

Nuclear Safety Review 2015

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Nuclear Safety Review 2015

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Foreword

The *Nuclear Safety Review 2015* contains an analytical overview of the dominant trends, issues and challenges worldwide in 2014 and the IAEA's efforts to strengthen the global nuclear safety framework in relation to those trends. The report also has an appendix describing developments in the area of the IAEA's safety standards during 2014.

A draft version of the Nuclear Safety Review 2015 was submitted to the March 2015 session of the Board of Governors in document GOV/2015/9. The final version of the *Nuclear Safety Review 2015* was prepared in light of the discussions held during the Board of Governors and also of the comments received.

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Executive Summary

The *Nuclear Safety Review 2015* focuses on the dominant nuclear safety trends, issues and challenges in 2014. The Executive Overview provides general nuclear safety information along with a summary of the major issues covered in this report: improving radiation, transport and waste safety; strengthening safety in nuclear installations; enhancing emergency preparedness and response (EPR); and strengthening civil liability for nuclear damage. The Appendix provides details on the activities of the Commission on Safety Standards (CSS), and activities relevant to the Agency's safety standards.

The global nuclear community continued to make steady progress in improving nuclear safety throughout the world in 2014; and, the Agency and its Member States continued to implement the *IAEA Action Plan on Nuclear Safety* (hereinafter referred to as "the Action Plan"), which was endorsed by the General Conference in 2011 after the Fukushima Daiichi accident in March 2011.

- Significant progress has been made in reviewing and revising various Agency's safety standards in areas such as management of radioactive waste, design basis hazard levels, protection of nuclear power plants (NPPs) against severe accidents, design margins to avoid cliff edge effects, multiple facilities at one site, and strengthening the prevention of unacceptable radiological consequences to the public and the environment, communications and EPR. In addition, the *Guidelines for Drafting IAEA Safety Standards and Nuclear Security Series Publications* was issued in July 2014.¹
- The Agency continued to analyse the relevant technical aspects of the Fukushima Daiichi accident and to share and disseminate lessons learned to the wider nuclear community. In 2014, the Agency organized two international experts' meetings (IEMs), one on radiation protection and one on severe accident management. Reports from previous IEMs were also published in 2014: *IAEA Report on Human and Organizational Factors in Nuclear Safety in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant*²; and *IAEA Report on Radiation Protection After the Fukushima Daiichi Accident: Promoting Confidence and Understanding*³. The Agency's report on severe accident management in the light of the accident at the Fukushima Daiichi NPP is currently in the publication process. Furthermore, during this reporting period, significant progress has been made in preparing the Agency's report on the Fukushima Daiichi accident. The report will be formally presented to the 59th session of the General Conference in 2015.

¹This guidance was added to the *Strategies and Processes for the Establishment of IAEA Safety Standards (SPSS)* document. See <http://www-ns.iaea.org/committees/files/CSS/944/GuidelinesfordraftingSPSSC14-07-16clean.doc>

² See <http://www.iaea.org/sites/default/files/humanfactors0914.pdf>

³ See <http://www.iaea.org/sites/default/files/radprotection0914.pdf>

- The Sixth Review Meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS) concluded in April 2014. Of the 76 Contracting Parties, 33 Contracting Parties have NPPs, while 43 Contracting Parties have no NPPs. Sixty-nine of the 76 Contracting Parties participated in the Review Meeting and 65 Contracting Parties provided National Reports which were presented and discussed at the six Country Group sessions. Additionally, to reinforce the effectiveness of the Convention peer review process, the Contracting Parties approved modifications to the CNS guideline documents recommended by the Working Group on Effectiveness and Transparency, set up after the Second Extraordinary Meeting of the Contracting Parties to the Convention in August 2012. These modifications aim, for example, to ensure greater consistency in reporting and to enhance international cooperation. The next Review Meeting will be convened in April 2017. At the CNS review meeting, the Contracting Parties agreed to convene a Diplomatic Conference within one year to examine a proposal from Switzerland to amend Article 18 of the Convention addressing the design and construction of both existing and new NPPs.
- The Agency organized the third International Conference on Challenges Faced by Technical and Scientific Support Organizations (TSOs) in Enhancing Nuclear Safety and Security: Strengthening Cooperation and Improving Capabilities, in October 2014, in Beijing, China. This conference was attended by more than 240 participants from 42 Member States and five organizations. The focus of the conference was to strengthen cooperation among TSOs and improve their capabilities to provide nuclear and radiation safety and security expertise to both regulators and operators. Important key outcomes focused on, for example: building capacity for Member States embarking on nuclear power development programmes; networking and knowledge sharing; and strengthening cooperative research and development (R&D) programmes in areas such as: decommissioning, remediation, human and organizational factors, safety analysis, and predicting severe accident progression.

The operational safety of NPPs remains high, as shown by safety performance indicators collected by the Agency and the World Association of Nuclear Operators. Figure 1 shows the number of unplanned shutdowns ('scrams') per 7000 hours (approximately one year) of operation. This is commonly used as an indication of success in improving plant safety by reducing the number of undesirable and unplanned scrams. Overall, during the past five years, the SCRAMS level continues to be lower when compared to those reported before 2008.

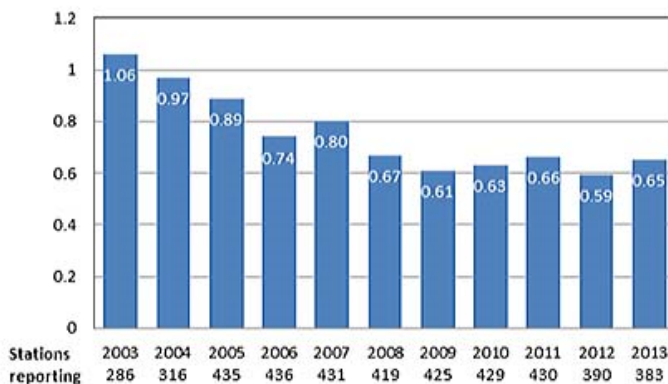


FIG 1. Mean rate of scrams (both automatic and manual) — the number of scrams that occur per 7000 hours of operation. Complete data for 2014 is not currently available. (Source: IAEA Power Reactor Information System <http://www.iaea.org/pris>)

As reported in the Nuclear Safety Review 2014,⁴ managing long term operation (LTO) of both power reactors and research reactors continued to be a major focus for Member States in 2014. At the end of October 2014, over 40% of the 438 nuclear power reactors operating in the world have been in operation for more than 30 years, and of these 14% have been in operation for more than 40 years. The number of NPPs that are eligible for an extension of their operating life is growing and hence the LTO issue needs to be systematically addressed and integrated into all aspects relevant to safety to ensure the required safety functions throughout the service life of the NPP. The safety and availability of research reactors continues to be challenged by ageing-related failures. More than 70% of the 247 operating research reactors have been in operation for over 30 years, with over half of those exceeding 40 years of operation.⁵ Prolonged shutdown of these reactors has led to and could lead to shortages of radioisotopes used for medical applications. Member States are encouraged to address these challenges at all levels of operation relevant to safety.

The Agency plays an important role in assisting Member States in the enhancement of regulatory practices in nuclear, radiation, transport and waste safety as well as emergency preparedness and nuclear security. The Integrated Regulatory Review Service (IRRS) Mission plays a key role in the global enhancement of regulatory oversight by assessing the current extent of conformity of the national safety regulatory infrastructure to IAEA Safety Requirements, which must be met to ensure the protection of people and the environment. In 2014, the Agency conducted six initial and four follow up IRRS missions to Cameroon, France, Jordan, Korea, Netherlands, Pakistan, Slovenia, USA, Vietnam and Zimbabwe (six of these missions were conducted in countries that operate nuclear power plants and four were conducted in countries that do not). To improve these missions, the Agency periodically convenes workshops on lessons learned inviting Member States who have hosted such a

⁴ See http://www.iaea.org/About/Policy/GC/GC58/GC58InfDocuments/English/gc58inf-3_en.pdf

⁵ See http://www.iaea.org/About/Policy/GC/GC57/GC57InfDocuments/English/gc57inf-3_en.pdf and http://www.iaea.org/About/Policy/GC/GC58/GC58InfDocuments/English/gc58inf-3_en.pdf

mission to share their experience). In December 2014, the fourth Workshop on Lessons Learned from IRRS Missions was held in the Russian Federation; 47 senior regulators from 25 Member States took part. Member States having received an IRRS mission since the previous workshop held in 2011 and Member States receiving a mission in the coming two years also shared their experience in preparing for the IRRS mission. For this workshop, the Agency also conducted an analysis of the recommendations and suggestions from previous missions to identify recurring nuclear, radiation, transport and waste safety and emergency preparedness issues. A challenge highlighted in this workshop was recruiting a sufficient number of knowledgeable and experienced reviewers to assist in conducting future IRRS missions.

With further regard to the operational safety of NPPs and research reactors, the Agency noted the following relating to its safety peer review and advisory services:

- The Agency conducted five full and seven follow-up Operational Safety Review Team (OSART) missions and one Corporate OSART mission⁶. Mission results from 2014 helped to identify areas where further safety enhancements were needed, such as: fostering leadership for safety and safety culture; strengthening fire protection; improving configuration control management; validation and verification of severe accident management guidelines and effective use of external operating experience, including timely implementation of lessons learned. Furthermore, the Agency has seen an increase in OSART mission requests (including corporate and pre-OSART missions), with six to seven OSARTs scheduled per year for the next several years to come. Despite this positive trend, there are still a few Member States that have not yet requested OSART missions in the last 5 -7 years, and some have not had an OSART mission for nearly two decades.
- To enable the Agency to seek consensus on further actions needed to continuously improve NPP operational safety, the Agency will host a Conference on Operational Safety, to be held 23-26 June 2015 in Vienna. This conference will take into consideration the wide variety of challenges faced by the nuclear industry and Member States, related to the role of peer reviews in improving safety and promoting the application of IAEA safety standards, implementation of lessons learned from the Fukushima Daiichi accident, the importance of operating experience feedback and safety culture and leadership in driving continuous safety improvements and the responsibility of corporate management for safety improvements throughout the lifetime of nuclear power plants.
- The Agency conducted two full and two follow-up Safety Aspects of Long Term Operation (SALTO) peer review service missions. As the number of power reactors eligible for operating life extensions continues to grow, LTO issues need to be systematically addressed and integrated into all aspects relevant to safety. Those Member States who have not yet done so are encouraged to request a SALTO peer review mission to evaluate LTO issues.
- The Agency carried out three Site and External Events Design (SEED) review missions to Bangladesh, Indonesia and Viet Nam. SEED missions assist Member States throughout the

⁶ A Corporate OSART mission is an OSART mission organized to review those centralized functions of the corporate organization of a utility with multiple NPP sites and conventional plant sites that affect all the operational safety aspects of the NPPs of this utility.

different stages of site selection, site evaluation and design of structures, systems and components to ascertain site specific external and internal hazards and the NPPs ability to withstand them. Since 2010, the number of SEED mission requests has steeply declined while the number of countries embarking on nuclear power programmes has steadily increased. Those Member States who have not yet done so are encouraged to request SEED review missions to evaluate siting and design issues.

- The Agency conducted seven Design and Safety Assessment Review Service (DSARS) missions in Armenia, Bangladesh, China, Jordan, Mexico, Russian Federation and Switzerland. These missions highlighted several issues including the challenges with establishing an appropriate safety infrastructure for newcomer countries, using probabilistic safety assessments for risk-informed decision making, and developing severe accident management guidelines. With the number of new designs and nuclear installations increasing, safety needs to be systematically addressed and integrated into all safety-relevant aspects; the Agency continues to encourage Member States to host a DSARS mission.
- Lessons learned from the Fukushima Accident and the Action Plan indicate that some Member States do not have severe accident management guidelines developed and in place. Member States need to develop these guidelines and the Agency provides a module in DSARS, called the Review of Accident Management Programmes (RAMP) which assesses the development and implementation of the NPPs accident management programme. No RAMP missions have been requested or conducted since 2012.
- The Agency conducted two Integrated Safety Assessment for Research Reactors (INSARR) missions at research reactors in Malaysia and Poland, providing safety recommendations and suggestions on the research reactors in these countries. Another expert safety review mission was conducted at the research reactor in Turkey, which provided recommendations in the frame of resuming reactor operations after a long period of shutdown for refurbishment and modernization. Additionally, eight expert missions were conducted at the research reactors in Bangladesh, Egypt, Ghana, Iran, Morocco, Peru and Slovenia. These missions contributed to establishing ageing management programmes as well as to establishing periodic safety review processes.

Knowledge networks provided by the Agency played an integral part in building nuclear safety capacity for Member States in 2014. The Agency's Global Nuclear Safety and Security Network (GNSSN) —a human network operating at global, regional and national levels, and supported by a strong web platform—continued to provide Member States with the ability to share information, expertise and knowledge. In 2014, GNSSN added two new global networks to its information platform: the Emergency Preparedness Network (EPnet) and the Global Nuclear Safety and Security Communications Network (GNSSCOM), bringing the total to 18 networks. During 2014, the Agency held 40 workshops and missions within the GNSSN framework, involving participants from 64 Member States, representing nuclear regulatory authorities, governmental organizations and technical support organizations.

Human resource development is also key to building nuclear safety capacity in Member States. In May 2014, the Agency organized the International Conference on Human Resource Development for Nuclear Power Programmes: Building and Sustaining Capacity. More than 300 participants from 65 countries and five international organizations met at the Agency's Headquarters to discuss the development of human resources in the nuclear power industry. Topics discussed included: workforce development, recruitment, education and training, networking, knowledge sharing and knowledge management. Furthermore, on the margins of this conference, the Agency also signed practical arrangements with the Arab Network of Nuclear Regulators (ANNuR) to support efforts in building

capacity, developing human resources and strengthening nuclear safety infrastructures in ANNuR Member States.

In reviewing developments in radiation protection, waste and transport safety during 2014, the Agency noted the following:

- Accidental radiation exposures continue to happen with medical uses of ionizing radiation. Safety measures need to be further enhanced considering the potential consequences. To assist Member States in this regard, the Agency strongly promotes the use of the Safety in Radiation Oncology (SAFRON) system, which provides a voluntary safety reporting and learning database, helping health professionals to learn valuable safety lessons in medical radiation therapy by allowing them to report radiation incidents. SAFRON is available on the Agency's Radiation Protection of Patients website.⁷
- More effort is needed to develop detailed guidance for the effective implementation of the radiation protection principles of justification and optimization⁸ in post-accident situations. In particular, more focus is needed on the development and implementation of optimized remediation strategies, which are strategies that appropriately balance radiological, technical, economic and societal factors. These remediation strategies would include, for example, methodologies for determining radiological criteria for remediation, supervising the ongoing remediation process, and techniques for remediation.
- Experience with recovery from severe accidents has shown that strategic and advanced planning in the fields of radioactive waste management, decommissioning and remediation would facilitate the recovery process.⁹ As part of this strategic planning process, the development of model or generic safety cases (e.g. for the demonstration of the safety of predisposal management facilities, including storage facilities or for near surface disposal facilities) is gaining more attention and the Agency has launched activities in this field. The development of these generic safety cases also provides a useful tool for assisting Member States in the demonstration of the safety of radioactive waste management predisposal and disposal facilities. The number of requests to the Agency for assistance in decommissioning has increased substantially and is expected to continue to grow in the years ahead as more facilities are decommissioned. The Agency anticipates an increasing number of requests related to the decommissioning of ageing facilities that are currently in extended shutdown status or under safe enclosure. The Agency is preparing for such demands by revising existing guidance on decommissioning and by launching new platforms for information exchange and promotion of good practices. Examples include the development of reference regulations for decommissioning, an ongoing project on decommissioning risk management and a new project on decommissioning and remediation of damaged nuclear facilities.

⁷ As described in the *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards* (IAEA Safety Standards Series, No. GSR Part 3). See <https://rpop.iaea.org/RPOP/RPoP/Modules/login/safron-register.htm>

⁸ See http://www-pub.iaea.org/MTCD/publications/PDF/p1531interim_web.pdf

⁹ See: IAEA Report on Decommissioning and Remediation after a Nuclear Accident, International Experts' Meeting, 28 January - 1 February 2013, Vienna, Austria. <http://www.iaea.org/sites/default/files/decommissioning0913.pdf>

- The goal of strengthening the regulatory oversight of legacy sites, especially former uranium production sites, has been furthered through the sharing of international experience amongst countries through international forums established by the Agency, as well as through multilateral and bilateral arrangements. This is bringing more consistency and strengthening safety awareness in regions where regulatory systems are still developing. Countries are also strengthening their technical approaches to legacy problems by examining international lessons learned and international best practices.
- The Agency's Postgraduate Educational Course (PGEC) in Radiation Protection and the Safety of Radiation Sources continues to provide the foundation studies for future professionals in the field of radiation protection. A new on-line system introduced in 2014 enabled 106 students from 62 Member States to carry-out their pre-learning studies prior to attending the PGEC in Algeria, Argentina, Ghana, Greece and Malaysia. The new system included on-line evaluation tests that provided the regional training centres with advance information about the students' prior knowledge

In reviewing developments in nuclear installation safety during 2014, the Agency noted the following:

- Periodic safety reviews (PSRs) assist in ensuring that the safe operation of a plant is being maintained, and that plants continue to operate in line with the Agency's safety standards, which further recommend that PSRs are conducted at least every 10 years. Findings from IRRS and OSART peer review safety missions indicate that some Member States would benefit from a PSR mission to assist in meeting the Agency's recommendations for PSRs.
- Enhancing regulatory effectiveness continues to be a challenge for Member States that operate research reactors. Specific challenges include establishing regulations specific to research reactors, reviewing and assessing safety documents for issuance of authorizations, and developing and implementing inspection programmes. It is also a challenge to develop staff with the necessary competencies to fulfil these regulatory functions. Feedback from the Fukushima Daiichi accident is relevant to operation and regulation of research reactors and has indicated that appropriate attention needs to be given to performing safety reassessments, including: analysing extreme external events; assessing robustness of reactor systems and components; considering long-term aging effects, and ensuring adequate emergency response.
- The Agency's Fuel Incident Notification and Analysis System (FINAS) is a self-reporting and information sharing system on lessons learned for fuel cycle professionals. In 2014, FINAS showed an increase in the level of safety information sharing and self-reporting. However, the level of event reporting to this system needs to be further improved to enhance networking and exchange of operating experience. FINAS data showed the need to give continued attention to the training and qualification of operating personnel, safety assessment, and ageing management of the fuel cycle facilities.
- With regard to site and design safety, the Agency continues to find that some embarking Member States have either selected a design and/or a site without having adequate regulatory guidelines and requirements in place for the sites and designs selected. Furthermore, findings indicate that some existing facilities need to undergo periodic site evaluations to ensure the continued safety of these facilities and mitigate any new risks that may have been uncovered since their last site evaluation was conducted.
- Embarking countries need to develop the nuclear safety infrastructure necessary for the successful use of nuclear technology, such as: a competent, effective and independent regulatory authority; competent, safety-focused owner/operators; competent technical support organizations (TSOs); competent organizations responsible for emergency preparedness and

response; and the means to provide sufficient specialists for all these organizations. Based on programme schedules reviewed during peer review and advisory missions in embarking countries, project milestones (site licensing, bids, construction, etc.) are outpacing development of the necessary safety infrastructure (legal, regulatory and technical), placing undue pressure on the relevant organizations to make sure that staff are recruited in time and trained in the requisite components of nuclear safety.

- To accomplish the regulatory goal of assuring nuclear safety, regulators must rely on a specialized, highly trained and technically competent workforce. As reported during the Sixth Review Meeting of the CNS, many Contracting Parties reported on critical challenges faced in maintaining staffing in their regulatory bodies and licensee organizations, as well as the challenges associated with an ageing workforce—for example, transferring and maintaining nuclear safety knowledge. Many indicators throughout this year have highlighted that as resource demands and constraints continue to increase, capacity building, knowledge management and recruitment efforts continue to lag.

In 2014, emergency preparedness and response issues and activities at both the national and international levels included the following:

- Requests for Emergency Preparedness Review (EPREV) services from Member States have increased. In response, the Agency conducted over 25 EPREV-related missions, five EPREV preparatory missions and three full EPREV missions.
- The Agency also continued to assist Member States in establishing adequate EPR arrangements consistent with the IAEA Safety Standards, including the provision of more than 40 training events, over 20 expert missions, seven scientific visits and fellowships, and provision of support for the procurement of equipment and the provision of EPR publications and training material in different UN languages.
- The Agency also conducted numerous Convention Exercises (ConvEx).¹⁰ ConvEx exercises provide an opportunity for Member States and international organizations to identify shortcomings in their national and/or international emergency response systems. These exercises are carried out at three levels of complexity: ConvEx-1 tests communication; ConvEx-2 tests response elements; and ConvEx-3 tests the full operation of national and international response systems worldwide. In 2014, the Agency conducted three ConvEx-1 exercises and eight ConvEx-2 exercises; not all contact points participated in testing their response arrangements through these exercises. In its first ConvEx-2e¹¹ exercise, conducted at the Darlington Nuclear Generating Station in Ontario, Canada, involving 55 Canadian government agencies and regional organizations, the Agency tested its assessment and prognosis process.

