATAN-Indonesia

*R. Langenati, B. Herutomo and A.S. Adhi*

National Nuclear Energy Agency (BATAN), INDONESIA

The Value of the Junior Professional Officer Program to the IAEA and its Member States

*S.E. Pepper*

Brookhaven National Laboratory, USA

Nuclear Education in Sudan with Emphasis on the Atomic Energy Council

*A.M.E. Hassan*

Ministry of Science and Technology, SUDAN

Educational Network Environment: Models and Implementation

*H. Zhivitskaya*

Belarusian State University of Informatics and Radioelectronics, BELARUS

Guarding the Gates: Confronting Social Engineering in Nuclear Power

*J. LeClair*

National Cybersecurity Institute at Excelsior College, USA

Building Newcomer Competence for NPP Safety Assessment through Learning by Doing: Development of Level 1 Probabilistic Safety Assessment for Research Reactors

*I. Kuzmina*

International Atomic Energy Agency (IAEA)

Education and Training Networks as a Tool for Nuclear Security Human Resource Development and Capacity Building

*D. Nikonov, A. Durczok and I.Y. Suh*

International Atomic Energy Agency (IAEA)

### **Session 3A (Wednesday): Building and Sustaining Capacity through Education and Training**

**(Introduction)** Education and Training

*J.K. Park*

International Atomic Energy Agency (IAEA)

Nuclear Education and Training for Building and Sustaining Capacity from Korean Experience

*Youngmi Nam*

Korea Atomic Energy Research Institute (KAERI), REPUBLIC OF KOREA

Overview of the NRA Human Resource Development Center and NRA Cooperation and Support for IAEA/ANSN

*S. Sato*

Nuclear Regulation Authority (NRA), JAPAN

Hungarian-Vietnamese Nuclear Energy Train the Trainers Course

*A. Aszódi, I. Boros, S. Czifrus and I. Kiss*

Budapest University of Technology and Economics, HUNGARY

EDF Skills Management for Operations

*C. Poizat*

Electricité de France (EDF), FRANCE

**Session 3B (Wednesday): Building and Sustaining Capacity through Education and Training**

The WINS Academy Security Certification Programme: The Route to Demonstrable Competence

*R. Howsley*

World Institute for Nuclear Security (WINS), AUSTRIA

Human Resources Management in the Belgian TSO Bel V

*M. Roobaert, B. Bernard and P. Mignot*

Bel V, BELGIUM

Strengthening Technical Specialist Training for an Expanding Nuclear Power Programme in the UK

*J. Robertson*

GEN II Engineering & Technology Training Ltd, UK

**Session 3C (Wednesday): Building and Sustaining Capacity through Education and Training**

Systematic Approach to Training and Professional Development Specialists of Physical Protection, Accounting and Control of Nuclear Materials in Ukraine

*N. Klos*

Ministry of Energy and Coal Industry, UKRAINE

Human Resource Development for the Proposed 9.6 GW Nuclear Build Programme in South Africa

*J.F.S. Larkin*

University of the Witwatersrand, SOUTH AFRICA

Improving Education, Training and Communication with the Public on Ionizing Radiation

*N. Železnik*

Regional Environmental Center for Central and Eastern Europe (REC), SLOVENIA

Nuclear Training Excellence Project in Slovenské elektrárne

*A. Kvočková, M. Tonkovičová and M. Baláž*

Slovenské elektrárne, SLOVAKIA

**Session 3D (Wednesday): Building and Sustaining Capacity through Education and Training**

The Nuclear Technology Education Consortium: Helping to Build and Maintain Nuclear Capacity Globally

*J. Roberts*

The University of Manchester, UK

Nuclear Business Acumen Training for Executives

*J. Blomgren*

Institute for Nuclear Business Excellence, SWEDEN

Lessons Learned in Performing and Implementing the Results of Training Needs Assessment in a Newly Developed Regulatory Body with a Mandate to Regulate the Country's Expanding Nuclear Power Programme: A Case Study of PNRA