¹⁰ The Agency has specific functions allocated to it under the Convention on Early Notification of Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, one of those functions is to assist Member States in advance preparation and response to nuclear or radiological emergencies. It has been recognized that good preparedness in advance of an emergency can substantially improve the response.

¹¹ ConvEx-2e is a new designation given to Member States national exercises that involve the Agency actively testing its assessment and prognosis process for a nuclear or radiological emergency.

- The Agency continued to promote the adoption and use of the International Radiological Information Exchange (IRIX) standard and reached an important milestone in 2014 when an upgraded version of the Agency’s Unified System for Information Exchange in Incidents and Emergencies (USIE) was released with new IRIX based features (referred to as “USIE Connect”). Contact points can now have their own emergency information systems connected to USIE for faster, more reliable transmission of information during an emergency.
- In November 2014, the United Nations Development Programme (UNDP) became the 18th member of the Inter-Agency Committee on Radiological and Nuclear Emergencies (IACRNE). IACRNE is an inter-agency mechanism to ensure coordinated and harmonized international response to nuclear or radiological incidents and emergencies.¹²

At its November 2014 meeting, the Board of Governors adopted the Resolution on the Establishment of Maximum Limits for the Exclusion of Small Quantities of Nuclear Material from the Application of the Vienna Conventions on Nuclear Liability¹³, establishing new maximum limits for the exclusion of small quantities of nuclear material from their respective scope of application. These limits are now in line with the *Regulations for the Safe Transport of Radioactive Material* – 2012 Edition (IAEA Safety Standards Series No. SSR-6).¹⁴

As mentioned, significant progress on the Agency’s Safety Standards has been made during 2014. The Appendix contains a summary of these activities, highlighting newly published standards and guidance as well as the activities of the CSS and the various safety standards committees.

¹² The Inter-Agency Committee on Radiological and Nuclear Emergencies, formerly the Inter-Agency Committee for the Co-ordinated Planning and Implementation of Response to Accidental Releases of Radioactive Substances, which was established following a meeting of representatives of FAO, UNEP, ILO, UNSCEAR, WMO, WHO and IAEA at the Special Session of the IAEA General Conference in September 1986, is the co-ordination mechanism between relevant international intergovernmental organizations to ensure that coordinated and consistent arrangements and capabilities for preparedness and response to nuclear and radiological incidents and emergencies are developed and maintained.

¹³ The adopted resolution is contained in document GOV/2014/63

¹⁴ The publication is available at: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1570_web.pdf

Analytical Overview

A. Improving Radiation, Transport and Waste Safety

A.1. Radiation Protection of Patients, Workers, the Public and the Environment

A.1.1. Trends and Issues

Radiation Protection of Patients

1. According to the United Nations Scientific Committee on the Effects of Atomic Radiation, patient exposure is by far the largest type of exposure to the world's population from man-made radiation sources. It has been estimated that the number of medical procedures using ionizing radiation has more than doubled over the past two decades, and is now several billion per year. The magnitude of risk is dose related, and wide variations in dose continue to occur. Too much or too little absorbed dose is problematic, with higher amounts of radiation being associated with higher risks.

2. Radiation protection of patients must also deal with medical procedures for the benefit of the patient including sensitive members of the population (children and pregnant women) that may be exposed to doses that could cause deterministic effects. Over the past five decades, radiation accidents involving medical uses have accounted for more deaths and early acute health effects than any other type of nuclear or radiological accident.¹⁵

Radiation Protection of Workers, the Public and the Environment

3. Regulatory bodies in Member States apply a system of notification, registration and licensing to the control of radiation sources. This system requires that there is compliance with dose limits for workers and for the public and the regulatory system generally ensures an appropriate level of safety. In addition, regulatory bodies apply a graded approach, whereby the stringency of control measures and conditions applied is commensurate with the degree of risk from the source.

4. Challenges remain in the field of occupational exposure in planned, existing and emergency exposure situations, especially for the protection of itinerant workers, female workers during and after pregnancy, and occupational dose to the lens of the eye.

Radiation Protection from Exposure due to Radon and Naturally Occurring Radioactive Material

5. Findings show that for most people, their yearly radiation exposure is received primarily from naturally occurring sources. While most of these exposures cannot be avoided, the International

¹⁵ Sources and Effects of Ionizing Radiation. United Nations Scientific Committee on the Effects of Atomic Radiation, New York, 2008; Volume 1 and Volume 2 are available at: http://www.unscear.org/unscear/en/publications/2008_1.html and http://www.unscear.org/unscear/en/publications/2008_2.html

Commission on Radiological Protection (ICRP)¹⁶ states that some of them are controllable, and should be controlled, under certain circumstances. While exposure due to radon¹⁷ in, for example, uranium mines is normally subject to regulatory control in all Member States, much less attention is given to the sometimes higher radiation doses that can be received from radon present in homes and workplaces. Such workplaces include not only other mining activities, where high concentrations of natural radiation may be present and certain extractive industries (mining and industries that generate naturally occurring radioactive material, or NORM), but also offices and buildings frequented by the public.

6. Very often, there is less focus on the control of natural sources of radiation already present in the environment. Natural sources of radiation are not insignificant from a radiation protection point of view, contributing to an estimated 80% of the worldwide annual collective dose from all sources of radiation. Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (IAEA Safety Standards Series No. GSR Part 3) (hereinafter referred to as “the Basic Safety Standards”) requires that a system be in place for evaluating which occupational and public exposures are of concern from the point of view of radiation protection and for implementing an appropriate protection strategy.

7. In 2009, the World Health Organization (WHO) published the *WHO Handbook on Indoor Radon* that considers radon from a public health perspective and presents recommendations on radon health risk reduction.¹⁸ In 2014, the ICRP finalized *Radiological Protection against Radon Exposure*, a report in which it outlines its approach to the management of exposure due to radon in homes and workplaces. Along with these activities and with regard to public exposure due to radon indoors, the Basic Safety Standards require that general information on radon, including information on health risks and the synergy with smoking, be made available to the public and other interested parties. Agency Member States should also determine whether an action plan for controlling exposure due to radon indoors is necessary, and, if so, to establish and implement such an action plan.

8. The maximum reference level for radon at workplaces specified in the Basic Safety Standards (1000 Bq/m³) has implications for occupational exposure to radon in non-uranium mines and other raw material processing industries and may require enhanced control measures. Increasing challenges have been observed in controlling exposures to NORM in industry. In particular it can be challenging to determine whether exposures may occur as part of planned or existing exposure situations and to determine methods to apply the appropriate protection strategies.

9. In 2014, the European Commission (co-sponsor of the Basic Safety Standards) published Council Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation. The Directive, which is legally binding, requires

¹⁶ ICRP Publication 126: <http://ani.sagepub.com/content/43/3/5>

¹⁷ Radon is a naturally occurring radioactive gas produced from the radioactive decay of the uranium that is found in varying amounts in all rocks and soils. As a gas, radon can move through the soil and, when it enters a building, it can sometimes build up to unacceptably high concentrations. For most people, radon is the major contributor to their annual effective dose. Long term exposure to radon has been shown to increase the risk of lung cancer, and exposure to both smoking and radon creates a greater risk of lung cancer than exposure to either factor alone.

¹⁸ The publication is available at: http://www.who.int/ionizing_radiation/env/radon/en/index1.html

EU Member States to establish a national action plan addressing long term risks from radon exposures in dwellings, buildings with public access and workplaces for any source of radon ingress, whether from soil, building materials or water.

Radiation Dosimetry and Monitoring

10. Increasing public concern about radiation safety has generated a strong demand for reliable and accurate dose measurements. Quality control in individual monitoring services is essential, and requires the implementation of safety standards governing quality assurance.¹⁹ There is an increasing need for support and quality assurance of radiation dosimetry and monitoring in Member States.

A.1.2. Activities

Activities for Patient Protection

11. The Technical Meeting on Justification of Medical Exposure and the Use of Appropriateness Criteria held by the Agency in Vienna, Austria, in March 2014 discussed ways to decrease unnecessary exposure of patients from unwarranted medical procedures using ionizing radiation. Around 65 health professionals and regulators from 49 Member States and international organizations participated. There are only a few organizations worldwide, such as the Royal College of Radiologists and the American College of Radiology that have the capacity to develop and maintain appropriateness criteria in medical imaging, or clinical imaging guidelines. The meeting focused specifically on the processes of adopting and adapting these few existing guidelines in the different diagnostic imaging environments around the world.

12. The Technical Meeting on Patient Safety in Radiotherapy was held in Vienna, Austria in October 2014. More than 40 health professionals and regulators from 24 Member States and five international organizations participated in the meeting. While there is broad agreement among experts that radiotherapy is a relatively safe treatment modality, with more than five million treatments delivered annually worldwide, safety measures need to be further enhanced considering the potential consequences when radiation accidents occur. The meeting highlighted to Member States, as well as to organizations, the opportunity to exchange radiotherapy safety information through the SAFRON voluntary safety reporting and learning system developed by the Agency.

Activities for Worker Protection

13. The Agency published *The Information System on Occupational Exposure in Medicine, Industry and Research (ISEMIR): Industrial Radiography* (IAEA-TECDOC-1747) in 2014. This publication details the results of the ISEMIR project during 2009–2012 and, in particular, the activities of the Working Group on Industrial Radiography. The ISEMIR project arose from the Action Plan for Occupational Radiation Protection, which was approved by the Board of Governors in September 2003, and which identified the need to establish networks for the exchange of information on experience and lessons learned between interested parties. The results on the international survey on occupational radiation protection in industrial radiography, the recommendations based on the survey and the suggestions for the ISEMIR database are included in the publication.

¹⁹ *Assessment of Occupational Exposure Due to External Sources of Radiation* (IAEA Safety Standards Series No RS-G-1.3). The publication is available at: http://www-pub.iaea.org/mtcd/publications/pdf/pub1076_web.pdf

14. During 2014 an information system on occupational radiation protection in uranium mining was established and a survey of radiation protection practices and worker doses was carried out. The survey identified the need to strengthen occupational radiation protection in the uranium mining industry to the standards that apply in other industries, including other components of the nuclear industry. This is particularly relevant in light of the expected increase in dose coefficients for radon, which can be an important component of the radiation exposure to miners. An international workshop was held in September 2014 in Canada to discuss and promote improved radiation protection for uranium miners worldwide.

15. The Occupational Radiation Protection Appraisal Service (ORPAS) is a peer review service for occupational radiation protection. Three full ORPAS missions were conducted to Peru, the United Republic of Tanzania, and the Bolivarian Republic of Venezuela in 2014 at the request of the Governments of those countries. Findings, recommendations and strengths established during the mission were reported to the countries. The information from the peer review missions will help to improve occupational radiation protection in Member States, especially for the end users and service providers. One pre-ORPAS mission to the United Arab Emirates was conducted in September 2014, where the scope, target facilities and date for the full mission were determined.

16. The International Conference on Occupational Radiation Protection: Enhancing the Protection of Workers — Gaps, Challenges and Developments, held in Vienna, Austria, in December 2014, was organized by the Agency, and co-sponsored by the International Labour Organization, in cooperation with fifteen other international organizations or associations. It was attended by 420 participants plus 50 observers from 79 Member States and 21 international organizations. Its purpose was to exchange information and experience, to review advances, challenges and opportunities since the first conference on this topic and to identify areas for future improvement. The recommendations for occupational radiation protection were included in the conclusions of the Conference.

Activities for Radon and NORM Protection

17. The importance of developing national action plans to reduce exposure due to radon is highlighted in Agency safety standards such as the Basic Safety Standards and *Protection of the Public Against Exposure Indoors Due to Radon and Other Natural Sources of Radiation* (soon to be published as IAEA Safety Standards Series No. SSG-32). This has generated increased interest in Member States. The Agency is currently implementing a two-year project focusing on establishing enhanced approaches to the control of public exposure to radon, in which 31 Member States in Europe are participating. Two meetings have been held in Vienna, Austria, and Sofia, Bulgaria, in 2014 and further meetings are planned for 2015. Furthermore, a regional training course organized in cooperation with the World Health Organization in Argentina in November 2014 was attended by 28 participants from 14 Member States in the region. In addition to the organization of regional training courses, the Agency has engaged in many bilateral discussions to advise and assist Member States in developing their national action plans to reduce public exposure due to radon.

Activities for Dosimetry and Monitoring

18. The Agency's Individual Monitoring Service Group (IMSG) monitors radiation doses for IAEA staff and for participants in IAEA-sponsored activities. To ensure quality of results, the IMSG participates in the European Radiation Dosimetry Group (EURADOS) through inter-comparison

studies, meetings and document formulation. EURADOS is a network of 50 European institutions and collaborating parties, including the Agency, for promoting R&D in the field of dosimetry. The EURADOS approved a strategic research agenda in 2014.²⁰ Strategic topics included: risk and dose assessment, improved protection of people, training and education.

A.1.3. Future Challenges

19. It was recognized at the 2012 International Conference on Radiation Protection in Medicine — Setting the Scene for the Next Decade that there is a need to strengthen radiation protection education and training of health professionals. In many countries there is a lack of radiation protection training for physicians, medical physicists and radiographers. There is also a shortage of qualified medical physicists to support radiation protection activities. In many countries medical radiation devices and uses are only minimally regulated and it remains a challenge for radiation protection measures to keep up with the rapidly evolving technology utilizing ionizing radiation in medicine²¹.

20. With the new radiation technologies and procedures being introduced in medicine, it remains vital that occupational radiation protection is strengthened in the medical area, especially considering the large number of medical professionals in the world.

21. As many nuclear reactors come to the end of their operating life, decommissioning activities are expected to increase significantly and raise additional challenges, such as the control of radiation exposure to workers in these areas. During the process of decommissioning, in addition to the risk from radiation, workers may be subject to other industrial risks, such as chemical, mechanical and toxic hazards. A harmonized coherent approach needs to be introduced to address these risks and to ensure the safety of the workers.

22. Radiation protection of itinerant workers requires further attention to address the issues and challenges that were identified during stress tests. As an example, after the Fukushima Daiichi accident, the activities related to stress tests have significantly increased, and workers involved in the tests changed their workplaces more frequently.

23. The Agency's Radon programme that aims to assist the development and implementation of national radon action plans to reduce exposure due to radon in homes, needs the direct involvement of the national authorities responsible for radiation protection, public health and building standards. Experience has shown that, without this coordinated approach, limited progress can be made. Member States need to inform the public about the health risks from radon exposure, including the synergistic relationship with tobacco use, as well as the actions that can be taken to reduce exposure, is also important.

24. Some building practices used in the construction of energy efficient buildings, or in the retrofitting of existing buildings to improve energy efficiency, can increase the concentration of radon indoors. This potential conflict between energy saving actions and increased risk of radon exposure

²⁰ *Visions for Radiation Dosimetry over the Next Two Decades — Strategic Research Agenda of the European Radiation Dosimetry Group* (EURADOS Report 2014-01, Braunschweig, May 2014). The publication is available at: http://www.eurados.org/~media/Files/Eurados/documents/EURADOS_Report_2014_01.pdf?la=en

²¹ See the Bonn Call for Action: <https://tpop.iaea.org/RPOP/RPoP/Content/News/poster-on-bonn-call-for-action.htm>

has been identified in a number of Member States. However, it is possible to conserve energy, maintain low radon concentrations, and have a high quality of indoor air only through proper building design.

25. Radiation protection in NORM industries (e.g. oil and gas, and rare earths extraction) needs to be strengthened in terms of identifying the activities that give rise to radiation exposure and identifying adequate regulatory approaches, inter alia, to control exposure due to NORM and radon.

26. Effective radiation protection programmes rely on effective quality assurance programmes to ensure that equipment is reliable, stable and appropriate to the task for which it is intended, and that procedures are in place to prevent contamination of measurement equipment. As new dosimetry service laboratories in Member States come into operation, Member States need to commit resources to the development and implementation of quality assurance programmes that operate in accordance with the quality policies they are based upon and to ensure that they are in line with the Agency's safety standards.



FIG. 2. Patient radiation protection in cardiac imaging, performed with a multi-detector computed tomography scanner, requires both appropriate use and optimized performance of this medical radiation equipment.

A.2. Strengthening Control over Radiation Sources

A.2.1. Trends and Issues

27. Sealed radioactive sources are used worldwide in medicine, industry and research for a wide range of applications. The sources can contain a broad spectrum of radionuclides, and also exhibit a wide range of activity levels and half-lives. Radioactive sources are defined as ‘disused’ when they are no longer used for the practice for which an authorization has been granted. The proper management (i.e. reuse and recycling, storage and disposal) of disused sealed radioactive sources continues to be a challenge. Member State commitment to their continuous control at every stage of their life cycle, especially when they reach the end of their useful life, is the only way to ensure their continued safety. However, only a few States have disposal arrangements for radioactive sources, and many States do not have appropriate long term management strategies and practical arrangements. In the President's findings of the International Conference on the Safety and Security of Radioactive Sources: Maintaining the Continuous Global Control of Sources throughout their Life Cycle, held in Abu Dhabi, United Arab Emirates, in October 2013, the development of additional guidance on this topic was recommended.

28. Industrial radiography is one of the most common industrial uses of sealed sources containing large amounts of radioactive material. Industrial radiography work poses minimal radiation risk when safely performed using appropriate equipment and in accordance with required procedures. However, accidents continue to occur in Member States and, despite efforts made in the past years, the practice of industrial radiography regularly results in a number of radiation overexposures, some of which produce adverse health effects such as radiation burns and, in a few cases, death among occupationally exposed individuals and members of the public. Contamination of people and the environment has also resulted from accidents involving corroded or damaged sources.

A.2.2. Activities

29. In response to the relevant recommendation of the Abu Dhabi Conference President's findings, the Agency organized an open-ended meeting to discuss the development of internationally harmonized guidance for implementing the recommendations of the Code of Conduct on the Safety and Security of Radioactive Sources in relation to the long term management of disused radioactive sources. The meeting was held at the Agency's Headquarters in Vienna, Austria, from 20 to 23 October 2014 and was attended by 162 experts from 73 Member States, one non-Member State and four international organizations. The chairman's report²² supported the initiative to develop guidance on the management of disused sources as supplementary guidance under the Code of Conduct.

30. Member States continue to be interested in and to support the Code of Conduct on the Safety and Security of Radioactive Sources. At the time of writing this report, 123 Member States have made a political commitment to implementing the Code of Conduct. Of this number, 90 have also notified the Director General of their intention to act in a harmonized manner with the Code's supplementary Guidance on the Import and Export of Radioactive Sources. One hundred and twenty eight Member States have nominated points of contact for the purpose of facilitating the export and import of radioactive sources and have provided the details to the Agency. The Agency has also continued to support national efforts in implementing the Code of Conduct through the provision of assistance, upon request, such as training and physical protection upgrades.

31. With regard to the transboundary movement of radioactive material inadvertently incorporated into scrap metal and semi-finished products of the metal recycling industries, the results of the discussions conducted in the period 2010–2013 on the development of a code of conduct were published in 2014 in a report entitled *Control of Transboundary Movement of Radioactive Material Inadvertently Incorporated into Scrap Metal and Semi-finished Products of the Metal Recycling Industries: Results of the Meetings Conducted to Develop a Draft Code of Conduct (IAEA/CODEOC/METRECYC)*.²³

32. A Technical Meeting on Radiation Safety in Industrial Radiography was held in Vienna, Austria, from 23 to 27 June 2014. The meeting provided an opportunity for an exchange between the Agency, regulators, industry representatives and equipment manufacturers. Based on discussions at

²² The chairman's report is available at: <http://www-ns.iaea.org/downloads/rw/code-conduct/info-exchange/chair-report-open-ended-meet-oct14.pdf>²³ The publication is available at: http://www-pub.iaea.org/MTCD/Publications/PDF/IAEA_CODEOC_METRECYC_web.pdf

²³ The publication is available at: http://www-pub.iaea.org/MTCD/Publications/PDF/IAEA_CODEOC_METRECYC_web.pdf

this meeting, it appears that the industrial radiography industry has made improvements in radiation safety, particularly in the design of equipment and in defining maintenance requirements. Various recommendations for further action by the Agency were developed by the participants and recorded in the Chairman's Report²⁴ on topics such as: the development of training materials and an internationally recognized training standard for individuals involved in radiography operations; efforts to increase the practical knowledge of regulators; the development of a training course for regulators on accident investigation; the development of a programme of safety culture training for radiography clients and managers of radiography companies; the development of new and revised Agency documents; and to encourage the adoption of International Organization for Standardization (ISO) equipment standards by Member States.

A.2.3. Future Challenges

33. Many Member States do not have sufficient technical capabilities and resources to fully implement the Code of Conduct on the Safety and Security of Radioactive Sources. Furthermore, a significant number of Member States have yet to make a political commitment to the Code of Conduct. Efforts to encourage Member States to make a political commitment and to move to full implementation are necessary and should continue.

34. Ensuring the long term safety of radioactive sources will remain a challenge due to the hazards associated with disused radioactive sources. A continuing concern in this regard is the lack of disposal facilities for radioactive sources, which many Member States have not constructed due to financial, technical, political and societal reasons.

35. Radiation overexposures associated with the practice of industrial radiography will continue, unless efforts are made to address the root causes of these accidents; therefore, the findings of the Technical Meeting on Radiation Safety in Industrial Radiography should be acted upon in a prioritized manner based on the relevance, usefulness and presumed effectiveness of the recommendations.

A.3. Strengthening the Safe Transport of Radioactive Material

A.3.1. Trends and Issues

36. Radioisotopes and radiation have many applications in agriculture, medicine, industry and research. In recent years, Member States have increased their demand for and use of radioactive material in such areas as: health care, food production and insect control, as well as in mining, construction and oilfield exploration. Worldwide, the volume of radioactive materials transported via rail, road, air and water has likewise increased dramatically over the past 10-15 years. This poses a significant safety issue in some regions where there is inadequate regulatory oversight of transport. In addition, many of the existing routes used to deliver radioactive material are not reliable, efficient or effective and denials of shipment invariably result. This is of particular concern in the medical sector, where failure to deliver radioactive material on time can often result in a direct effect upon the lives of those patients who are dependent upon them.

²⁴ The Chairman's report is available at:

<http://gnsn.iaea.org/CSN/TM%2048337%20Industrial%20Radiography/FINAL%20Chairman%20Report%20TM%20Industrial%20Radiography%2023%20-%2027%20June%202014.pdf>

A.3.2. Activities

37. The meeting of the Transport Safety Standards Committee (TRANSSC) in November 2014 launched the process for the next review cycle for the revision of *Regulations for the Safe Transport of Radioactive Material* (IAEA Safety Standards Series No. SSR-6) that will begin in January 2015, where TRANSSC will review submissions received from Member States with proposals for changes in SSR-6 and its supporting Safety Guide No. SSG-26, *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition)*. Revisions to SSR-6 will be made only following a decision by TRANSSC, which will consider whether the proposed changes will, inter alia, allow for easier implementation of the regulations by Member States seeking to improve the regulatory infrastructure for transport in their countries.

38. Regional projects to build capacity in transport safety for competent authorities continued to foster a coordinated and harmonized approach for the interpretation and implementation of the regulations for the transport of radioactive material in several regions of the world. The aim of these projects has been to provide a proactive means of maintaining and developing a consistent, high level of transport safety in individual regions, as well as in relation to, and with, neighbouring regions.

39. Regional networks are currently being developed in Africa, Asia, the Caribbean Islands, the Mediterranean region and the Pacific Islands, and several regional meetings have been held in 2014 to further these efforts. These networks base their approach on an existing network developed in 2008, the European Association of Competent Authorities, which brings together—on a voluntary and non-legally binding basis, the competent authorities from European Union (EU) Member States who regulate safe transport of radiative material.

40. Workshops were held in April/May and June 2014 for the Pacific and Caribbean islands transport networks respectively. The initial workshops consisted of an introduction to the basic international requirements for the transport of radioactive material, including, for example, Agency, United Nations and international regulations, transport package types, documentation and labelling, medical applications of radioactive materials and self-assessments of the regulatory infrastructure. These workshops included participants from nearly 30 countries: 18 from the Caribbean region and nine from the Pacific Island region. These workshops provided the opportunity for those working in transport safety to meet their counterparts from other countries of the region, in some cases for the first time.

41. Other networks, such as those from the African, Asian and Mediterranean regions initiated the process for self-assessments of their Member States' regulatory infrastructures for transport, with the objective of carrying out peer reviews of the self-assessment exercises and developing action plans for transport, both for individual countries as well as for the regions as a whole. Workshops for these regions included participants from over 50 countries: 20 from the Africa region, 18 from the Asia region and 12 from the Mediterranean region.

42. Amongst the specific actions identified as a first priority for most of the networks was to compile a list of import/export and transit requirements, and develop an approach for compliance inspection and approval of packages.

43. Arising out of the Agency's work on denials of shipment under the International Steering Committee on Denials of Shipment of Radioactive Material came a clearer understanding of the reasons for denials of shipment. In 2014, a Transport Facilitation Working Group (TFWG) was formed, independently from the Agency, comprised of past Chairs of the Steering Committee, representatives of industry, and transport regulators. The TFWG submitted its first formal report to the Inter-Agency Group²⁵, and the Inter-Agency Group subsequently reported on the report to TRANSSC, held in November 2014.

44. Furthermore, the creation of regional collaborative networks of competent authorities will provide a mechanism to address, in part, the issue of denials of shipment by contributing to a common understanding of transport safety regulatory oversight and the consequential understanding of a safety culture and the importance and benefits of regulatory compliance. Contacts in each of the regional networks currently being developed will be established to replace the functions performed by the national focal points for denial of shipment to provide an ongoing capability to develop ways to reduce the instances of denials.

A.3.3. Future Challenges

45. The provision of appropriate regulatory infrastructures and transport safety regulatory oversight remains a challenge for the future and the continuing work to develop collaborative networks is intended to mitigate, to an extent, these challenges in the future.

46. It is a challenge for the Agency to provide training for the staff of regulatory bodies that meets both the needs and timescales of Member States. To augment the strategic approach of building regional networks of transport safety for competent authorities, modular training material for transport is currently being developed for safety regulators and will be provided on a prioritized basis in the coming two years. The modular training will be structured into industry sectors requiring regulatory oversight, namely, agriculture, industrial, medical, mining and nuclear power sectors, with the content managed to reflect the needs and future ambitions of Member States. To establish the existing capabilities in Member States and to identify gaps and areas for possible collaboration, the Agency will continue to use the Radiation Safety Information Management System (RASIMS) and other Agency assessment tools.

A.4. Strengthening the Safety of Waste Management and Decommissioning

A.4.1. Trends and Issues

47. The safe management of all types of radioactive waste remains an objective for all Member States. It is essential that all Member States establish a comprehensive, integrated, cradle to grave approach for the management of radioactive waste, in particular with regard to disposal. The Agency is playing an important role in assisting Member States in developing comprehensive and safe radioactive waste management strategies.

²⁵ The Inter-Agency Group is an ad-hoc group comprising IAEA, United Nations Economic Commission for Europe, International Civil Aviation Organization and the International Maritime Organization that meet twice per year to discuss issues related to regulations of the transport of radioactive material; the Agency is the Secretariat for this group.

48. Experience is continuously being gained in the development of radioactive waste disposal solutions in many countries. Safe disposal solutions for low level waste and intermediate level waste are in place in many Member States and experience in managing these can benefit all other Member States. Progress is also being made in the disposal of high level waste, with a few Member States moving towards licensing such facilities, while others are progressing with the siting phase of geological disposal facilities.

49. The Agency must further develop and assist in the application of guidance for Member States for the recovery from severe accidents and the management of large amounts of radioactive waste following an accident, and for the strategic planning for radioactive waste management in these situations, including the advanced planning of generic predisposal management facilities (handling, treatment, conditioning and storage) and disposal considerations.

50. The term ‘decommissioning’ refers to the administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility (except for the part of a disposal facility in which the radioactive waste is emplaced, for which the term ‘closure’ instead of ‘decommissioning’ is used). Decommissioning actions are the procedures, processes and work activities (for example, decontamination and/or removal of structures, systems and components) that have to be carried out to achieve the approved ‘end state’ for the facility as specified in the decommissioning plan. There are two broad strategies for decommissioning that have been adopted by Member States: immediate dismantling and deferred dismantling. ‘Entombment’, in which all or part of the facility is encased in a structurally long lived material, is not considered a decommissioning strategy and is not an option in the case of planned permanent shutdown. It may be considered a solution only under exceptional circumstances (e.g. following a severe accident).

51. Decommissioning experience gained worldwide and technological improvements have made immediate dismantling a widely accepted and preferred decommissioning strategy in many countries. There are cases where an initially adopted deferred dismantling strategy has been replaced by immediate dismantling and where the safe enclosure period for deferred dismantling has been shortened. New technologies that improve the efficiency and safety of decommissioning actions are becoming available. Examples are remote tools for characterization and dismantling/demolition, and routine application of three dimensional visualization and simulation technologies in characterization and detailed planning of decommissioning works. It has been demonstrated that safe decommissioning can be done even if disposal routes are not available for all decommissioning waste streams. Long term storage of decommissioning waste is an acceptable option in many countries. Restricted reuse of sites within the nuclear sector or industrial reuse is often a preferred end state for decommissioning, especially for decommissioning of large and complex facilities.

A.4.2. Activities

52. In 2014, the Agency launched the IAEA Radioactive Waste Management Integrated Review Service (ARTEMIS)²⁶ to cover disused sealed sources, spent fuel management, and decommissioning and remediation programmes. This new peer review service is complementary to the aims of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste

²⁶ See <http://www.iaea.org/artemis/>

Management and is targeted at operators as well as regulatory and policymaking bodies.²⁷ ARTEMIS is available to Member States with nuclear power programmes, as well as to Member States that use radioactive materials only for medicine, research and industrial applications. Guidelines for implementation of ARTEMIS are being developed to respond to Member State needs and also to cover peer review obligations of the EU waste directive for the responsible and safe management of spent fuel and radioactive waste.²⁸

53. The Agency is working towards the development of model/generic safety cases for the demonstration of safety of pre-disposal management and disposal of radioactive waste, in particular with a view to assisting Member States in the safe development of predisposal and disposal facilities. More specifically, the Application of the Practical Illustration and Use of the Safety Case Concept in the Management of Near-Surface Disposal Project and the International Project on Complementary Safety Reports: Development and Application to Waste Management Facilities are focusing on the development of model/generic safety cases for near surface disposal and for storage facilities, respectively. For the geological disposal of radioactive waste, the International Project on Demonstration of the Operational and Long-Term Safety of Geological Disposal Facilities for Radioactive Waste is focusing on the integrated operational and long term safety case for the disposal of high level radioactive waste.

54. The Agency published *Decommissioning of Facilities* (IAEA Safety Standards Series No. GSR Part 6) in 2014.²⁹ In these revised Safety Requirements, only two strategies for decommissioning are recognized: immediate dismantling, which is the preferred strategy, and deferred dismantling. Entombment is no longer recognized as a decommissioning strategy — rather it is an option to be used under limited circumstances. The Agency is working on achieving an international consensus on the applicability of the entombment option in different situations. The revised Safety Requirements cover decommissioning of legacy facilities and damaged facilities, but at present there is no specific guidance developed for such situations.

55. In 2014, the Agency initiated a new project on research reactor decommissioning to assist Member States in North Africa to put in place decommissioning plans. The Agency is also revising the decommissioning Safety Guides applicable to the decommissioning of NPPs, research reactors, fuel cycle facilities and medical, industrial and research facilities. The safety implications of poor management of project risks during planning and implementation of decommissioning have recently been recognized as a priority by many Member States. The Agency is implementing the International Project on Decommissioning Risk Management to address this issue and to develop recommendations based on the experiences of Member States.

²⁷ The text of the Joint Convention is available at: <http://www.iaea.org/publications/documents/conventions/joint-convention-safety-spent-fuel-management-and-safety-radioactive-waste>

²⁸ EU Council Directive 2011/70/EURATOM of 19 July 2011 establishing a community framework for the responsible and safe management of spent fuel and radioactive waste.

²⁹ The publication is available at: <http://www-pub.iaea.org/MTCD/publications/PDF/Pub1652web-83896570.pdf>

A.4.3. Future Challenges

56. Challenges remain for radioactive waste management in countries that do not have large radiation and nuclear safety infrastructures, particularly in those countries without ample financial resources.

57. The number of peer reviews on radioactive waste management is expected to increase in the coming years, owing to the progress made by Member States in the development of national radioactive waste management programmes and, especially, of disposal facilities. In particular, peer review requests from all EU Member States will increase in relation to the obligations under the EU Council Directive for the responsible and safe management of spent fuel and radioactive waste to submit national radioactive waste management programmes to international peer reviews. In this regard, challenges will be faced to ensure provision of appropriate Agency resources for organizational purposes and Member State resources for the involvement of recognized experts in the peer reviews.

58. About half of all NPPs worldwide that have been shut down are being decommissioned under the deferred dismantling strategy. To complete the safe decommissioning of NPPs that have been shut down under a strategy of deferred dismantling, provision will have to be made for knowledge management and their long term care and maintenance until final decommissioning can be carried out; sufficient funding to carry out these activities will have to be provided. Another challenge for decommissioning is the appreciable number of research reactors worldwide that are shut down and need to be decommissioned; many of these do not have decommissioning plans in place. In many countries with research reactors and other smaller facilities, decommissioning is not properly addressed within the national regulatory framework; regulatory frameworks for decommissioning will have to be strengthened in these countries.

A.5. Remediation and Protection of the Environment

A.5.1. Trends and Issues

59. Legacy uranium mining areas in the former Soviet Union continue to present potential radiological risk for the health and environment of the people living in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan. For example, the Government of Tajikistan reported in September 2014 that the total amount of uranium residues stored in the country is more than 55 million tonnes. In November 2014, Kyrgyzstan concluded a nuclear energy agreement with the Russian Federation, which will provide 500 million roubles for the reclamation of uranium tailings in Min-Kush and Kaji-Sai under this agreement.³⁰ The State registry of Kyrgyzstan mining wastes includes 92 tailings dumps, totalling 457 billion tonnes of uranium residues.³¹ Central Asia has many uranium residue storage facilities located in seismically active, landslide- and mudflow-prone areas, as well as near rivers in Central Asia's Ferghana Valley, making this region vulnerable to events that could have transboundary consequences.

³⁰ See <http://www.highbeam.com/doc/1G1-367062539.html>

³¹ See <http://en.tengrinews.kz/disasters/Kyrgyzstans-uranium-polluted-rivers-threaten-Central-Asia-14023/>

60. According to the Basic Safety Standards, governments need to ensure that existing exposure situations on their territories have been identified and evaluated in terms of occupational and public exposures that are of concern for radiation protection. Existing exposure situations include areas contaminated by a nuclear or radiological emergency and areas contaminated by past practices (e.g. legacy sites). The Basic Safety Standards also require that remediation programmes be established and implemented for geographical areas of concern, and that such programmes include a strategy for managing radioactive wastes arising from remediation activities.

61. The increasing use of nuclear techniques and applications worldwide causes an increased demand for analysing and evaluating the radiological relevance of radionuclides being released to the environment since such facilities require licensing and surveillance during their operation. In addition, some activities in the past were less rigorously regulated than would be necessary according to present-day safety standards. Before the release of areas to unrestricted use, the potential exposure to people living in those areas needs to be assessed and, if necessary, appropriate remediation measures have to be taken to ensure that radiation doses to people remain below the radiological criteria defined in international standards.

A.5.2. Activities

62. Progress continues to be made with the remediation of former uranium production sites in Central Asia through a number of bilateral and multilateral initiatives. These include initiatives of the Eurasian Economic Community, the EU, the Government of Norway and the Agency. The Agency facilitates the work of the Coordination Group for Uranium Legacy Sites (CGULS). The objective of the CGULS is to promote cooperation amongst Agency Member States, and national and international organizations involved in the management, remediation and regulatory oversight of legacy uranium production facilities. Through the CGULS, the Agency is encouraging the implementation of a cohesive remediation approach across the region. Review and assessment of site characterization, environmental monitoring and remediation plans for some sites are being supported by the Agency. Environmental impact assessments are being carried out at a number of former uranium production sites in the region. At the second annual meeting of the CGULS, held in Issyk Kul, Kyrgyzstan, from 9 to 13 June 2014, the European Bank for Reconstruction and Development announced plans to establish a fund for the remediation of former uranium production sites in the region. The IAEA's International Working Forum on Regulatory Supervision of Legacy Sites continues to promote effective supervision of legacy sites globally.

63. In order to support Member States in fulfilling regulatory requirements with regard to exposures of the public and radiological impacts to the environment, the Agency set up, in 2012, the Modelling and Data for Radiological Impact Assessments (MODARIA) programme. The third Technical Meeting of the MODARIA programme was held in November 2014, attended by about 150 participants nominated by about 40 Member States, indicating the high interest in the subject. The programme supports the build-up of experience and the transfer of knowledge in the field of assessing radiation doses arising from radionuclides in the environment. The programme addresses a wide range of topics including the licensing of facilities and activities, remediation of areas affected by enhanced levels of radionuclides and modelling the fate of radionuclides released to the marine environment.

64. For many years, under the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention), advice has been sought from the Agency by the Secretariat of the Convention in assessing and evaluating radiological impacts to people and the environment from natural and man-made radionuclides in marine systems. Currently, the Agency is updating a report on radioactive materials at sea resulting from past dumping activities, accidents and losses involving radioactive materials. This report will serve as the basis for discussions in connection

with the London Convention focusing on the remaining radiological risks of radioactive waste that was dumped in the past.

65. The Agency's experience is also called upon by Member States requesting advice when managing extraordinary contamination situations. An example refers to practical arrangements made with the Fukushima Prefecture, Japan, in which the Agency is to provide advice on the remediation of terrestrial and aquatic environments affected by the accident at the Fukushima Daiichi NPP. The work started in 2013 and addresses the effectiveness of remediation measures that were and are still being implemented in the Fukushima Prefecture. Special emphasis is given to technical feasibility and acceptance by the public. The results are considered in the management of the remediation activities of the Fukushima Prefecture.

A.5.3. Future Challenges

66. Remediation of legacy sites, such as former uranium production sites and sites where R&D programmes were carried out presents unique regulatory challenges. In many countries that have such challenges, the regulatory infrastructure to deal with the remediation of legacy sites is still evolving. The needs of countries in the Central Asia region for remediation of former uranium production sites in terms of capacity building, regulatory and physical infrastructure and financial resources are substantial and will present a challenge for many years to come for all parties involved.

67. Being prepared in advance for situations that require the remediation of large areas, for example, in the event of a major nuclear or radiological accident, will facilitate the set-up and implementation of optimized remediation strategies. Remediation preparedness includes planning for the implementation of remediation policies, the establishment of criteria for doses to people and contamination levels in soil and foodstuffs. Generic remediation plans have to be ready for adaptation to specific situations.

68. The systematic linking of data from environmental and individual monitoring and the results of radiological impact assessments models will considerably improve the accuracy and the transparency of the radiological characterization of affected areas. This is essential to enable remediation strategies to be tailored to site specific conditions, and to validate and communicate the success of remediation measures.

A.6. Regulatory Effectiveness of Radiation, Transport and Waste Safety

A.6.1. Trends and Issues

69. While some Member States are making good progress in establishing or strengthening their regulatory effectiveness in radiation, transport and waste safety, many other Member States are still building their infrastructure in this area. The Agency collects and analyses information from Member States that receive assistance in order to help identify needs and to better plan future support.³² As shown in Figure 3, more than 70% of those Member States requesting assistance need additional support to be in full compliance with the Agency's safety standards. Building an effective regulatory

³² See <https://rasims.iaea.org>

infrastructure often takes many years to reach fruition, and it is generally those Member States that have been receiving Agency assistance over the longer term that have made better progress.

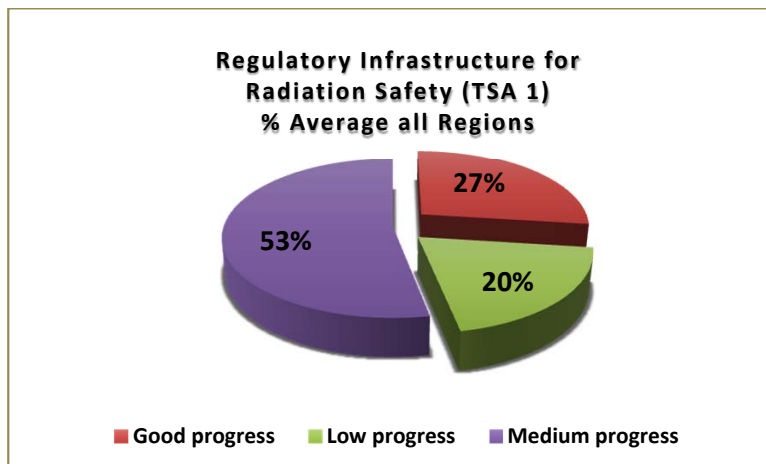


FIG. 3. Status of progress made in establishing a national radiation safety regulatory infrastructure in Member States receiving Agency assistance

70. It has been found that the reasons for such slow progress include difficulties due to institutional instability, general infrastructural weaknesses, additional support needed at the decision-making level, changes in national programme priorities, as well as insufficient human and financial resources for the regulatory body.

71. Governments have an essential role to play in the improvement of regulatory infrastructures, as well as in the implementation of a national safety policy and strategy, and they need to ensure that all individuals within the regulatory body, as well as other individuals with responsibilities for the safety of facilities and activities, receive the necessary professional training for building and maintaining the appropriate competencies. The data reviewed during this analysis³³ indicate that there is a need to ensure that governments have a clear understanding of these roles and are committed to fulfilling them.