*M. Shahzad*

Pakistan Nuclear Regulatory Authority (PNRA), PAKISTAN

New Initiatives for International Cooperation for Nuclear Education in the Russian Federation

*M. Strikhanov*

National Research Nuclear University MEPhI, RUSSIAN FEDERATION

SEC NRS Experience in Development of Training Programs in Nuclear Safety Regulation

*E. Sokolova*

Scientific and Engineering Centre for Nuclear and Radiation Safety (SEC NRS), RUSSIAN FEDERATION

The Concept of a Training System for Newly Established Operators in Embarking States

*Y. Seleznev, V. Aspidov and V. Artisiuk*

Rosatom Central Institute for Continuing Education and Training (Rosam-CICE&T), RUSSIAN FEDERATION



The Role of Computer-based Educational Laboratories in Nuclear Engineering University Programmes

*S.A. Korolev, A.N. Kosilov, E.V. Chernov and S.B. Vygovskiy*

National Research Nuclear University MEPhI, RUSSIAN FEDERATION

Nuclear Security Education in ‘Non-nuclear’ Countries — Inseparable Component of the Global Nuclear Security Scheme: Example of Montenegro

*S. Jovanovic*

University of Montenegro, MONTENEGRO

Nuclear Energy Management Curriculum

*Y. Yanev*

Nuclear Knowledge Management Institute, AUSTRIA

Multimedia Course on Nuclear Reactor Physics, Application to a Tailored on the Job Training Course

*J. Dies*

Nuclear Engineering Research Group (NERG), Technical University of Catalonia (UPC), SPAIN

ISIS Training Reactor: A Reactor Dedicated to Education and Training for Students and Professionals

*F. Foulon*

French Alternative Energies and Atomic Energy Commission (CEA), FRANCE

The Safety Assessment Education and Training Programme (SAET)

*M. Mellinger-Deroy*

International Atomic Energy Agency (IAEA)

IAEA Strategic Approach to E&T in Nuclear Safety 2013–2020

*M.J. Moracho Ramirez*

International Atomic Energy Agency (IAEA)

International Training Program on Nuclear Engineering at Kinki University

*S. Hohara, G. Wakabayashi, H. Yamanishi and T. Itoh*

Kinki University, Atomic Energy Research Institute, JAPAN

Policy, Development and Delivery of Education and Training Programmes in Radiation Protection: A Crucial Contribution to the Safe Use of Ionising Radiation

*M. Coeck*

SCK•CEN Academy, BELGIUM

Establishing Requirements for Nuclear Engineering Educational Programs

*N.I. Geraskin, A.N. Kosilov and M.M. Sbaffoni*

National Research Nuclear University MEPhI, RUSSIAN FEDERATION

Approaches to Education and Training for Kenya's Nuclear Power Program

*H.A. Kalambuka*

University of Nairobi, KENYA

Contribution of a Master's Program to Building Competencies in Nuclear Sciences in Morocco

*O.K. Hakam*

University of Ibn Tofail, MOROCCO

Country Presentation

*N. Kone*

Malian Radiation Protection Agency (AMARAP), MALI

Human Resource Development for Nuclear Power Programme in Uganda

*O. Henry*

Ministry of Energy and Mineral Development, UGANDA

E-learning for Newcomers on the IAEA Milestones Approach

*L. Halt*

International Atomic Energy Agency (IAEA)

Systematic Assessment of Regulatory Competences (SARCON) V18a

*M. Zimmermann*

International Atomic Energy Agency (IAEA)

#### **Session 4A (Thursday): Knowledge Management**

**(Introduction)** How IAEA Nuclear Knowledge Management Approaches Support the Building and Sustaining of Nuclear Capacity in Member States

*J. de Grosbois*

International Atomic Energy Agency (IAEA)

Knowledge Management at the U.S. Nuclear Regulatory Commission

*J. Hudson*

Nuclear Regulatory Commission (NRC), USA

A Knowledge Transfer Program for Engineering Students at Master Level at the Technical University of Madrid