72. There has also been an increase in the number of requests for IRRS missions by Member States without nuclear power programmes, from one conducted in 2013 to eight requests for 2015, showing increased recognition of the benefits of a regulatory infrastructure peer review for those Member States without nuclear power programmes.

73. Through the Agency's Programme for Action for Cancer Therapy (PACT), the WHO, the International Agency for Research on Cancer and other cancer-related organizations work together with the Agency to coordinate a global response in supporting low and middle income Member States in their implementation of comprehensive national cancer control programmes. Member States need to

³³ Derived from the RASIMS database: <http://rasims.iaea.org>

have an adequate regulatory infrastructure for radiation safety to ensure the safe use of the radiation technologies that are provided through this programme. Many low and middle income Member States have not yet established this infrastructure. An increasing number of Member States have begun relying on guidance and technical assistance from the Agency to address these issues.

74. The work to encourage Member States to develop regional networks for the regulatory oversight of transport safety has revealed the need for the Agency to develop and provide appropriate and adequate training for regulatory staff to enable the Member State alone, or in collaboration with others, to establish an effective regulatory oversight regime for the various industry sectors.

A.6.2. Activities

75. In May 2014, a group of international experts attended a Technical Meeting to develop a strategic approach for establishing and strengthening national infrastructures for radiation, transport and waste safety. This approach proposes that each Member State take a holistic approach to strengthening radiation safety by developing its own tailor-made national strategy based on identified needs, while at the same time considering all nationally and internationally available resources in order to maximize synergies and reduce overlaps.

76. In 2014, the Agency organized 17 advisory missions in Member States or at Agency Headquarters aimed at assessing and providing expert guidance on strengthening national regulatory infrastructures for radiation safety and the control of radiation sources.

77. During 2014, IRRS missions to review the status of the national regulatory infrastructure for radiation, transport and waste safety in Member States without nuclear power programmes were conducted in Cameroon, Jordan, Viet Nam (follow-up mission) and Zimbabwe. Preparatory work for upcoming missions began for Chile, Croatia, Estonia, Guatemala, Indonesia, Ireland, Lithuania, Malaysia, Malta and the United Republic of Tanzania.

78. The effectiveness of the regulatory infrastructure for radiation, transport and waste safety was also reviewed in IRRS missions conducted at the invitation of the following Member States that have nuclear power programmes: France, the Republic of Korea, the Netherlands, Pakistan, Slovenia and the UK (follow-up).

79. Additional courses for drafting regulations were organized in 2014 for Member States in Europe (through the technical cooperation programme) and in the Middle East (through the Regulatory Infrastructure Development Project, see below). Training courses to address specific needs of radiation safety regulatory bodies have recently been developed on authorization and inspection of uranium mining activities; organization and competence of the regulatory body; and enforcement of regulatory decisions. These courses have been held under regional technical cooperation projects throughout 2014.

80. *Model Regulations for the Use of Radioactive Sources and for the Management of the Associated Radioactive Waste* (IAEA-TECDOC-1732)³⁴ was published as a supplement to *Regulatory Control of Radiation Sources* (IAEA Safety Standards Series No. GS-G-1.5). This publication

³⁴ The publication is available at: http://www-pub.iaea.org/MTCD/Publications/PDF/TE-1732_web.pdf

provides advice on establishing an appropriate set of regulations covering all aspects of the use of radiation sources and the safe management of the associated radioactive waste.

81. The new Regulatory Infrastructure Development Project was launched in December 2013 to strengthen the national regulatory infrastructure for the safe use of radiation sources in selected States in North Africa and the Middle East. The project complements the relevant technical cooperation programme of the participating Member States. In 2014, bilateral meetings took place with all participating States to identify their priority needs. A group workshop on self-assessment and a school for drafting regulations were also conducted in 2014.

82. To extend the pool of experts needed for the ambitious and diverse IRRS schedule and programme, the second training course for future IRRS team members was organized in October 2014 in Vienna, Austria. A national course was also organized for the UK Office for Nuclear Regulation. Similar national courses are being prepared for regulatory bodies providing experts for many missions and in all technical areas of the IRRS.

83. Many of the thematic questionnaires of the Self-Assessment of Regulatory Infrastructure for Safety (SARIS) methodology and tools were revised and made available in March 2014; the *SARIS Guidelines: 2014 Edition* (Services Series No. 27) was published in April 2014. Several national and regional workshops on self-assessment have been conducted.³⁵

84. To further promote the integration of radiation safety infrastructure into national cancer control programmes, the Agency continued to address radiation safety infrastructure through the integrated missions of PACT (imPACT); all future imPACT missions will include a radiation safety expert.

85. Networks for radiation safety regulatory bodies are being facilitated through the dedicated Control of Sources Network (CSN) website on the GNSSN platform. The CSN website facilitates information sharing related to conferences and meetings and provides access to tools and documentation related to radiation safety and the control of sources. The CSN website is also used for online collaboration on the development of documents, training courses and specific projects. A regional workshop for African regulators was organized to demonstrate its capabilities and promote its use.

86. Based on feedback from users, work is being carried out to develop the next version of the Regulatory Authority Information System (RAIS), which currently helps Member State regulators to maintain their national register of radiation sources and manage the information related to their regulatory functions.³⁶ The Agency continued to support Member States in the system's use by carrying out 12 expert missions and four regional training courses, using the latest released version RAIS Web 3.3 in 2014.³⁷

87. A Safety Guide on establishing a national radiation safety infrastructure has been developed and was sent for Member States' comments in 2014. This Safety Guide will provide advice for Member States to assess the level of their national radiation safety infrastructure in line with the Agency's

³⁵ See <http://www-ns.iaea.org/tech-areas/regulatory-infrastructure/sat-tool.asp>

³⁶ See <http://www-ns.iaea.org/tech-areas/regulatory-infrastructure/rais.asp>

³⁷ See <http://gnssn.iaea.org/CSN/RAIS/default.aspx>

safety standards, and to enable them to effectively implement a set of actions to fully meet safety requirements progressively in an integrated manner, while taking full account of their specific national circumstances. Additionally, two Safety Guides are being developed—one on the organization, management and staffing of a regulatory body and functions and the other on the processes of regulatory bodies. These Safety Guides will help Member State regulatory bodies to implement the requirements of *Governmental, Legal and Regulatory Framework for Safety* (IAEA Safety Standards Series No. GSR Part 1) in an effective manner, considering the extent of the national applications of radiation sources.³⁸

88. Over the course of 2014, 95 Member States that receive Agency assistance actively updated their national information on radiation, transport and waste safety infrastructure in RASIMS.³⁹ The updated information in RASIMS provided baseline data for the development of new Agency projects and aided the radiation safety clearance process prior to the procurement of radiation sources and related equipment.

89. To assist users in gaining a better understanding of the system, the RASIMS e-learning portal was also improved in 2014 by adding new modules and additional voice-overs. This portal was accessed by people in 76 Member States. A workshop for RASIMS national coordinators from the Asia and the Pacific region was held in December 2014 and attended by representatives from 19 Member States.

90. In 2014, 137 participants (many of whom were from regulatory bodies) from 73 Member States attended the Agency's Postgraduate Educational Courses in Radiation Protection and the Safety of Radiation Sources. These courses were held in Algeria, Argentina, Ghana, Greece and Malaysia.

A.6.3. Future Challenges

91. In view of the growing extent and diversity of radiation technologies (especially in medicine) and the associated increase in the transport of radioactive materials, a major challenge for Member States and the Secretariat will be to ensure that sufficient priority and resources are made available to meet all the demands for strengthening national regulatory infrastructures for radiation safety.

92. To establish and further strengthen national radiation, transport and waste safety infrastructures in line with the Agency's safety standards will require a full commitment from governments. Even with assistance from the Agency, it will be a challenge for some Member States to develop sufficient regulatory competencies within the desired timescales.

93. With the increasing demand for IRRS missions in the near future, coupled with the increasing number of Member States developing national cancer control programmes, it will be a challenge to mobilize additional resources at the required level both in the Agency and in Member States to meet this demand.

³⁸ The publication is available at: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1465_web.pdf

³⁹ See <http://rasims.iaea.org/Default.aspx?tabid=36>

B. Strengthening Safety in Nuclear Installations

B.1. Nuclear Power Plant Safety

B.1.1. Reinforcing the Safety of Nuclear Power Plants

Trends and Issues

94. Over the years, substantial improvements in safety standards, practices and technological advances have occurred, and NPPs continue to undergo both routine and specific safety reviews taking into account these improvements. Periodic safety reviews (PSRs) have been extremely beneficial in this regard as they strive to assess the degree of plant conformity with these improvements and help to determine whether the safe operation of a plant can be further enhanced by means of reasonably practicable safety improvements. Member States use different regulatory approaches to PSRs and can choose their own safety review methodology and timeframe. For instance EU countries, under their amended nuclear safety directives, are required to conduct a PSR at least every 10 years in line with the Agency's safety standards. However, findings from IRRS and OSART peer review safety missions indicate that some Member States would benefit from a PSR mission to assist in meeting the Agency's recommendations for PSRs. As noted during the Sixth Review Meeting of the Contracting Parties to the CNS in March-April 2014, implementation schedules for PSRs and safety improvements in response to the Fukushima Daiichi accident are occurring on different timescales as dictated by factors including different natural conditions, in particular to extreme natural events; different regulatory approaches and application of periodic safety assessments.

95. The use of nuclear energy, including the future deployment of innovative reactor designs, and the progressive ageing of the NPP fleet in operation require that all reasonable measures are taken to have the highest assurance that accidents with large external consequences will be prevented in the future. The Fukushima Daiichi accident and the measures taken thereafter in Member States have reinforced the need to ensure that the possibility of an accident of such magnitude is practically eliminated⁴⁰. The new reactors currently being licensed already incorporate improvements in their design to prevent and mitigate the consequences of severe accidents. In the past few years, work has been conducted to backfit the existing nuclear reactor fleet to cope with the risks of some multiple failure scenarios and some severe accident conditions. In addition, the lessons learned from the Fukushima Daiichi accident have led to the identification of important areas of safety enhancements in current plant designs, such as the consideration of site-specific external natural hazards exceeding the design basis; the possible loss of ultimate heat sink; and the capability for using mobile sources of electric power and coolant. Complementary permanent or mobile systems and equipment with new capabilities are an example of changes that have been backfitted to many existing NPPs

96. State-of-the-art, innovative power reactor technologies such as Small Modular Reactors offer significant performance benefits and higher levels of safety and have little resemblance to earlier reactor types that are in operation. However, the current design and licensing rules apply mostly to

⁴⁰ "The possibility of certain conditions occurring is considered to have been practically eliminated if it is physically impossible for the conditions to occur or if the conditions can be considered with a high level of confidence to be extremely unlikely to arise." *Safety of Nuclear Power Plants: Design* (IAEA Safety Standards Series No. SSR-2/1)

large water reactors and there is no consensus as to whether the current requirements will need to be changed to fit the design, safety assessment and licensing of the new innovative reactors. While it is expected that the safety of innovative reactors will be better than that of existing installations, it will be necessary to develop standards and requirements against which this can be demonstrated.

Activities

97. *Safety of Nuclear Power Plants: Design* (IAEA Safety Standards Series No. SSR-2/1) reflects the safety developments and knowledge accumulated up to its publication in 2012.⁴¹ Since this publication was finalized prior to the Fukushima Daiichi accident, some of the lessons learned from the accident have affected some of its provisions. The Agency, therefore, has initiated the revision of its suite of Safety Guides for the design and safety assessment of NPPs. In parallel, while the Safety Guides are being revised, a TECDOC will be published in the first quarter of 2015 on considerations pertaining to the application of the Safety Requirements for the design of NPPs aimed at facilitating the understanding and interpretation of some complex issues introduced in the new Safety Requirements. It addresses, for example, the extension of the design basis of the plant, the practical elimination of the possibility of large or early radioactive releases and the effective implementation of defence in depth. This TECDOC takes into account the outcomes of the International Conference on Topical Issues in Nuclear Installation Safety: Defence in Depth — Advances and Challenges for Nuclear Installation Safety, held in 2014, and will support the preparation of the upcoming topical issues meeting on the safety demonstration of advanced water cooled NPPs to be conducted in 2015.

98. The Agency continues to provide assistance to Member States on the implementation of safety standards for NPP design. In the framework of the Design and Safety Assessment Review Service (DSARS), a number of new generic NPP designs have been reviewed against the new Safety Requirements. In addition, the DSARS modules have been used to review the design safety regulations for new NPPs in some Member States to assess consistency with the latest Safety Requirements and provide assistance in the implementation of PSRs⁴².

99. The Agency continued working in close cooperation with international organizations that are active in the application of safety requirements for advanced power reactor designs, such as the Multinational Design Evaluation Programme and the Generation IV International Forum (GIF). GIF is currently using the Agency's safety standards for design for the development of safety design criteria and safety guidelines for sodium cooled fast reactors. The Agency is also facilitating the establishment of the Small Modular Reactor (SMR) Regulators Forum, which will address the application and development of safety standards for SMRs.

Future Challenges

100. Notwithstanding the fact that Member States with existing power reactors are making very important progress in strengthening safety after the Fukushima Daiichi accident, it remains a challenge to demonstrate that all the Safety Requirements established in the latest safety standards are met. Examples of new Safety Requirements which are challenging for an existing facility to meet are design extension conditions and the concept of practical elimination. The use of mobile or

⁴¹ The publication is available at: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1534_web.pdf

⁴² See <http://nucleus.iaea.org/sites/gsan/services/Pages/PSRS.aspx>

non-permanent equipment has certainly improved the capabilities for prevention and mitigation of the consequences of severe accidents, and work will continue to demonstrate that these measures are capable of addressing all possible accident sequences.

101. As for advanced power reactor designs, challenges remain to convincingly demonstrate that new safety features for the prevention and mitigation of the consequences of severe accidents and the application of new technologies (e.g. digital instrumentation and passive systems, and the reinforcement of defence in depth, including the protection against external hazards) will result in the practical elimination of the possibility of early or large radioactive releases. In addition, for the more innovative designs, including SMRs, fast reactors and other concepts discussed in GIF, achieving consensus regarding applicable safety criteria remains a challenge.

102. Some Member State requirements for PSR have changed in the light of the Fukushima Daiichi accident and now include the need to perform a peer review of PSRs. The Agency's Periodic Safety Review Service is an ideal candidate to fulfil this requirement, but work is needed on the guidance for this service to ensure that it is consistent with the latest Agency safety standards.

B.1.2. Severe Accident Management

Trends and Issues

103. The work conducted on strengthening severe accident management following the Fukushima Daiichi accident focused on implementing adequate measures and lessons learned to manage severe accidents. As discussed during the Agency's International Experts' Meeting on Severe Accident Management in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant held in March 2014, there is still more work that can be done to strengthen the nuclear industry's ability to reduce the impact of a nuclear accident. The meeting's conclusions highlighted the need to improve technical guidance, strengthen regulatory oversight of severe accident management measures, and develop robust training.

104. Given the robustness of the design of nuclear power plants, severe accidents are the result of a complex combination of multiple failures or errors that lead to an accident. Given the complexity of a severe accident, it is recognized that it is impossible for Severe Accident Management Guidelines (SAMGs) alone to provide specific accident management guidance for every accident event scenario. Therefore, during efforts to prevent or mitigate the consequences of a severe accident, operators may face the need to transition from a procedure-based response (i.e. SAMGs) to a knowledge-based response. A knowledge-based response begins when operators start making decisions based on their technical knowledge of plant operations and severe accident phenomena rather than using specific procedural guidelines. As this concept is incorporated into SAMGs consideration needs to be given to the latest developments in the technical bases documents and the appropriate regulatory provisions.

Activities

105. In March 2014, the International Experts' Meeting on Severe Accident Management in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant was attended by over 170 experts from 37 Member States and six international organizations. This meeting brought together the on-site and off-site response communities to share expert views on these topics individually and the interfaces between these two communities. The sessions on on-site response focused on training, regulatory control of SAMGs, improvements to SAMGs, and the identification of gaps in knowledge in this area. This meeting highlighted the recent improvements to severe accident management and identified areas that need further work, such as reaching consensus on the appropriate level of regulatory control and the need to develop realistic learn-by-doing practical training programs.

106. In 2014, the content and plan for the revision of *Severe Accident Management Programmes for Nuclear Power Plants* (IAEA Safety Standards Series No. NS-G-2.15), reflecting lessons learned from the Fukushima Daiichi accident, were approved by the Commission on Safety Standards and is planned to be completed in 2017.⁴³

107. As part of the DSARS programme, the Agency offers a module called the Review of Accident Management Programmes (RAMP).⁴⁴ The Agency continued to encourage Member States to take advantage of the RAMP module, as it provides advice and assistance at the utility/NPP level for the preparation, development and implementation of effective plant specific accident management programme. This module provides a peer review on the completeness and adequacy of plant specific emergency operating procedures as well as the plant accident management programme performed in Member States. There have been more than ten requests for RAMP missions since RAMP was set up, but the last request dates back to 2012.

Future Challenges

108. The proper implementation of SAMGs is a challenge that needs continued focus. The first part of this challenge relates to the need for continual improvement to the guidelines themselves. The most difficult part of the development and verification of guidelines is the need to use analysis software to predict the accident sequence and the impact of operator actions on the progression of the accident. However, the understanding of severe accident phenomena is in some cases still quite uncertain and this uncertainty is reflected in the software, which makes accurate predictions difficult. Continued R&D to reduce this uncertainty is needed. The second aspect of the challenge in the implementation of SAMGs relates to training. In order to successfully prepare operators to enable them to move from a rule-based to a knowledge-based response, operators need to have specialized training in plant response and severe accident physics. Developing and implementing this training will require continual improvement to existing operator training programmes.

109. As new and improved SAMGs are implemented in NPPs, the use of international peer reviews can increase the confidence and transparency of the success of this activity. As mentioned earlier, the Agency offers the RAMP module of the DSARS to provide this type of peer review, but its usage has been limited so far. The challenge for the international community is to increase the use of peer reviews such as the RAMP service.

B.1.3. Operational Experience Feedback (Safety Significant Event Analysis and Investigation)

Trends and Issues

110. Learning from operating experience is one of the keys to maximizing the safety and reliability of NPPs, preventing the recurrence of safety significant events and continuously improving operational safety performance. The most recent review missions by the Agency and the nuclear power industry have identified that in many NPPs, safety significant event analysis and investigation

⁴³ The publication is available at: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1376_web.pdf

⁴⁴ Service information is available at: <http://nucleus.iaea.org/sites/gsan/services/Pages/RAMP.aspx>

which would have uncovered the root causes and provided for realistic countermeasures to be taken to prevent the recurrence of such events have not been rigorously or comprehensively conducted.

111. Industry statistics have shown that about 50% of the safety significant events that occurred in the past several years could have been prevented or mitigated if the operating experience from past safety significant events had been internalized and corrective actions to prevent recurrence had been implemented. Several reasons for the failure to identify the root causes have been identified: lack of qualified root cause analysis investigators or training of the event investigators; an inadequate classification process to identify events for root cause analysis; and missing plant guidelines or procedures on how to conduct root cause analysis. In addition, several review missions identified that management support was not commensurate with the importance of event analysis and investigation and in some NPPs staff do not perceive career development opportunities in the operating experience area.

112. Most NPPs in Member States have a strong operating experience feedback programme covering internal events. However, external safety significant events are not always analysed with the same rigour as internal events. A mindset of “these kinds of events cannot happen here” still exists in many NPPs and utilities when it comes to analysing external events. Some external safety significant events with important learning points were not internalized and the opportunities to prevent similar events were missed.

Activities

113. In 2014, the Agency provided national training on root cause analysis in Beijing, China (52 participants from China), and a regional training workshop on root cause analysis in Bulgaria to EU participants (33 participants from seven Member States). In addition, the Agency and WANO provided a joint workshop on operating experience in Bulgaria (32 participants from 12 Member States).

114. A joint IAEA/NEA Technical Meeting of the Incident Reporting System’s (IRS) National Coordinators was convened to exchange experience on recent events in NPPs, in October 2014 in Vienna, Austria (52 participants from 34 Member States). An additional Technical Meeting on a draft Safety Guide covering operating experience feedback for nuclear installations, was convened in December 2014, in Vienna, Austria.

115. In 2014, the Agency conducted several OSART missions covering operational safety performance experience in France, Hungary, the Netherlands, the Russian Federation and the USA.

Future Challenges

116. Access to high quality root cause analysis training was not easily available for some Member States in the commercial market, and a lack of trained and qualified event investigators continues to be a challenge in many NPPs. Member States are encouraged to request services and training from the Agency in this area.

117. The IRS receives about 80 event reports each year, which is about 0.2 events/unit. Many safety significant events were not reported in the IRS. With the small number of reported events, no meaningful analysis of events or establishment of statistical trends can be done, and Member States are not able to learn from each other. Member States are encouraged to enhance their reporting of events with safety significance for the benefit of the whole international nuclear community.

B.2. Research Reactor Safety

B.2.1. Trends and Issues

118. Feedback from Agency activities, including safety missions and meetings on the application of the Code of Conduct on the Safety of Research Reactors, showed that regulatory effectiveness continues to be an important safety issue in many Member States, particularly in the areas of establishing regulations specific to research reactors, reviewing and assessing safety documents for issuance of authorizations, and developing and implementing inspection programmes. This is especially important for those Member States without operating NPPs which are facing difficulties in developing staff with the necessary competencies to fulfil the regulatory functions.

119. In addition and in view of the feedback from the Fukushima Daiichi accident, appropriate attention needs to be given to ensuring the ability of research reactor operating organizations to perform safety reassessments, including: analysing extreme external events; assessing robustness of reactor systems and components, taking ageing effects into consideration; revising safety documents; and reviewing capabilities for emergency response to events at research reactors with potential off-site radiological consequences. This also highlights the need to ensure regulatory effectiveness in evaluating safety under the above-mentioned conditions.

120. Additionally, Agency activities showed that there was a need to enhance the safety of experiments and experimental facilities, particularly in relation to safety classification of experiments and the associated safety analysis and approval routes. Furthermore, decommissioning was not considered in the design of many research reactors that were built several decades ago, and many of the operating research reactors are facing challenges to develop an up-to-date decommissioning plan due to a lack of adequate human and financial resources.

B.2.2. Activities

121. In June 2014, the Agency held the third triennial International Meeting on Application of the Code of Conduct on the Safety of Research Reactors in Vienna, Austria, with the participation of 40 Member States. The meeting provided a forum for the participating countries to exchange information on the safety status of their research reactors and experience in the application of the Code's provisions. The Member States' self-assessments of the application of the Code were reviewed and discussed during the meeting. This resulted in the identification of areas where the Code was being satisfactorily applied and areas where further improvements were necessary. The meeting noted increased recognition by the Member States of the Code as a primary guidance document for the safe management of research reactors and provided recommendations for further improvements in some areas, including regulatory supervision, ageing management, and consideration of human factors at different stages of research reactor lifetime.

122. A Workshop on Safety Analysis and Safety Documents for Research Reactors was conducted in May 2014 in Vienna, Austria, with the participation of operating organizations and regulatory bodies from 27 Member States. The workshop discussed various aspects of performing safety analysis and the development, review and assessment of safety documents for research reactors, including the results of safety reassessments for research reactors and considering the feedback from the Fukushima Daiichi accident and the relevant regulatory considerations.

123. A Workshop on Operating Programmes for Research Reactors was held in April 2014 in Vienna, Austria, with the participation of 20 Member States. The participants discussed fuel handling, operating procedures, operational limits and conditions, maintenance and fire protection programmes. The annual meeting of the Regional Advisory Safety Committee for Research Reactors in Africa was conducted in December 2014 in Egypt, with particular emphasis on analysis of internal events, including fire. A Workshop on Fire Safety for Research Reactors was conducted for the Asia and the Pacific region in December 2014 in the USA, with the participation of eight Member States. These activities provided practical knowledge on establishing the programmes mentioned above and

facilitated the sharing of experience on effective regulatory supervision in these programmes. In addition, the development and implementation of effective regulatory inspection programmes was the topic of a Workshop on Regulatory Inspection Programmes for Research Reactors held in October 2014 in Egypt, with the participation of the countries operating or considering the operation of research reactors in Africa and the countries that are members of the Arab Network of Nuclear Regulators.

124. The Agency also conducted a Technical Meeting on the Development of Decommissioning Plans and Managing the Transition Period between Operation and Decommissioning for Research Reactors in December 2014 in Vienna, Austria. The meeting discussed various aspects of the development of decommissioning plans, safety programmes and activities during the transition between operation and decommissioning, and criteria for relief from regulatory control of decommissioned research reactors.

125. Additionally, the Agency conducted, in 2014, three expert missions that supported the regulatory body in South Africa in establishing a certification programme for research reactor operating personnel, the regulatory body in Ghana to establish a licensing process for the core fuel conversion of the research reactor to low enriched uranium, and the regulatory body in the Islamic Republic of Iran to review and assess safety documents for research reactor licensing. Two national technical meetings were held in Vienna, Austria, in March and November 2014 to provide technical support to the regulatory body of Nigeria on the development of the national safety requirements for research reactors. Furthermore, three safety missions dedicated to enhancing the safety of experiments were conducted at the research reactors in China, Morocco and Slovenia. These missions provided recommendations for further enhancing the safety of experiments and programmes related to radioisotope production, irradiation facilities and beam tubes. A regional workshop on the same topic was held in December 2014 in Algeria with the participation of the African Member States operating or planning to operate research reactors.

B.2.3. Future Challenges

126. Enhancing effective independence of the regulatory body continues to be a challenge in many Member States operating research reactors. Additional efforts are needed to establish systematic regulatory inspection programmes. This is increasingly important in the light of the feedback from the Fukushima Daiichi accident that indicates that specific inspections need to be conducted to verify the robustness of structures, systems and components important to safety, of operating programmes and procedures, and of the emergency preparedness measures that are currently in place.

127. Taking into account the limited resources available to regulatory bodies, another challenge will be to review and revise the existing national regulations and the existing regulatory supervision activities to ensure that they are adequate to verify compliance of the operating organizations with any new IAEA safety requirements established in the light of the feedback from the Fukushima Daiichi accident. In this regard, the operating organizations also face the challenge of developing capabilities to perform safety reassessments of their research reactor facilities, including evaluation of site-specific hazards and assessment of extreme external hazards.

128. In addition, the results of the self-assessments submitted by the Member States that participated in the International Meeting on the Application of the Code of Conduct on the Safety of Research Reactors, held in 2014, showed the continuing need for further improvement in effective ageing management, operational radiation protection, and decommissioning planning. This constitutes another challenge in view of the limited financial resources available to research reactor organizations.

B.3. Fuel Cycle Facility Safety

B.3.1. Trends and Issues

129. Fuel cycle facilities cover a wide range of activities, including milling and refining, conversion and enrichment, fuel fabrication, interim spent fuel storage, reprocessing and waste conditioning. Many of these facilities are operated by the private sector, with operators often in competition with each other and making much of the process and technology information commercially sensitive. Although in the past this sensitivity often extended to the safety area, there is now more sharing of information on specific technical safety practices.

130. Feedback provided under the Fuel Incident Notification and Analysis System (FINAS) shows the need to give continued attention to the training and qualification of operating personnel. In some Member States, regulatory bodies lack human and financial resources, which makes it difficult to establish regulations specific to fuel cycle facilities. This is particularly important in view of the relevant feedback from the accident at the Fukushima Daiichi NPP and the fact that the international safety guidance currently available for such facilities is still incomplete and needs to be further developed.

B.3.2. Activities

131. In 2014, the Agency completed the development of Safety Requirements for fuel cycle facilities and published *Safety of Nuclear Fuel Cycle Facilities* (IAEA Safety Standards Series No. NS-R-5 (Rev. 1))⁴⁵, a revised version of an earlier publication. This includes requirements on nuclear fuel reprocessing and R&D fuel cycle facilities. Significant progress was achieved in the development of two Safety Guides on these facilities.

132. In 2014, the Agency also published *Criticality Safety in the Handling of Fissile Material* (IAEA Safety Standards Series No. SSG-27)⁴⁶, which provides guidance on meeting the Safety Requirements for ensuring subcriticality when dealing with fissile material and for planning and response to criticality accidents. A workshop was conducted in February 2014 in Vienna, Austria, on the application of this Safety Guide with the participation of 21 Member States. The workshop provided the participants with practical information on criticality analysis and on the prevention of criticality in fuel cycle facilities.

133. In September 2014, the Agency also conducted in Vienna, Austria, the biennial meeting for the national coordinators of FINAS with the participation of 19 Member States. The meeting provided a forum for the exchange of operating experience and discussed the events reported to FINAS, including their root causes and actions taken to prevent recurrences of such events. The meeting also provided recommendations for further enhancing the effectiveness of FINAS.

134. Additionally, a workshop was conducted in July 2014 at the fuel fabrication facility in Brazil. The workshop provided guidance and recommendations on establishing an effective operational radiation protection programme at the facility.

⁴⁵ The publication is available at: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1641_web.pdf

⁴⁶ The publication is available at: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1549_web-51742615.pdf

B.3.3. Future Challenges

135. Although the number of Member States joining FINAS has increased during the past few years, the level of event reporting to the system needs to be further improved. Taking into consideration the sensitive nature of these facilities, increased efforts need to be exerted to enhance networking and better exchange of operating experience.

136. Regulators and operators both share concerns with regard to ageing fuel cycle facilities. Operators need to face the challenge of establishing rigorous and systematic ageing management programmes that address the diversity of the fuel cycle facilities, taking into account the potential nuclear and chemical hazards that, due to the uniqueness of the designs of these facilities, are often specific to a particular facility.

137. The potential expansion of nuclear power will lead to programmes for new commercial fuel cycle facilities that can be of innovative design. It also requires the production of new nuclear fuel adapted to the design of future NPPs. In this context, adequate qualified human resources and adequate competencies are essential in areas related to regulatory supervision, safety assessment, construction, commissioning, safe operation, and decommissioning.

B.4. Site and Design Safety

B.4.1. Trends and Issues

138. A site evaluation analyses those factors at a site that could affect the safety of a facility or activity on that site. This includes site characterization, consideration of factors and activities that could affect safety features of a facility, resulting in a release of radioactive material to the public or the environment, as well as access issues relevant to safety (e.g. feasibility of evacuation, location of people and resources). For new nuclear installations, it is important to ensure that site selection and evaluation are done in accordance with currently recognized engineering practices, aimed at sound consideration of external hazards and any site-related aspects that would affect the dispersion of radioactive material. Additionally, evaluating new and existing nuclear facilities against natural hazards and human induced events and site-related environmental aspects requires state-of-the-art methods and continuous improvement of methodologies.

139. As discussed in the *Nuclear Safety Review 2014*,⁴⁷ the Agency continues to find that some embarking Member States have selected a design but do not have adequate regulatory requirements in place to guide implementing organizations and regulatory bodies prior to site evaluation and site selection. Also, many embarking countries are searching for sites without having regulatory guidelines and requirements in place for site selection.

140. Furthermore, with regard to existing facilities, these must also undergo periodic site evaluation, based on lessons learned, improved methodologies and operational experience, to ensure the continued safety of the facility and mitigate any new risks that may have been uncovered.

⁴⁷ This publication is available at: http://www.iaea.org/About/Policy/GC/GC58/GC58InfDocuments/English/gc58inf-3_en.pdf

141. The Agency provides the Site and External Events Design (SEED) review service to assist Member States throughout the different stages of site selection, site evaluation and design of structures, systems and components to withstand the site specific external and internal hazards, whilst recognizing that the ultimate responsibility for ensuring the safety of the public and the environment lies with the Member State. The Agency has developed and provides training and workshops on site-related technical and engineering areas to support the site evaluation process in embarking countries.

142. The number of training activities and SEED missions has steeply declined since 2010, with only a slight upturn for training in the past two years (see Figure 4); however, the number of countries embarking on nuclear power programmes has steadily increased.

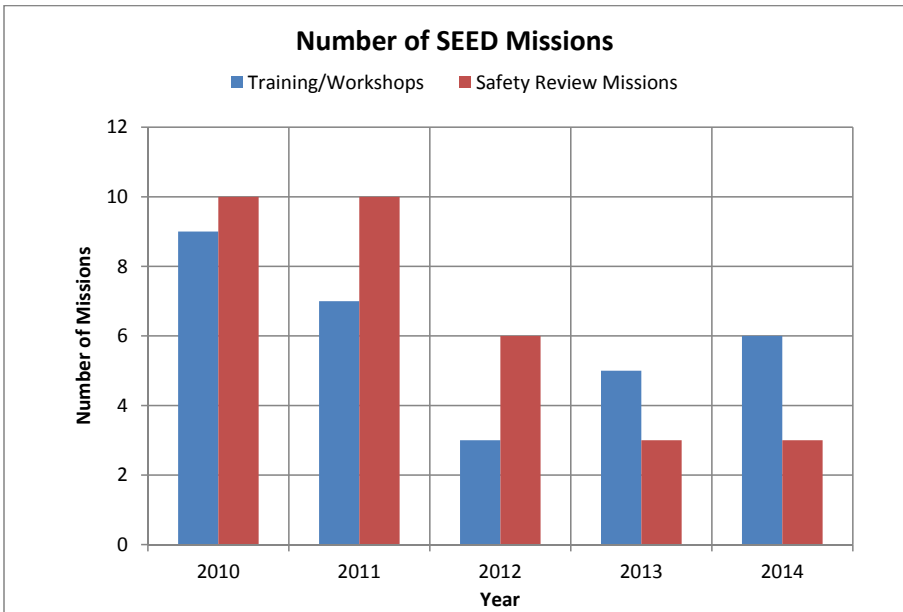


FIG. 4. Number of training activities and safety review missions provided through the SEED programme.

B.4.2. Activities

143. Several new Safety Reports and TECDOCs complementing the Agency’s safety standards in relation to site evaluation safety are currently being developed by the Agency; these new publications cover, for example, assessments and evaluations of natural external hazards (e.g. seismicity, volcanic activity, flooding); assessment of NPPs against human-induced external events; and probabilistic safety assessments for multi-unit sites. Also, SEED guidelines are currently being developed to provide Member States with information about SEED safety review services, including roles, responsibilities, and expectations during the preparation, conducting and reporting of SEED missions. These are due to be published in 2015.

144. In 2014, the Agency provided training on site safety topics to Bangladesh, China, Indonesia, the Islamic Republic of Iran, Romania and Viet Nam.

145. A new training approach was implemented in Indonesia by having the participants perform a simulated safety review of hazard characterization for two sites in Bangka Island. This approach provided the participants with a better understanding of how the Agency’s safety standards are used when conducting a safety review mission.

146. Generic and specific educational and training manuals are being developed by the Agency for a number of site-related technical and engineering areas to support capacity building. These manuals will be used in national and regional training workshops to build the technical competencies of the implementing organizations and regulators in newcomer countries in the site selection, site evaluation and licensing of NPP sites. This training will be available in 2015.

B.4.3. Future Challenges

147. Countries embarking on nuclear power programmes continue to face challenges in establishing a national regulatory basis for site evaluation and in making available the resources needed to properly characterize the sites. Member States cannot adequately evaluate site safety without first having adequate regulatory requirements in place to ensure that the site is appropriate for the proposed power reactor design. SEED missions, complemented by capacity building related to site safety topics, are available to assist Member States as they develop a national regulatory basis to perform site evaluations for proposed NPPs.

148. Implementation of SEED review recommendations continues to pose challenges. However, it should be noted that all recommendations are established in consultation with each Member State concerned to ensure that the cost–benefit ratio of remedial actions is reasonable at the national level. Furthermore, by identifying remedial actions in their National Reports under the CNS, Member States will promote greater transparency and allow for the sharing of experience on remedial actions among Member States.

149. The Fukushima Daiichi accident showed that extreme external events can affect multiple units at a site. The SEED hazard assessment methodologies provide the flexibility to assess the safety of all units at a site in a holistic manner. With few exceptions, multiple unit safety assessments have not been addressed by the nuclear industry in the past. SEED missions provide advisory and review services for establishing site level safety assessments.

150. When a site's external hazards are not identified and assessed, the associated risks cannot be determined, leaving the nuclear facility at risk and vulnerable to negative impacts. The Agency encourages all Member States (those embarking on a nuclear power programme and those with existing programmes) to request SEED safety review services.

151. Member States face the ongoing challenge of advancing the current state of practice for coping with uncertainties related to protection of nuclear installations against external hazards. Certain gaps that exist between current Agency safety standards and recent practices (for example with regard to multiple units, tsunami design and potential for surface faulting) should be addressed in future revisions of Agency safety standards.

B.5. Safety Infrastructure for Embarking Countries

B.5.1. Nuclear Power Programmes

Trends and Issues

152. Nuclear safety is a precondition for the successful use of nuclear technology and it takes time and resources to develop the necessary safety infrastructure for countries embarking on nuclear programmes. A strong nuclear safety infrastructure requires: a competent, effective and independent regulatory authority; a competent, safety-focused owner/operator; competent technical support organizations (TSOs); competent organizations responsible for EPR; and the means to provide sufficient specialists for all these organizations.

153. Based on reviews of current NPP and research reactor programme schedules in embarking countries during peer review and advisory missions, a trend has been observed that project milestones (site licensing, bids, construction, etc.) are outpacing the development of the necessary safety infrastructure (legal, regulatory and technical), placing undue pressure on the relevant organizations to make sure that staff are recruited in time and trained in the requisite components of nuclear safety. Additionally, weaknesses in establishing a well-functioning and effective regulatory framework and an independent regulatory body with sufficient financial and human resources to discharge its regulatory mandate have also been identified during safety review missions.

154. Some Member States lack adequately qualified staff and adequate competencies in areas such as regulatory capacity, safety assessment, construction, commissioning, operation, safe utilization, and decommissioning. This substantially contributes to their inability to develop the necessary safety infrastructure. Additionally, most newcomers do not have a clear national strategy for human resource development or for building these necessary competencies. For example, one of the longest lead time items is the development of safety assessment competencies. Safety assessment is a broad multidisciplinary field requiring a solid understanding of basic physics and the risks associated with the technology, as well as the capability to apply this knowledge to solving practical problems. Most of this practical knowledge comes from experience that can only be acquired by working on actual safety assessment projects and finding appropriate institutions/organizations for on-the-job training can be difficult.

155. Over 33 Member States have expressed an interest in introducing nuclear power. Belarus and the United Arab Emirates have begun construction of new NPPs and Bangladesh, Egypt, Jordan, Nigeria, Poland, Saudi Arabia, Turkey and Viet Nam have taken significant steps towards their first NPP.

156. Capacity building programmes for embarking countries are supported through the technical cooperation programme and/or extra-budgetary programmes. The Agency was able to provide extensive assistance to countries embarking on nuclear power programmes through workshops, training courses and expert missions, taking into account implications from the Fukushima Daiichi accident on Agency safety standards and safety services.

Activities

157. The Agency continued strengthening and promoting Integrated Regulatory Review Service (IRRS) peer review missions for newcomer Member States through the tailored module for countries embarking on nuclear power programmes. The extended IRRS follow-up mission to Viet Nam in October 2014 included the specifically tailored module as did the full-scope IRRS mission to Jordan in June 2014.

158. In the area of governmental and regulatory infrastructure for safety, a regional workshop took place in Egypt in November 2014 to enable national decision-makers of newcomer countries to better understand their national commitments and responsibilities regarding their prospective nuclear power programme. Additional national or regional events included the review of specific regulations and review of compliance of national legislation with international requirements, as well as the identification of gaps or areas for improvement in the development of human resources, inspections, leadership and management systems, oversight and regulatory safety culture. Member States receiving expert assistance of this kind included Bangladesh, Belarus, Egypt, Indonesia, the Islamic Republic of Iran, Kenya, Malaysia, the Philippines, Saudi Arabia, Uganda, the United Arab Emirates and Viet Nam.

159. In 2014, one national and two regional workshops on the regulatory framework and regulatory approaches for NPPs (based on *Establishing the Safety Infrastructure for a Nuclear Power Programme*, IAEA Safety Standards Series No. SSG-16) were organized for Indonesia, for newcomer countries in the Europe region and for members of the Arab Network of Nuclear Regulators and the Forum of Nuclear Regulatory Bodies in Africa (FNRBA). A national workshop on the development of safety regulations and guides was conducted in the Philippines.

160. The Integrated Review of Infrastructure for Safety methodology guidelines provide guidance to newcomer Member States to assess the development level of their national safety infrastructure on the basis of the relevant Agency safety standards. The Safety Report entitled *Development of a Regulatory Inspection Programme for a New Nuclear Power Plant Project* (Safety Reports Series No. 81)⁴⁸, which was published in February 2014, covers regulatory inspection during the siting, design, construction and commissioning stages, as well as during the transition to operation.

161. The Agency offers a number of services and missions aimed at helping embarking Member States to improve their safety infrastructure. As part of the DSARS, the Safety Assessment Advisory Programme (SAAP) is designed exclusively for embarking countries. This service consists of several phases designed to assist a Member State in performing a comprehensive assessment of its competencies in the area of safety assessment. During 2014, the Agency conducted two SAAP missions. Similarly, two national and regional workshops on safety review and assessment by the regulatory body were conducted for Indonesia and Turkey and for newcomer countries that are members of the Asian Nuclear Safety Network (ANSN).

162. Some of these activities focus on improving the safety infrastructure by deploying various modules of the Safety Assessment Education and Training (SAET) Programme. In 2014, the Agency conducted 21 SAET Programme activities, during which the Agency generally observed that the requisite technical knowledge has been improving, but also that more work remains to be done to establish the required technical expertise to be able to make proper safety focused decisions.