*G. Jimenez and E. Mínguez*

Technical University of Madrid (UPM), SPAIN

Evolution of Knowledge Management: From Expert Systems to Innovation 2.0

*D. Karagiannis*

University of Vienna, AUSTRIA

How Knowledge Mapping is Being Used to Integrate Plans for Safe and Reliable Operations

*J. Day*

Sellafield Ltd, UK

#### **Session 4B (Thursday): Knowledge Management**

Knowledge Management: The Case of Turkey as a Newcomer

*Ş. Udum*

Hacettepe University, TURKEY

Human Resource Development Activities in Japan and Contribution to the Global Standards

*M. Uesaka*

Nuclear Professional School, University of Tokyo, JAPAN

Nuclear Knowledge Loss Risk Management: Lessons Learned, Implementation Experiences

*R. Květoňová*

ČEZ, a.s., CZECH REPUBLIC

Approaches to Maintaining and Building Organisational Knowledge

*T. Juurmaa*

Fortum Nuclear and Thermal, FINLAND

## **Session 4C (Thursday): Knowledge Management**

Managing Knowledge for Innovative Development

*V. Pershukov*

State Atomic Energy Corporation “Rosatom”, RUSSIAN FEDERATION

Knowledge Management Strategy Adopted by PNRA: A Case Study

*Z.A. Baig, F. Ansari and A. Awan*

Pakistan Nuclear Regulatory Authority (PNRA), PAKISTAN

Knowledge Management Integration into Strategic Human Capital Management Systems

*T. Marco and D. Heler*

Palo Verde Nuclear Generating Station, USA

## **Session 5A (Thursday): Knowledge Networks**

**(Introduction)** Education and Training, and Knowledge Networks for Capacity-building in Nuclear Security

*K. Mrabit*

International Atomic Energy Agency (IAEA)

European Technical Safety Organisations Network (ETSON) as Important Part of International Nuclear Safety Knowledge Networks

*H. Teske, F. Dierschow and C. Eibl-Schwäger*

Gesellschaft für Anlagen- und Reaktorsicherheit mbH (GRS), GERMANY

Contribution of IAEA, FNRBA and ANNuR as Networking in Developing and Maintaining Capacity Building for a Nuclear Power Programme: Comparative Study

*O. Elsiddig Ali Osman*

Sudanese Nuclear and Radiological Regulatory Authority (SNRRA), SUDAN

AFRA-NEST: A Tool for Human Resource Development

*E. Amanor, E.H.K. Akaho and Y. Serfor-Armah*

Ghana Atomic Energy Commission, GHANA

The Importance of Knowledge Management in Human Resource Development

*S. Pleslic*

University of Zagreb, CROATIA

Knowledge Management Course for Master Program in Nuclear Engineering  
*N.I. Geraskin, A.N. Kosilov and E.G. Kulikov*  
National Research Nuclear University MEPHI, RUSSIAN FEDERATION

ROSATOM Knowledge Management System  
*A. Dub*  
State Atomic Energy Corporation “Rosatom”, RUSSIAN FEDERATION

Knowledge Management (KM) Risk Assessment of Critical Knowledge Loss  
in an Organization with an Expanding Nuclear Power Program  
*M. Mohsin*  
Pakistan Atomic Energy Commission (PAEC), PAKISTAN

Knowledge Pipeline: A Task Oriented Way to Implement Knowledge  
Management  
*Jiajie Pan*  
Shanghai Nuclear Engineering Research and Design Institute, CHINA

Integrating Knowledge Management into Everyday Practices: The Case of the  
Intellectual Capital Section (ICS) at CNEA  
*A.T. Chavez Flores*  
National Atomic Energy Commission (CNEA), ARGENTINA

Capacity Building Challenges for Safety Culture Improvements: Strategies for  
Training and Practices  
*N. Afghan*  
Institute of Business Administration (IBA), PAKISTAN

E-Catalogue: Knowledge Management Practices in Nuclear Organizations  
*Z. Pasztory and S. Sheveleva*  
International Atomic Energy Agency (IAEA)