163. Updated guidelines for the Education and Training Review Service permit an integrated and comprehensive evaluation of education and training and set the basis for developing a national strategy and implementation plan for education and training. The Strategic Approach to Education and Training in Nuclear Safety 2013–2020⁴⁹ identifies roles, responsibilities, processes and mechanisms to

⁴⁸ The publication is available at: http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1636_web.pdf

⁴⁹ The document is available at: <http://www-ns.iaea.org/downloads/ni/training/strategy2013-2020.pdf>

build effective capacity in order to develop safety infrastructures for nuclear power newcomers. In support of the implementation of the strategic approach, a regional workshop addressing main factors in developing a strategy for capacity building was held in Indonesia, in October 2014. Fourteen representatives from regulatory bodies, TSOs and research institutions in the Asia region identified and discussed main factors influencing the development of capacity building.

164. Within the Global Nuclear Safety and Security Network, the International Regulatory Network and the Global Safety Assessment Network provide platforms for embarking countries to exchange information in the areas of regulatory knowledge, design safety and safety assessment. They are being actively used for the effective development of projects and the implementation of Agency activities in real time and enable strong cooperation and coordination with Agency Member States and partner organizations.

165. The Regulatory Cooperation Forum (RCF) began to provide coordinated regulatory support for Belarus and Poland in 2014. In December 2014, at the request of the Belarusian regulatory body, a group of senior international regulators from the RCF met with high-level government officials in Minsk, Belarus, to discuss the importance of fostering a strong safety culture from the earliest stages of the development of the national safety infrastructure for a nuclear power programme. It also continued to assist Jordan and Viet Nam in the development of an effectively independent and robust nuclear safety regulatory body. The forum expanded its membership to 27, with Sudan being the newest member.

Future Challenges

166. Countries embarking on a nuclear programme will need to fully understand, plan and incorporate into their nuclear project plans the time required for the development of the necessary safety infrastructure. Newcomers will further need to make a strong national commitment to providing appropriate resources (i.e. finance and human resources). The regulatory body, operating organizations and the relevant institutions that will provide technical support will need to develop and maintain the required competencies as outlined in the Agency's safety standards.

167. There will be continued challenges to establish a well-functioning and effective regulatory framework and an independent regulatory body consistent with project milestones (site licensing, bids, construction, etc.) that will place pressure on these organizations to meet their national commitments and responsibilities regarding the safety of their nuclear power programme.

168. Many embarking countries will have difficulty in finding staff with the appropriate background education for further training programmes on the required subjects. Mechanisms and/or local infrastructures for the required basic training and education need to be developed to promote and achieve a high level of safety for nuclear installations.

169. Even embarking countries where the needs and the overall resource intensity of a nuclear programme are understood will continue to experience difficulty, in both the short and long term, in finding experienced and knowledgeable experts and institutions that can provide direct or indirect assistance and guidance on the establishment of the various elements of the nuclear safety infrastructure, and in finding appropriate host institutions/organizations for the development of human resources, particularly for on-the-job training.

170. In order to meet these challenges, Member States with established nuclear safety infrastructures and regulatory frameworks will have to provide better and more coordinated assistance to embarking countries.

B.5.2. Research Reactor Programmes

Trends and Issues

171. More than 20 Member States are currently at different stages of developing new research reactor programmes, with the majority building their first research reactor in preparation for embarking on a nuclear power programme. These Member States continue to have difficulties in developing the necessary safety, regulatory and technical infrastructures. This is primarily because the majority of these Member States lack adequate qualified staff and adequate competencies in areas related to safety assessment, construction, commissioning, operation, safe utilization, and decommissioning, and do not have a clear national strategy for human resource development or for building the necessary competencies. Weaknesses in the establishment of an effective regulatory body and in government support related to its establishment have also been identified during safety review missions.

172. Agency missions in Member States where new research reactors are developed as a first step towards embarking on a nuclear power programme showed the need to ensure effective coordination between the research reactor project and nuclear power development teams.

Activities

173. In 2014, the Agency published *Technical Requirements in the Bidding Process for a New Research Reactor* (IAEA Nuclear Energy Series No. NP-T-5.6)⁵⁰. This publication provides practical guidance on the preparation of the technical safety and utilization requirements for the bidding process of a new research reactor project. A workshop on the application of this publication was held in Vienna, Austria, in October 2014 with the participation of 23 Member States. Another workshop was held in Vienna, Austria, in May 2014 on specific considerations and milestones for a new research reactor project. The workshop provided the participants from 30 Member States with practical information and knowledge on establishing the safety and technical infrastructure for a new research reactor project in accordance with the Agency's safety standards and the Milestones approach. The workshop also provided the participating countries with a forum to exchange information and share experience on challenges and lessons learned in the development and implementation of new research projects.

174. The Agency also conducted three expert missions on new research reactor projects in Kuwait, Saudi Arabia and the United Republic of Tanzania. These missions supported the countries in the assessment of the existing national infrastructure and provided recommendations and guidance in relation to the development and establishment of a first research reactor. The Agency also supported Saudi Arabia, in a national workshop conducted in November 2014, to establish a licensing process for research reactors. In addition, the Agency supported Tunisia, in a Technical Meeting, held in Vienna, Austria, in February 2014, to develop the safety and technical requirements for the bidding process for the installation of a subcritical assembly. Another meeting was held in February 2014 in Vienna, Austria, on the new research reactor in Jordan. The progress of the reactor construction work and the need for Agency assistance with respect to the construction and commissioning of the reactor were discussed at the meeting.

⁵⁰ The publication is available at: <http://www-pub.iaea.org/books/IAEABooks/10606/Technical-Requirements-in-the-Bidding-Process-for-a-New-Research-Reactor>

175. Additionally, Member States that are building (or considering) their first research reactor participated in Agency activities conducted in 2014 under the programme on enhancing the safety of research reactors (e.g. the International Meeting on Application of the Code of Conduct on the Safety of Research Reactors, and the Workshop on Safety Analysis and Safety Documents for Research Reactors). These activities helped to make these Member States more aware of the relevant regulatory and safety requirements and supported the development of the human resources needed for the safe implementation of the new research reactor projects.

Future Challenges

176. Feedback from the Agency's activities, including safety missions and meetings on the application of the Code of Conduct on the Safety of Research Reactors, showed that the establishment, in a timely manner, of a safety infrastructure continues to be a challenge for Member States embarking on new research reactor programmes. This includes the development of an adequate regulatory infrastructure in parallel with the implementation of a new research reactor project. This will be especially challenging for Member States with limited qualified human resources to fulfil both regulatory functions and implementation activities for design, construction, commissioning and operation. In addition, for Member States where new research reactors are developed as a first step towards embarking on a nuclear power programme, there is a need to ensure effective coordination between the research reactor project and nuclear power development teams.

B.6. Regulatory Effectiveness of Nuclear Installation Safety

B.6.1. Trends and Issues

177. To accomplish the regulatory goal of assuring nuclear safety, regulators must rely on a specialized, highly trained and technically competent workforce. Fundamentally, the regulator's effectiveness in assuring nuclear safety depends upon this technically sound and skilled workforce being able to knowledgeably and impartially conduct oversight activities at these facilities and to see that the operator takes the appropriate and timely corrective actions to bring these facilities into regulatory compliance. To do this, regulators must draw from many sources of information, such as inspection reports, periodic safety reviews, Agency mission results and other information sources to be able to carry out an integrated assessment of the safety level of these facilities and then to make judgements based on this assessment. Regulators must integrate knowledge from many other organizations as well (e.g. designer, operator, waste management agencies), and also obtain and integrate safety knowledge from very different perspectives (the legal, regulatory and organizational basis; the technical disciplines; regulatory practices; and personal and behavioural knowledge).

178. At the Sixth Review Meeting, a number of Contracting Parties to the CNS reported on the challenges of maintaining staffing in regulatory bodies and licensee organizations, as well as the challenges and measures associated with transferring and maintaining nuclear safety knowledge in response to an ageing workforce. Regulators find it an increasing challenge to systematically collect and analyse this safety and regulatory information and then store and effectively manage it in a knowledge base so that it can be preserved and readily accessed and shared across the regulatory body. Regulators must be able to manage this knowledge over long timescales in order to provide a basis for their decisions over the full lifetime of the nuclear installation, including its decommissioning.

179. The Integrated Regulatory Review Service (IRRS) was established in 2006 to strengthen and enhance the effectiveness of national regulatory infrastructures for nuclear, radiation protection, transport and waste safety, as well as for EPR provisions and the security of radioactive sources. IRRS findings (i.e. recommendations and suggestions) from these missions are based on Agency safety

standards. A total of 60 IRRS missions (47 initial and 13 follow-up missions) were conducted in the period 2006–2014.

180. The Agency conducted an analysis of the recommendations and suggestions from the previous IRRS missions that identified some statistically significant trends. For example, many of the missions identified that the framework for regulatory activities lacked the specific legal provisions necessary for discharging regulatory responsibilities. Some of the typical recommendations included: governments should establish the legal framework for an independent regulatory body with clearly defined, specific responsibilities; the regulatory body should be provided with the authority to issue or have involvement in the issuance of regulatory requirements; and provisions should be made for an appeals process to challenge regulatory decisions.

181. In addition, regulatory bodies were provided with recommendations and suggestions regarding the development and implementation of inspection programmes. Typical findings were that the regulatory body should expand (or should consider expanding) the inspection programme (in terms of scope, type, and frequency), develop further the inspection system (initiation, methodology, monitoring, evaluation), and improve inspection planning. The missions also recommended that the regulatory body develop guidance and procedures that adequately cover all levels of defence in depth and all areas relevant to safety.

182. The IRRS missions also recommended that the regulatory bodies should develop integrated human resource management programmes, including strategies for near term recruitment and staffing plans and long term succession planning strategies. Suggestions were made on methods to improve retention, hiring and motivation and efforts to attract suitably qualified staff and fill vacancies.

183. As shown by the IRRS follow-up missions, Member States have difficulty in implementing the recommendations and suggestions regarding the legal framework prior to the follow-up mission. This is in part because legislative changes can take a long time to implement.

B.6.2. Activities

184. In December 2014, the fourth Workshop on Lessons Learned from IRRS Missions was held in the Russian Federation; 47 senior regulators from 25 IAEA Member States took part. Member States having received an IRRS mission since the previous workshop held in 2011 and Member States receiving a mission in the coming two years also shared their experience in preparing for the IRRS mission. The Agency provided the results of their analysis of the recommendations and suggestions from previous missions to identify recurring nuclear, radiation, transport and waste safety and emergency preparedness issues.

185. The Agency's Steering Committee on Competence of Human Resources for Regulatory Bodies, comprising 20 regulators, held its sixth annual Technical Meeting in Vienna, Austria, in November 2014. The primary objective of this meeting was to discuss and extend the scope of the committee to include strategies for safety knowledge management with a focus on nuclear installation safety. In September 2014, the Agency held in Vienna, Austria, a workshop on developing a training programme and knowledge management system that was attended by 18 Member States from the Asia and the Pacific region. In addition, the Agency is preparing guidance on knowledge management for regulators.

186. The Agency helps Member States develop the legal framework for regulatory activities necessary for discharging regulatory responsibilities. In October 2014, the Agency's Nuclear Law Institute provided intensive training for two weeks in Vienna, Austria, for 60 lawyers from 51 Member States in all areas of nuclear law and in drafting corresponding national legislation. The

Agency also assisted approximately 25 Member States individually and on a regional basis in developing their national laws for the peaceful uses of nuclear energy and ionizing radiation.

187. In 2014, the Agency conducted two workshops on legal and regulatory frameworks for safety for the ANSN and one national experts' meeting to conduct an overview of the governmental, legal and regulatory framework for safety for a nuclear power programme in Algeria.

188. The Agency supported the development and implementation of inspection programmes for a number of Member States. For example, a consultancy meeting with the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies was held on the development of a training programme for regulatory staff on licensing and safety inspections for nuclear reactors and a workshop on regulatory inspection programmes for research reactors with the FNRBA. The Agency has worked with Romania to analyse the status of the inspection-related framework and to finalize the inspection procedures and programme.

189. The Agency is developing regulatory inspection training material for countries embarking on nuclear power, covering the implementation of inspection and enforcement, human and organizational factors and integrated management for licensees.

190. To support Member States in the development of integrated human resource management programmes, the safety standards relating to the management of the regulatory body and the functions of the regulatory body, such as authorization, review and assessment, inspection and enforcement on the one hand, and the production of regulations and guides on the other, are being combined. Two Safety Guides are currently being drafted to address the technical aspects of the regulatory core functions, and to address the organizational arrangements. These Safety Guides are complementary and will be presented to Member States and the Safety Standards Committees for approval in 2015.

191. The Strategic Approach to Education and Training in Nuclear Safety 2013–2020⁵¹ provides guidance on the development and implementation of adequate and sustainable programmes for education and training in nuclear safety consistent with the Agency's safety standards to ensure that the highest possible levels of safety are achieved. In 2014, under this approach, 110 workshops and 17 training events were conducted.

B.6.3. Future Challenges

192. For the Steering Committee on Competence of Human Resources for Regulatory Bodies to effectively address knowledge management issues broadly, it will need to identify and assess common information management problems faced by regulators; review and suggest improvements to business processes that collect and store data; and then ascertain which technology solutions could be deployed to provide adequate data warehousing and access to information.

193. A challenge highlighted in the Workshop on Lessons Learned from IRRS Missions held in the Russian Federation was recruiting a sufficient number of knowledgeable and experienced reviewers to assist in conducting IRRS missions.

⁵¹ The document is available at: <http://www-ns.iaea.org/downloads/ni/training/strategy2013-2020.pdf>

194. There continue to be challenges in the development and implementation of inspection programmes especially for embarking countries. The Agency is developing training for inspectors that will commence in 2015.

195. Member States will continue to face challenges in recruiting, training and retaining a competent workforce. This is especially true for embarking countries where the education and training resources for nuclear power expertise has not yet been established. It was noted at the Sixth Review Meeting of the Contracting Parties to the CNS that the difficulties were often exacerbated by the current economic conditions.

C. Strengthening Emergency Preparedness and Response

C.1. Emergency Preparedness and Response at the National Level

C.1.1. Trends and Issues

196. Recently, Member States, the Secretariat and other relevant international organizations have devoted much effort to strengthening national and international arrangements to effectively respond to a nuclear or radiological emergency, irrespective of its cause. In particular, increased attention has been given to severe emergencies of very low probability, such as those affecting several units at a site and those that coincide with a natural disaster. However, as reported during the International Experts' Meeting on Severe Accident Management in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant held in 2014, more work is still needed in this area to ensure and demonstrate through exercises that EPR arrangements, both on- and off-site, are more resilient to severe disruptions of the basic infrastructure.⁵²

197. Furthermore, results from ConvEx-3 exercises and outcomes from the Emergency Preparedness and Response Expert Group meetings have indicated the importance of harmonized EPR arrangements worldwide. The Agency's EPR safety standards continue to provide a solid basis for achieving such harmonization when establishing an adequate level of preparedness for an effective response to nuclear and radiological emergencies. It is essential that Member States make further efforts to utilize, as broadly as possible, the Agency's safety standards in the area of EPR to mitigate major inconsistencies between Member States during an emergency and thereby avoid serious disruptions at the international level.

198. Increased attention has focused on preparedness for terminating an emergency, transitioning from an exposure situation and returning to normal social and economic activities. Member States have requested international guidance on this subject.

199. Studies and outcomes from actual emergencies have reconfirmed that technical language and jargon are barriers to successful communication with the public. In order for public communications in

⁵² The President's summary of the meeting is available at: http://www-pub.iaea.org/MTCD/Meetings/PDFplus/2014/cn233/cn233_ChairsSummary.pdf

an emergency to be effective in facilitating the implementation of protective and other actions and mitigating fear and anxiety, it is of key importance for actions to be clearly communicated and explained in understandable language.⁵³

200. The Emergency Preparedness Review (EPREV)⁵⁴ service provides Member States with an in-depth peer review of national EPR arrangements and capabilities against the relevant Agency safety standards. The findings from recent EPREV missions again highlighted the ongoing challenges in clear allocation of EPR roles and responsibilities, at the operator, local, provincial/regional and national levels, in conducting regular exercises, in training first responders to radiological emergencies, in staffing respective EPR positions, in public communications in the area of EPR, as well as in establishing coordinated and integrated plans and procedures for a range of emergencies, including severe emergencies of very low probability. On the other hand, a need was identified to further improve the effectiveness of EPREV.

201. Member States continue to express interest in conducting training on a variety of EPR topics such as notification to, reporting to and requesting assistance from the Agency; communication with the public and the use of the International Nuclear and Radiological Event Scale (INES); public protective actions in case of severe reactor accidents; medical response; optimization of emergency plans; as well as first response and medical response. To remain effective, training materials need to be regularly updated, taking into consideration enhancements in the EPR area and advancements in adult learning techniques and tools, such as encouraging reciprocity and cooperation, as well as recognizing and making use of different ways of learning.

202. Results from various Technical Meetings and round table discussions held with Member States indicate growing interest in transparency in sharing preparedness information amongst Member States and international organizations, as well as with the public. An effective and broader knowledge management and information sharing platform has been seen as a potential step towards greater transparency.

C.1.2. Activities

203. In 2014, activities implemented to help Member States establish adequate EPR arrangements consistent with the Agency's safety standards included: over 40 training events on different topics in EPR;⁵⁵ over 20 expert missions to support national EPR efforts⁵⁶; five EPREV preparatory and three EPREV missions; seven scientific visits and fellowships; procurement of equipment under various national and regional projects; and ongoing translation of different EPR publications and training materials into various languages in an effort to increase their availability and usefulness to Member States.

⁵³ This includes, for example, clear and plain communication as to when it is safe for evacuees to return home.

⁵⁴ See <http://www-ns.iaea.org/appraisals/emergency-reviews.asp>

⁵⁵ Of these, 7 training events were held at the national level, 12 training events were held at the regional level and 4 training events were held at the interregional level.

⁵⁶ Primarily on early warning systems, implementation of EPREV recommendations, elaboration and improvement of national and regional plans, assessing medical capabilities, and preparation for the conduct and evaluation of exercises.

204. In 2014, the Agency worked to strengthen its safety standards in the area of EPR by revising *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GS-R-2)⁵⁷—and by taking initial steps to develop two new Safety Guides covering public communications in an emergency and termination of an emergency.

205. Several countries expressed interest in the concept of capacity building centres and concrete steps have been taken towards their development in the area of EPR. Discussions are in progress with Latin American and European partners on the establishment of a capacity building centre for medical response to nuclear or radiological emergencies. Preliminary discussions were held with interested European countries on the establishment of centres, focusing on on-site EPR and on the management of on-site and off-site interfacing and coordination issues. In addition, taking advantage of the variety and quality of training material developed by the Agency on EPR matters, a syllabus for a three-week training course (the School of Radiation Emergency Management) has been developed.⁵⁸

206. In an effort to improve the review of EPR arrangements in place in Member States and their consistency with the Agency's safety standards, the Agency has revised and strengthened the EPREV guidelines and EPR self-assessment tool on the basis of experience gained in the last ten years. EPREV-related consultancy meetings and Technical Meetings have been held to share experience in hosting and conducting EPREV missions. On the basis of the feedback received, the EPREV methodology has been enhanced to more appropriately tailor the missions to Member States' needs and priorities, to increase the operational expertise component of the review teams, to more fully standardize the approach by different expert teams, to enhance the effectiveness and depth of the review, to streamline the review reports, and to more systematically address follow-up actions resulting from EPREV missions. In 2014, the IAEA conducted three EPREV missions (South Africa, Tajikistan and the United Republic of Tanzania), while two additional missions, originally planned for 2014, were postponed to 2015 (Kuwait and Nigeria).

207. Further to the issues stated above, the development of an Emergency Preparedness and Response Information Management System (EPRIMS) has been initiated in order to increase the availability of key information on Member States' EPR arrangements, improve access to relevant EPR information by the Agency during an emergency (in line with the Agency's expanded role on assessment and prognosis) and facilitate information exchange on national EPR arrangements among Member States. The initial stages of this system are expected to be tested and implemented during the first quarter of 2015. This system is expected to provide the capability for Member States to upload information on their EPR arrangements and share technical information on their operating nuclear power reactors.

208. To increase transparency and share preparedness information amongst Member States, the Emergency Preparedness Network (EPnet) was launched during the 58th session of the General Conference as part of the GNSSN. EPnet includes six professional sub-networks to encourage knowledge exchange between like-minded EPR professionals: emergency planners, first responders, radiation specialists, medical practitioners, dose assessment experts and public information officers.

⁵⁷ The current version of this publication is available at: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1133_scr.pdf

⁵⁸ The course material is being consolidated on the basis of existing Agency training publications and the pilot course is expected to be delivered in 2015.

209. "The Use of INES for Event Communication" – Guidelines and Good Practices for Setting up of a National Framework on the Effective Use of INES for Event Communication – was published. The INES Rating Interactive Learning Tool aimed to help understand the methodology for INES rating of events was posted on the IAEA webpage accessible to the public. In addition, the INES Rating Wizard – an interactive tool used for training on the application of INES methodology – was posted on the restricted NEWS webpage.

C.1.3. Future Challenges

210. Broader coordination and harmonization of emergency arrangements among Member States, taking into account the Agency's safety standards, remains a challenge.

211. Communication with the public is an area that requires ongoing attention. Properly communicating the potential consequences, based on an objective analysis of available information and the prognosis, will continue to be a challenge and require greater efforts and commitment on the part of Member States, as well as relevant international organizations.

212. Measures to enhance information sharing arrangements are being implemented to improve the situation, such as sharing technical information on nuclear power reactors within EPRIMS. The Agency will continue to make future enhancements and improvements to EPRIMS to enhance the availability of technical information to support the assessment and prognosis of a developing situation during an emergency.

213. Member States' support and commitment are required for the implementation of the enhanced EPREV methodology, reviewing and keeping information up-to-date in EPRIMS, and for promoting the establishment of capacity building centres on EPR in all regions.

C.2. Emergency Preparedness and Response at the International Level

C.2.1. Trends and Issues

214. States Parties to the Convention on Early Notification of a Nuclear Accident are obliged to make known their competent authorities and points of contact.⁵⁹ Currently, there are 119 Parties to the Convention. In addition, the Agency's Secretariat asks all States to designate their contact points in accordance with the *Operations Manual for Incident and Emergency Communication* (Emergency Preparedness and Response Series, EPR-IEComm 2012)⁶⁰. In 2014, eight more Member States designated contact points, increasing the number of Member States compliant with EPR-IEComm to 104. Currently, there are 46 Member States that have designated contact points but

⁵⁹ Adopted in 1986 following the Chernobyl NPP accident, the Convention on Early Notification of a Nuclear Accident establishes a notification system for nuclear accidents that have the potential for international transboundary release that could be of radiological safety significance for another State. It requires States to report the accident's time, location, radiation releases, and other data essential for assessing the situation. The text of the Convention is available at: <http://www.iaea.org/publications/documents/infcircs/convention-early-notification-nuclear-accident>

⁶⁰ This publication is available at: http://www-pub.iaea.org/MTCD/publications/PDF/EPR_IEComm-2012_Web.pdf

not in accordance with definitions in EPR-IEComm, and 12 Member States that have not provided their emergency contact points to the Agency⁶¹.

215. The total number of registered users in the Agency's Unified System for Information Exchange in Incidents and Emergencies (USIE) increased by 11% in 2014, from 791 individual users to 878 users.⁶² The number of countries that have registered users in USIE increased by 9% in 2014, from 105 countries to 115. This continues the positive trend from the previous year. Many of the countries whose contact points have registered their first users in USIE during 2014 are from Latin America, Africa and the Middle East, regions in which the Agency has recently conducted workshops on notification, reporting and requesting assistance.

216. States Parties to the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency are obliged to "within the limits of their capabilities, identify and notify the Agency of experts, equipment and materials which could be made available for the provision of assistance to other States Parties in the event of a nuclear accident or radiological emergency". This may be achieved by registering their national assistance capabilities in the Agency's Response and Assistance Network (RANET). In 2014, four States Parties (Belgium, China, Israel and Switzerland) registered their capabilities in RANET, increasing the total number of States in RANET to 27. This means that only 24% of the 112 Parties to the Assistance Convention are in compliance with this obligation.

217. Timely receipt of emergency communications is a vital aspect of emergency response; however, not all contact points participate in testing these arrangements through the ConvEx exercises⁶³. About 14% of contact points do not send replies in the ConvEx-1 exercises, which are simple communication tests of their emergency communication channels. Approximately 35% of all contact points do not participate in the ConvEx-2 exercises, which test parts of the international emergency arrangements based on an elaborated scenario. For those contact points that have attended workshops on notification, reporting and requesting assistance held in 2014, there was a noted increase in participation in these exercises.

C.2.2. Activities

218. During 2014, the Agency conducted five workshops on notification, reporting and requesting assistance that were attended by a total of 39 Member States. The workshops are designed to help

⁶¹ Member States should designate contact points in compliance with EPR-IEComm in order to facilitate timely and effective communications from the Agency in nuclear or radiological of an incident or emergency.

⁶² USIE is an Agency website for contact points of States Parties to the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency to enable them to exchange urgent information during nuclear and radiological incidents and emergencies, and for officially nominated INES National Officers to post information on events rated using the INES.

⁶³ The Agency conducts regular exercises within the framework of the Early Notification and Assistance Conventions, entitled ConvEx exercises. ConvEx exercises have three levels of complexity: at level 1 (ConvEx-1) only communication tests with emergency contact points are performed; at level 2 (ConvEx-2) emergency communications as well as different parts of emergency arrangements are tested; and at level 3 (ConvEx-3) the exercise aims to test full scale emergency arrangements and capabilities at national and international level.

official contact points to effectively implement the arrangements for communicating with the Agency's Incident and Emergency Centre during emergencies as described in EPR-IEComm 2012.

219. In May 2014, the Agency released an upgraded version of USIE with new International Radiological Information Exchange (IRIX) based features (referred to as "USIE Connect"). The IRIX standard was developed with the aim of enhancing and speeding up international emergency information exchange. The update allows contact points to have their own emergency information systems interfaced to USIE to enable faster and more reliable transmission of information during an emergency. Actual use of this new service will depend on contact points extending their own emergency information exchange systems in a similar manner. Furthermore, the upgraded version of USIE also includes improvements to its international assistance related functions⁶⁴.

220. Other improvements related to USIE include the development and testing of the International Radiation Monitoring Information System (IRMIS) with Member States and the European Commission. IRMIS will provide Member States with a tool for reporting large volumes of radiological monitoring data during an emergency. The system will interface with USIE and will be able to graphically present these data. It will assist Member States and international organizations, in particular the Agency, in assessing the radiological situation during an emergency. IRMIS will become operational in 2015.

221. Draft guidelines for response and assistance "products" during a nuclear or radiological emergency were prepared in consultation with experts from Member States. The guidelines are intended to help harmonize the provision and "products" of international assistance so that the assistance may be effectively received by a requesting State. The Agency carried out an exercise on the assessment and prognosis process with Member States. Based on the conclusions of the Seventh Meeting of Representatives of Competent Authorities identified under the Convention on Early Notification of a Nuclear Accident and the Convention Assistance in the Case of a Nuclear Accident or Radiological Emergency,⁶⁵ these exercises are acknowledged and performed as ConvEx-2e exercises and are based on national exercises. ConvEx-2e provides the Secretariat and Member States with an opportunity to practice the development of harmonized messages appropriate for delivery to the public, technical audiences and the relevant authorities. In 2014, five ConvEx-2e exercises and one ConvEx-2d⁶⁶ exercise were conducted with Member States, where the full assessment and prognosis process was practiced.

222. Operational protocols in the form of practical arrangements within the framework of the Inter-Agency Committee on Radiological and Nuclear Emergencies (IACRNE) and the Joint

⁶⁴ An improved Request for Assistance Form and a new form through which States may offer their assistance to another State were implemented. In addition a new assistance area is available under each USIE event through which States may see compiled requests for and offers of assistance to help ensure the effective provision of international assistance.

⁶⁵ See <http://www-pub.iaea.org/iaecmeetings/45386/Seventh-Meeting-of-Representatives-of-Competent-Authorities-identified-under-the-Convention-on-Early-Notification-of-a-Nuclear-Accident-and-the-Convention-on-Assistance-in-the-Case-of-a-Nuclear-Accident-or-Radiological-Emergency>

⁶⁶ ConvEx 2 exercises comprise several specific exercises as follows: ConvEx-2a tests the ability of competent authorities to complete the appropriate reporting forms; ConvEx-2b tests the arrangements for a request and the provision of assistance; ConvEx-2c tests arrangements for a transnational radiological emergency; ConvEx-2d tests arrangements for a transnational nuclear emergency; and ConvEx-2e tests the IAEA's assessment and prognosis process.

Radiation Emergency Management Plan of the International Organizations (JPLAN) are being developed. During 2014, operational protocols were discussed with the Comprehensive Nuclear-Test-Ban Treaty Organization, the European Police Office, the Food and Agriculture Organization of the United Nations, International Civil Aviation Organization and the International Maritime Organization, INTERPOL, the World Health Organization and the World Meteorological Organization. The 24th Regular Meeting of IACRNE in November 2014 endorsed the United Nations Development Programme as the 18th member of the Committee. The Committee also endorsed five standard operating procedures that operationalize some processes set out in the JPLAN.

C.2.3. Future Challenges

223. Encouraging Member States to provide radioactivity monitoring data to IRMIS and thus ensuring global coverage will continue to be a challenge for both the Secretariat and Member States. The continued willingness of Member States to exchange monitoring data with the Agency will be required. The Agency's technical support to Member States may also be necessary to assist in implementation of the IRIX standard.

224. The Agency needs to continue to encourage States Parties to the Assistance Convention that have consolidated response capabilities to register their national assistance capabilities in RANET, particularly in the functional area of "Nuclear Installation Assessment and Advice".

225. Exercising of the international emergency response arrangements is essential to ensure that Member States and the Agency are prepared to meet their respective obligations and functions under the Early Notification and Assistance Conventions. The ConvEx-2c, ConvEx-2d, ConvEx-2e and ConvEx-3 level exercises are designed to exercise and strengthen international arrangements developed within the framework of the Conventions. Encouraging Member States to host these exercises continues to be challenging and requires the commitment of Member States to be willing to offer their national exercises to be used as a ConvEx-2c/d/e or ConvEx-3 exercise.

226. The Agency's expanded response role to perform assessment and prognosis during emergencies at a nuclear power plant requires significant Member State involvement and support. The Agency continues to approach Member States to work to incorporate their advanced capabilities into the process. Carrying out assessment and prognosis during a nuclear or radiological emergency constitutes a technical challenge, requiring the timely provision of information and data, sharing of advanced tools and procedures and direct contact between technical teams within the Agency and the 'accident State' during an emergency to discuss and harmonize their views.

227. For some Member States operating nuclear power reactors, the logistics of how critical technical information can be best made available represents a serious challenge. The Agency continues to closely follow this issue and test solutions in the ConvEx-2 and the ConvEx-3 exercises.

228. The harmonization of response and assistance capabilities to ensure effective assistance will continue to be another challenge. The Agency's support may be required to assist Member States in developing and adapting their key emergency response capabilities to address this issue. In addition, further development of the draft guidelines for response and assistance products during a nuclear or radiological emergency will be necessary to address harmonization issues for the remaining response and assistance capabilities ensuring that, in the coming years, all RANET functional areas are addressed by the harmonization guidelines.

229. It is of key importance that relevant international organizations provide consistent public information in an emergency. Public information officers of IACRNE organizations need to regularly carry out coordination exercises in sharing public information in order to ensure consistency of the information provided.

C.3. Regulatory Effectiveness in Emergency Preparedness and Response

C.3.1. Trends and Issues

230. In the regulatory area related to EPR, there has been an increased focus on the need for regulatory bodies to ensure coordination between severe accident management guidelines and emergency response, and in particular on integrated exercises that challenge emergency response organizations in realistic and severe emergency scenarios. This was highlighted, for example, during the International Experts' Meeting on Severe Accident Management in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, held in Vienna, Austria, in March 2014.

231. Findings from recent IRRS missions highlighted issues in differentiating between regulatory and coordination functions in relation to EPR, integration of arrangements for preparedness and response between operators and other response organizations, and regulatory bodies' arrangements to respond to emergencies.

C.3.2. Activities

232. The self-assessment guide for the EPR module of IRRS missions was updated with a greater focus on measures taken by the regulatory bodies to ensure that operating organizations have appropriate EPR arrangements in place to handle a broad spectrum of nuclear and radiological emergencies, including severe emergencies.

233. The updated module on EPR, highlighting the focus on the effectiveness of the regulatory process regarding operating organizations, was presented at the second basic IRRS training course in October 2014.

C.3.3. Future Challenges

234. Regulatory bodies need to give more attention to the regulatory oversight of the interface between severe accident management and EPR, including enhancing the evaluation of emergency response exercises involving realistic severe emergency conditions combined with external events.

235. The differentiation between regulatory and coordination functions in relation to EPR and integration of arrangements for response between operators and other response organizations continue to pose challenges.

D. Strengthening Civil Liability for Nuclear Damage

D.1. Trends and Issues

236. Member States continue to attach importance to having effective civil liability mechanisms in place to provide insurance against harm to human health, property and the environment, as well as consequential economic loss, caused by nuclear damage.

237. A number of international conventions have been adopted to ensure some degree of harmonization of national laws in this area and the international legal regime created by these conventions was further enhanced after the Chernobyl accident. However, the absence of treaty relations between States parties to different conventions and the comparatively low number of

adherences to some of those conventions have so far prevented the achievement of a global nuclear liability regime.

238. The IAEA Action Plan on Nuclear Safety specifically called on Member States to work towards establishing a global nuclear liability regime and to give due consideration to the possibility of joining the international nuclear liability instruments as a step towards achieving such a global regime. Pursuant to the Action Plan, the International Expert Group on Nuclear Liability (INLEX) adopted at its 12th regular meeting in 2012 a set of recommended actions to facilitate the achievement of a global nuclear liability regime.⁶⁷

D.2. Activities

239. The 14th Meeting of INLEX took place in Vienna, Austria, from 20 to 22 May 2014. The Group discussed, inter alia, the revision of the Board decision excluding small quantities of nuclear material from the scope of the nuclear liability conventions following the adoption of the 2012 edition of the Transport Regulations; liability issues in the context of the Assistance Convention; whether there is a need to establish a special liability regime covering radioactive sources; the scope of application of the IAEA liability conventions as regards shutdown reactors or reactors being decommissioned; the revision of the model provisions on nuclear liability in the *Handbook on Nuclear Law: Implementing Legislation*; and outreach activities.

240. As regards the need for an international liability regime covering radioactive sources, the prevailing view within the Group was that there was no need for such a regime and that the matter was best being dealt with by national law. However, at its next meeting, the Group will discuss the issue further including the desirability of recommending to States to require, as a condition for the licensing of an activity involving a high activity radioactive source, that the licensee take out insurance to cover its potential third party liability.

241. As regards the scope of application of the IAEA nuclear liability conventions, the Group concluded that a shutdown reactor or an installation being decommissioned could qualify as a “nuclear installation’ under the existing definition in all the IAEA nuclear liability conventions, even in the absence of a Board decision to expressly include them. The Group came to the same conclusion as regards facilities where radioactive waste is disposed of.

242. The Third Workshop on Civil Liability for Nuclear Damage was held in Vienna, Austria, in May 2014 and was attended by 54 participants from 39 Member States. The purpose of the workshop was to provide diplomats and experts from Member States with an introduction to the international legal regime of civil liability for nuclear damage.

243. As regards other outreach activities in 2014, joint Agency/INLEX missions were conducted in Nigeria and Saudi Arabia to raise awareness of the international legal instruments relevant for achieving a global nuclear liability regime. Preparations are under way to organize similar missions in 2015.

244. In addition, a Sub-regional Workshop on Civil Liability for Nuclear Damage was held in Viet Nam in March 2014 to provide participants with information on the existing international nuclear

⁶⁷ The text of the recommendations is available at: <http://ola.iaea.org/ola/documents/ActionPlan.pdf>

liability regime and to advise on the development of national implementing legislation. The event was attended by 35 participants from 12 Member States.

245. At its meeting on 20 November 2014, the Board of Governors adopted the Resolution on the Establishment of Maximum Limits for the Exclusion of Small Quantities of Nuclear Material from the Application of the Vienna Conventions on Nuclear Liability⁶⁸, which established new maximum limits in line with the 2012 edition of the *Regulations for the Safe Transport of Radioactive Material* (Safety Standards Series No. SSR-6) for the exclusion of small quantities of nuclear material from their respective scope of application.⁶⁹

D.3. Future Challenges

246. The main challenge for the international legal regime of civil liability for nuclear damage remains the comparatively low number of Contracting Parties to the relevant international conventions, in particular those embodying the modernized regime adopted under the auspices of the Agency after the Chernobyl accident.

247. The Agency and INLEX will continue to facilitate the establishment of a global nuclear liability regime as called for by resolution GC(58)/RES/10, inter alia by carrying out further outreach activities and taking into account the aforementioned recommendations adopted by INLEX in 2012.

⁶⁸ GOV/2014/63

⁶⁹ The publication is available at: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1570_web.pdf

Appendix

The Agency's Safety Standards: Activities during 2014

A. Summary

1. The Commission on Safety Standards (CSS) met twice in 2014 and endorsed the following draft safety standards for submission to the Board of Governors or for publication:

- Revision by amendment of the Safety Requirements GSR Part 1 on Governmental, Legal and Regulatory Framework for Safety (DS462)
- Revision by amendment of the Safety Requirements NS-R-3 on Site Evaluation for Nuclear Installations (DS462)
- Revision by amendment of the Safety Requirements SSR-2/1 on Safety of Nuclear Power Plants: Design (DS462)
- Revision by amendment of the Safety Requirements SSR-2/2 on Safety of Nuclear Power Plants: Commissioning and Operation (DS462)
- Revision by amendment of the Safety Requirements GSR Part 4 on Safety Assessment for Facilities and Activities (DS462)
- Revision of the Safety Requirements GS-R-2 on Preparedness and Response for a Nuclear or Radiological Emergency (DS457)
- Safety Guide on Design of Electric Power Systems for Nuclear Power Plants, revision of NS-G-1.8 (DS430)
- Safety Guide on Instrumentation and Control Systems and Software Important to Safety for Research Reactors (DS436)
- Safety Guide on Construction for Nuclear Installations (DS441)
- Safety Guide on Radiation Safety for Consumer Products (DS458)
- Safety Guide on Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition) (DS461)
- Safety Guide on Site Survey and Site Selection for Nuclear Installations (DS433)
- Safety Guide on Design of Instrumentation and Control Systems for Nuclear Power Plants (DS431)

2. The CSS also approved in 2014 the following Document Preparation Profiles (DPPs):

- DPP for Safety Requirements on Safety of Research Reactors, revision of NS-R-4 (DS476)
- DPP for Safety Requirements on Safety of Nuclear Fuel Cycle Facilities, revision of NS-R-5 (DS478)

- DPP for Safety Requirements on Site Evaluation for Nuclear Installations, revision of NS-R-3 (DS484)
- DPP for a Safety Guide on Operating Experience Feedback for Nuclear Installations, revision of NS-G-2.11 (DS479)
- DPP for a Safety Guide on Design of the Reactor Coolant System and Associated Systems in Nuclear Power Plants, revision of NS-G-1.9 (DS481)
- DPP for a Safety Guide on Design of the Reactor Containment System for Nuclear Power Plants, revision of NS-G-1.10 (DS482)
- DPP for a Safety Guide on Severe Accident Management Programme for Nuclear Power Plants, revision of NS-G-2.15 (DS483)
- DPP for a Safety Guide on Ageing Management and Programme for Long Term Operation for Nuclear Power Plants, revision of NS-G-2.12 (DS485)
- DPP for a Safety Guide on Establishing the Safety Infrastructure for a Nuclear Power Programme, revision of SSG-16 (DS486)
- DPP for a Safety Guide on Design of Fuel Handling and Storage Systems for Nuclear Power Plants, revision of NS-G-1.4 (DS487)
- DPP for a Safety Guide on Design of the Reactor Core for Nuclear Power Plants, revision of NS-G-1.12 (DS488)

A.1. Review of the Agency's Safety Standards in the Light of the Fukushima Daiichi Accident

3. The IAEA Action Plan on Nuclear Safety includes the following action on the Agency's safety standards:

“Review and strengthen IAEA Safety Standards and improve their implementation.

- The Commission on Safety Standards and the IAEA Secretariat to review, and revise as necessary using the existing process in a more efficient manner, the relevant IAEA Safety Standards in a prioritized sequence.
- Member States to utilize as broadly and effectively as possible the IAEA Safety Standards in an open, timely and transparent manner. The IAEA Secretariat to continue providing support and assistance in the implementation of IAEA Safety Standards.”

Review/Revision of Safety Requirements

4. In 2011 the Secretariat started a review of Safety Requirements publications in the IAEA Safety Standards Series on the basis of information that was available on the Fukushima Daiichi accident, including two reports from the Government of Japan, issued in June 2011 and September 2011, the report of the IAEA International Fact Finding Expert Mission conducted in Japan from 24 May to 2 June 2011, and a letter from the Chairman of the International Nuclear Safety Group (INSAG) to the Director General dated 26 July 2011. As a first priority, the Secretariat considered the Safety Requirements applicable to NPPs and to the storage of spent fuel. The review consisted first of a comprehensive analysis of the findings of these reports. In the light of the results of this analysis, the Safety Requirements publications were then examined in a systematic manner in order to decide whether amendments were desirable to reflect any of these findings.