International Nuclear Management Programmes  
*F. Adachi*  
International Atomic Energy Agency (IAEA)

Promoting Intercultural Competencies  
*K.M. Bachner*  
Brookhaven National Laboratory, USA

The Storer System: A Tool for Traceability and Radioactive Wastes Record Preservation

*C.L. Vetere, P.R. Gomiz and M.B. Lavallo*

National Atomic Energy Commission (CNEA), ARGENTINA

Nuclear Regulatory Authority Personnel Educating and Training within the National Nuclear Program Development

*V. Potapov, T. Goryaeva, A. Moiseenko, E. Kapralov and A. Museridze*

Federal State Unitary Enterprise VO “Safety”, RUSSIAN FEDERATION

Nuclear Knowledge Management Implementation Issues in Sri Lanka

*H.M.N.R. Bandara*

Atomic Energy Authority, SRI LANKA

Knowledge Management in the Development and Use of Radiation Technologies

*E.R. Kartashev, A.V. Egorkin, N.A. Sumina and M.V. Kheteev*

Scientific Research Institute of Technical Physics and Automation (JSC NIITFA), RUSSIAN FEDERATION

Knowledge Management: Applications for Nuclear Facilities

*E. Volkov*

State Atomic Energy Corporation “Rosatom”, RUSSIAN FEDERATION

Cyber Learning Platform for Nuclear Education and Training

*M. Vojtela*

International Atomic Energy Agency (IAEA)

### **Session 5B (Friday): Knowledge Networks**

Attracting and Retaining Talent in the Global Nuclear Industry

*C. Thomas*

Thomas Thor Associates, NETHERLANDS

European Nuclear Education Network (ENEN), Ten Years of Experience

*J. Dies, W. Ambrosini and P. Dieguez*

Technical University of Catalonia (UPC), SPAIN

National Nuclear Regulatory Portal (NNRP) — A Useful Regulatory Knowledge Network

*A. Georgieva*

Nuclear Regulatory Agency (NRA), BULGARIA

Nuclear Education, Training and Outreach in Latin America and the Caribbean Region

*A.T. Chavez Flores, R.O. Barrachina, J.L. François and M. Scaffoni*

National Atomic Energy Commission, ARGENTINA

Creation of Knowledge Networks — the Best Practices from Russian Communities of Practice

*N. Belenkaya*

State Atomic Energy Corporation “Rosatom”, RUSSIAN FEDERATION

Knowledge Management for Business Process Management

*R. Woitsch*

BOC Asset Management GmbH, AUSTRIA

Knowledge Sharing through Virtual Modes: The Influenced Factors for KM Development among the Researchers in Nuclear Malaysia

*H. Adnan, M.S. Sulaiman, M.H. Yusof and I. Ali*

Nuclear Malaysia, MALAYSIA

Education and Training of Nuclear Energy Personnel: The Nigerian Initiative

*E.C. Agedah*

Nigeria Atomic Energy Commission (NAEC), NIGERIA

Developing an Education Capability Assessment and Planning (E-CAP) Framework for Establishing National Educational Networks

*U.N. Ugbor*

International Atomic Energy Agency (IAEA)

## **CLOSING SESSION**

Summary and Conclusions: Slide Presentation

*M. Žiaková*

President of the Conference, Nuclear Regulatory Authority of the Slovak Republic (ÚJD SR), SLOVAKIA

Summary and Conclusions: Paper Presentation

*M. Žiaková*

President of the Conference, Nuclear Regulatory Authority of the Slovak Republic (ÚJD SR), SLOVAKIA

Closing Remarks for the International Conference on Human Resource Development for Nuclear Power Programmes: Building and Sustaining Capacity  
*A. Bychkov*

Deputy Director General and Head of the Department of Nuclear Energy, International Atomic Energy Agency (IAEA)

Closing Remarks for the International Conference on Human Resource Development for Nuclear Power Programmes: Building and Sustaining Capacity  
*D. Flory*

Deputy Director General and Head of the Department of Nuclear Safety and Security, International Atomic Energy Agency (IAEA)