5. On that basis, the CSS approved, at its meeting in October 2012, a proposal for a revision process by amendment for the following five Safety Requirements publications: *Governmental, Legal and Regulatory Framework for Safety* (IAEA Safety Standards Series No. GSR Part 1), *Site Evaluation for Nuclear Installations* (IAEA Safety Standards Series No. NS-R-3), *Safety of Nuclear Power Plants: Design* (IAEA Safety Standards Series No. SSR-2/1), *Safety of Nuclear Power Plants: Commissioning and Operation* (IAEA Safety Standards Series No. SSR-2/2), and *Safety Assessment for Facilities and Activities* (IAEA Safety Standards Series No. GSR Part 4). The revision of several publications simultaneously is a new approach, which aims to improve the efficiency of the process while maintaining the consistency of these five Safety Requirements.

6. Additional inputs were considered in preparing the draft text of the proposed amendments to these five safety standards in 2012 and 2013, including the findings of International Experts' Meetings and presentations made at the Second Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety in August 2012. Several national and regional reports were also analysed.

7. The proposed draft amendments were reviewed by the Secretariat in consultants' meetings, as well as by the Nuclear Safety Standards Committee, the Radiation Safety Standards Committee, the Transport Safety Standards Committee and the Waste Safety Standards Committee, in the first half of 2013. They were also presented for information to the Nuclear Security Guidance Committee in 2013. The draft amendments were then submitted to IAEA Member States for comment and revised in consultants' meetings in the light of comments received. The proposed amendments were then approved by all four Safety Standards Committees at their meetings in June and July 2014, and were endorsed by the CSS at its meeting in November 2014.

8. For GSR Part 1, the revisions relate to the following main areas:

- Independence of the regulatory body;
- Prime responsibility for safety;
- Emergency preparedness and response;
- International obligations and arrangements for international cooperation;
- Liaison between the regulatory body and authorized parties;
- Review and assessment of information relevant to safety; and
- Communication and consultation with interested parties.

9. For NS-R-3, the revisions relate to the following main areas:

- Potential combination of events;
- Establishing the design basis hazard level and associated uncertainties;
- Multiple facilities at one site; and
- Monitoring of hazards, periodic review of site specific hazards.

10. For SSR-2/1, the revisions relate to the following main areas:

- Strengthening the prevention of unacceptable radiological consequences to the public and the environment;

- Strengthening severe accident mitigation measures so that, if an accident occurs, off-site contamination is avoided or minimized; and
 - Preventing severe accidents by strengthening the plant design basis, including strengthening the independence of level four of defence in depth, consideration of external hazards and sufficient margins.
11. For SSR-2/2, the revisions relate to the following main areas:
- Periodic safety review;
 - Emergency preparedness;
 - Accident management; and
 - Feedback from operating experience.
12. For GSR Part 4, the revisions relate to the following main areas:
- Margins to withstand external events;
 - Margin to avoid cliff edge effects;
 - Multiple facilities/activities at one site;
 - Cases where resources are shared; and
 - Human factors in accident conditions.
13. This revision process was carried out in conjunction with the revisions of *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GS-R-2) (DS457) and of *The Management System for Facilities and Activities* (IAEA Safety Standards Series No. GS-R-3) (DS456), for which consultation of Member States and of the Safety Standards Committees was organized in parallel to that for DS462.
14. With a view to also taking into account lessons learned from the Fukushima Daiichi accident for other facilities, and particularly for research reactors and fuel cycle facilities, two DPPs were initiated in 2012 for the revision of the Safety Requirements NS-R-4 and NS-R-5. The DPPs were submitted to the Safety Standards Committees and approved by the CSS early in 2014. A DPP for the revision of NS-R-3 on site evaluation for nuclear installations was also submitted to the Committees and approved by the CSS in November 2014.
15. The review by the Safety Standards Committees of other Safety Requirements led to the conclusion that, at this stage, there is no need to revise the Safety Requirements publications *Predisposal Management of Radioactive Waste* (IAEA Safety Standards Series No. GSR Part 5) and *Disposal of Radioactive Waste* (IAEA Safety Standards Series No. SSR-5). The revision of the Safety Requirements *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GS-R-2) (DS457) and actual experience from the remediation activities after the Fukushima Daiichi accident will probably result in a future proposal to revise, only through specific amendments, *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards* (IAEA Safety Standards Series No. GSR Part 3). Finally, certain specific aspects related to transport safety are also considered for the *Regulations for the Safe Transport of Radioactive Material* (IAEA Safety Standards Series No. SSR-6).

Review/Revision of Safety Guides

16. With regard to the review/revision of Safety Guides, a first step was to analyse whether the methodology adopted for the Safety Requirements would also be appropriate for the Safety Guides and to prioritize the review of the Safety Guides on the basis of the same list of lessons learned as identified for the above-mentioned review of the Safety Requirements.

17. A pilot study was conducted in 2012 for the review of three Safety Guides applicable to nuclear power plants, namely *Design of the Reactor Coolant System and Associated Systems in Nuclear Power Plants* (IAEA Safety Standards Series No. NS-G-1.9), *Design of Reactor Containment Systems for Nuclear Power Plants* (IAEA Safety Standards Series No. NS-G-1.10) and *Severe Accident Management Programmes for Nuclear Power Plants* (IAEA Safety Standards Series No. NS-G-2.15).

18. It was concluded that the methodology was appropriate but that any revision should not be restricted to taking into account lessons learned only from the Fukushima Daiichi accident, as other aspects, and particularly guidance on meeting the new Safety Requirements SSR-2/1 and SSR-2/2 would also need to be addressed, together with the guidance on meeting the amendments proposed to SSR-2/1 and SSR-2/2 as part of the draft DS462 mentioned above. Three DPPs were then prepared for the revision of these three Safety Guides and submitted to the Committees, before their approval early in 2014 by the CSS.

19. A complementary pilot study was also performed in 2013 with the review of three additional Safety Guides, namely *External Events Excluding Earthquakes in the Design of Nuclear Power Plants* (IAEA Safety Standards Series No. NS-G-1.5), *Seismic Design and Qualification for Nuclear Power Plants* (IAEA Safety Standards Series No. NS-G-1.6), and *Deterministic Safety Analysis for Nuclear Power Plants* (IAEA Safety Standards Series No. SSG-2), for which it was also concluded that revisions were necessary. Two additional Safety Guides, *Storage of Spent Nuclear Fuel* (IAEA Safety Standards Series No. SSG-15) and *Design of Fuel Handling and Storage Systems for Nuclear Power Plants* (IAEA Safety Standards Series No. NS-G-1.4) were also reviewed. DPPs for the revisions of these five Safety Guides are currently in preparation or being reviewed by the Committees and the CSS.

20. Other Safety Guides were proposed for revision as a result of lessons learned from the Fukushima Daiichi accident, for example *Remediation Process for Areas Affected by Past Activities and Accidents* (IAEA Safety Standards Series No. WS-G-3.1), and the DPP for this revision was approved at the CSS meeting in October 2012.

21. Additional new Safety Guides were also proposed, such as DS474 on arrangements for the termination of a nuclear or radiological emergency and DS475 on arrangements for public communications in preparedness and response for a nuclear or radiological emergency, for which DPPs were approved at the CSS meeting in November 2013.

A.2. The IAEA Safety Standards Series and the IAEA Nuclear Security Series

22. The Nuclear Security Guidance Committee (NSGC) was established in March 2012 as a standing body of senior representatives in the area of nuclear security, open to all Member States, to make recommendations to the Deputy Director General, Head of the Department of Nuclear Safety and Security, on the development and review of IAEA Nuclear Security Series publications.

23. An Interface Group was also established, immediately following the first meeting of the NSGC, to review all DPPs for IAEA Safety Standards Series and IAEA Nuclear Security Series publications — excluding those for Technical Guidance — and, after considering the recommendations of the

Coordination Committee on IAEA Safety Standards and IAEA Nuclear Security Series publications, to identify whether there is a safety/security interface, to document the nature of the interface and to refer the DPP to the appropriate Committee(s) for review and approval.

24. The Interface Group was consulted in 2014 essentially through electronic consultation (a dedicated web page was established and a consultation process by email put in place). Ten new or revised DPPs (for seven draft IAEA Safety Standards Series and three draft IAEA Nuclear Security Series publications) were submitted to the Interface Group with a recommendation from the Coordination Committee. With these consultations, it appears that almost 80% of the draft safety standards under development have some sort of interface with nuclear security that needs to be reviewed by the NSGC, and more than 80% of the draft IAEA Nuclear Security Series publications under development have an interface with safety that needs to be reviewed by at least one Safety Standards Committee.

25. Internal guidance for Technical Officers on how to address the interfaces between nuclear safety and nuclear security was inserted in the Strategies and Processes for the Establishment of IAEA Safety Standards (SPSS) document entitled *Guidelines for Drafting IAEA Safety Standards and Nuclear Security Series Publications* and issued in July 2014 after consultation with all Committees.

A.3. Future Review, Revision and Publication Process

26. After more than 50 years of history of the Agency's safety standards and after having a nearly complete set of standards covering all main safety areas, the CSS discussed a proposal from the Secretariat for the adoption of a more efficient approach for the future review, revision and publication of the safety standards, with the following key objectives:

- To ensure that the review and revision of published standards are based on a systematic feedback collection and analysis process;
- To ensure that any revision of a safety standard or part of a safety standard is justified by the above-mentioned feedback process, therefore also ensuring stability of the parts of the standard that remain valid;
- To maintain the technical consistency among the standards through management of the standards as a complete collection rather than by management of individual standards;
- To enhance semantic consistency through the systematic use of harmonized terminology;
- To ensure the completeness of the collection through a systematic top-down development approach complemented by topical gap analyses; and
- To support the harmonized use and application of the safety standards by enhancing their user-friendliness and by providing tools for users to easily navigate within the whole collection.

27. A new information technology platform is currently being developed for this purpose and is composed of three main elements:

- A content management system, to manage the whole collection of standards, the feedback mechanism, the content of the standards and the relationships between the standards;
- An electronically supported process management system for the revision of the standards; and

- Support for enhanced user-friendliness of the publications and for facilitating the reporting on feedback from their use.

B. Current Agency Safety Standards

B.1. Safety Fundamentals

SF-1 *Fundamental Safety Principles* (2006), co-sponsorship: Euratom, FAO, ILO, IMO, OECD/NEA, PAHO, UNEP, WHO [ACEFRS]⁷⁰

B.2. General Safety Standards (Applicable to All Facilities and Activities)

GSR Part 1 *Governmental, Legal and Regulatory Framework for Safety* (2010) [ACEFRS]

GS-R-3 *The Management System for Facilities and Activities* (2006) [ACEFRS]

GSR Part 3 *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards* (2014), co-sponsorship: EC, FAO, ILO, OECD/NEA, PAHO, UNEP, WHO [E]

GSR Part 4 *Safety Assessment for Facilities and Activities* (2009) [ACEFRS]

GSR Part 5 *Predisposal Management of Radioactive Waste* (2009) [ACEFRS]

GSR Part 6 *Decommissioning of Facilities* (2014) [E]

GS-R-2 *Preparedness and Response for a Nuclear or Radiological Emergency* (2002), co-sponsorship: FAO, ILO, OCHA, OECD/NEA, PAHO, WHO [ACEFRS]

GS-G-2.1 *Arrangements for Preparedness for a Nuclear or Radiological Emergency* (2007), co-sponsorship: FAO, ILO, OCHA, PAHO, WHO [ES]

GS-G-3.1 *Application of the Management System for Facilities and Activities* (2006) [ER]

GS-G-3.2 *The Management System for Technical Services in Radiation Safety* (2008) [EF]

GS-G-3.3 *The Management System for the Processing, Handling and Storage of Radioactive Waste* (2008) [E]

GSG-1 *Classification of Radioactive Waste* (2009) [ER]

GSG-2 *Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency* (2011), co-sponsorship: FAO, ILO, PAHO, WHO [AEFRS]

GSG-3 *The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste* (2013) [E]

⁷⁰ A = available in Arabic; C = available in Chinese; E = available in English; F = available in French; R = available in Russian; S = available in Spanish.

- GSG-4 *Use of External Experts by the Regulatory Body* (2013) [E]
- RS-G-1.1 *Occupational Radiation Protection* (1999), co-sponsorship: ILO [ACEFRS]
- RS-G-1.2 *Assessment of Occupational Exposure Due to Intakes of Radionuclides* (1999), co-sponsorship: ILO [ACEFRS]
- RS-G-1.3 *Assessment of Occupational Exposure Due to External Sources of Radiation* (1999), co-sponsorship: ILO [ACEFRS]
- RS-G-1.4 *Building Competence in Radiation Protection and the Safe Use of Radiation Sources* (2001), co-sponsorship: ILO, PAHO, WHO [ACEFRS]
- RS-G-1.7 *Application of the Concepts of Exclusion, Exemption and Clearance* (2004) [CERS]
- RS-G-1.8 *Environmental and Source Monitoring for Purposes of Radiation Protection* (2005) [ES]
- RS-G-1.9 *Categorization of Radioactive Sources* (2005) [ACEFRS]
- WS-G-2.3 *Regulatory Control of Radioactive Discharges to the Environment* (2000) [ACEFRS]
- WS-G-2.5 *Predisposal Management of Low and Intermediate Level Radioactive Waste* (2003) [ERS]
- WS-G-2.6 *Predisposal Management of High Level Radioactive Waste* (2003) [ERS]
- WS-G-3.1 *Remediation Process for Areas Affected by Past Activities and Accidents* (2007) [ES]
- WS-G-5.1 *Release of Sites from Regulatory Control on Termination of Practices* (2006) [ERS]
- WS-G-5.2 *Safety Assessment for the Decommissioning of Facilities Using Radioactive Material* (2008) [ES]
- WS-G-6.1 *Storage of Radioactive Waste* (2006) [ERS]

B.3. Specific Safety Standards (Applicable to Specified Facilities and Activities)

B.3.1. Nuclear Power Plants

- SSR-2/1 *Safety of Nuclear Power Plants: Design* (2012) [ACEFRS]
- SSR-2/2 *Safety of Nuclear Power Plants: Commissioning and Operation* (2011) [ACEFRS]
- NS-R-3 *Site Evaluation for Nuclear Installations* (2003) [ACEFRS]
- GS-G-1.1 *Organization and Staffing of the Regulatory Body for Nuclear Facilities* (2002) [CEFRS]
- GS-G-1.2 *Review and Assessment of Nuclear Facilities by the Regulatory Body* (2002) [CEFR]
- GS-G-1.3 *Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body* (2002) [CEFRS]
- GS-G-1.4 *Documentation for Use in Regulating Nuclear Facilities* (2002) [CEFRS]

- GS-G-3.5 *The Management System for Nuclear Installations* (2009) [ER]
- GS-G-4.1 *Format and Content of the Safety Analysis Report for Nuclear Power Plants* (2004) [CE]
- NS-G-1.1 *Software for Computer Based Systems Important to Safety in Nuclear Power Plants* (2000) [CEF]
- NS-G-1.3 *Instrumentation and Control Systems Important to Safety in Nuclear Power Plants* (2002) [CEFR]
- NS-G-1.4 *Design of Fuel Handling and Storage Systems for Nuclear Power Plants* (2003) [ERS]
- NS-G-1.5 *External Events Excluding Earthquakes in the Design of Nuclear Power Plants* (2003) [ER]
- NS-G-1.6 *Seismic Design and Qualification for Nuclear Power Plants* (2003) [ER]
- NS-G-1.7 *Protection against Internal Fires and Explosions in the Design of Nuclear Power Plants* (2004) [ER]
- NS-G-1.8 *Design of Emergency Power Systems for Nuclear Power Plants* (2004) [ER]
- NS-G-1.9 *Design of the Reactor Coolant System and Associated Systems in Nuclear Power Plants* (2004) [ERS]
- NS-G-1.10 *Design of Reactor Containment Systems for Nuclear Power Plants* (2004) [ER]
- NS-G-1.11 *Protection against Internal Hazards other than Fires and Explosions in the Design of Nuclear Power Plants* (2004) [E]
- NS-G-1.12 *Design of the Reactor Core for Nuclear Power Plants* (2005) [CER]
- NS-G-1.13 *Radiation Protection Aspects of Design for Nuclear Power Plants* (2005) [ER]
- NS-G-2.1 *Fire Safety in the Operation of Nuclear Power Plants* (2000) [CEFR]
- NS-G-2.2 *Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants* (2000) [CEFRS]
- NS-G-2.3 *Modifications to Nuclear Power Plants* (2001) [CEFRS]
- NS-G-2.4 *The Operating Organization for Nuclear Power Plants* (2001) [CEFR]
- NS-G-2.5 *Core Management and Fuel Handling for Nuclear Power Plants* (2002) [ER]
- NS-G-2.6 *Maintenance, Surveillance and In-Service Inspection in Nuclear Power Plants* (2002) [ER]
- NS-G-2.7 *Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants* (2002) [ERS]
- NS-G-2.8 *Recruitment, Qualification and Training of Personnel for Nuclear Power Plants* (2002) [ER]
- NS-G-2.11 *A System for the Feedback of Experience from Events in Nuclear Installations* (2006) [ERS]
- NS-G-2.12 *Ageing Management for Nuclear Power Plants* (2009) [ER]
- NS-G-2.13 *Evaluation of Seismic Safety for Existing Nuclear Installations* (2009) [ER]

NS-G-2.14	<i>Conduct of Operations at Nuclear Power Plants</i> (2008) [ERS]
NS-G-2.15	<i>Severe Accident Management Programmes for Nuclear Power Plants</i> (2009) [ER]
NS-G-3.1	<i>External Human Induced Events in Site Evaluation for Nuclear Power Plants</i> (2002) [CEFR]
NS-G-3.2	<i>Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants</i> (2002) [ER]
NS-G-3.6	<i>Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants</i> (2004) [CER]
SSG-2	<i>Deterministic Safety Analysis for Nuclear Power Plants</i> (2009) [ERS]
SSG-3	<i>Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants</i> (2010) [ER]
SSG-4	<i>Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants</i> (2010) [ER]
SSG-9	<i>Seismic Hazards in Site Evaluation for Nuclear Installations</i> (2010) [E]
SSG-12	<i>Licensing Process for Nuclear Installations</i> (2010) [ES]
SSG-13	<i>Chemistry Programme for Water Cooled Nuclear Power Plants</i> (2011) [ER]
SSG-16	<i>Establishing the Safety Infrastructure for a Nuclear Power Programme</i> (2011) [E]
SSG-18	<i>Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations</i> (2011), co-sponsorship: WMO [E]
SSG-21	<i>Volcanic Hazards in Site Evaluation for Nuclear Installations</i> (2012) [E]
SSG-25	<i>Periodic Safety Review for Nuclear Power Plants</i> (2013) [E]
SSG-27	<i>Criticality Safety in the Handling of Fissile Material</i> (2014) [E]
SSG-28	<i>Commissioning for Nuclear Power Plants</i> (2014) [E]
SSG-30	<i>Safety Classification of Structures, Systems and Components in Nuclear Power Plants</i> (2014) [E]
WS-G-2.1	<i>Decommissioning of Nuclear Power Plants and Research Reactors</i> (1999) [ACEFR]

B.3.2. Research Reactors

NS-R-3	<i>Site Evaluation for Nuclear Installations</i> (2003) [ACEFRS]
NS-R-4	<i>Safety of Research Reactors</i> (2005) [ACEFRS]
GS-G-1.1	<i>Organization and Staffing of the Regulatory Body for Nuclear Facilities</i> (2002) [CEFRS]
GS-G-1.2	<i>Review and Assessment of Nuclear Facilities by the Regulatory Body</i> (2002) [CEFR]
GS-G-1.3	<i>Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body</i> (2002) [CEFRS]
GS-G-1.4	<i>Documentation for Use in Regulating Nuclear Facilities</i> (2002) [CEFRS]

- GS-G-3.5 *The Management System for Nuclear Installations* (2009) [ER]
- NS-G-2.11 *A System for the Feedback of Experience from Events in Nuclear Installations* (2006) [ERS]
- NS-G-2.13 *Evaluation of Seismic Safety for Existing Nuclear Installations* (2009) [ER]
- NS-G-4.1 *Commissioning of Research Reactors* (2006) [E]
- NS-G-4.2 *Maintenance, Periodic Testing and Inspection of Research Reactors* (2006) [E]
- NS-G-4.3 *Core Management and Fuel Handling for Research Reactors* (2008) [E]
- NS-G-4.4 *Operational Limits and Conditions and Operating Procedures for Research Reactors* (2008) [E]
- NS-G-4.5 *The Operating Organization and the Recruitment, Training and Qualification of Personnel for Research Reactors* (2008) [E]
- NS-G-4.6 *Radiation Protection and Radioactive Waste Management in the Design and Operation of Research Reactors* (2008) [E]
- SSG-9 *Seismic Hazards in Site Evaluation for Nuclear Installations* (2010) [E]
- SSG-10 *Ageing Management for Research Reactors* (2010) [E]
- SSG-12 *Licensing Process for Nuclear Installations* (2010) [ES]
- SSG-18 *Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations* (2011), co-sponsorship: WMO [E]
- SSG-20 *Safety Assessment for Research Reactors and Preparation of the Safety Analysis Report* (2012) [E]
- SSG-21 *Volcanic Hazards in Site Evaluation for Nuclear Installations* (2012) [E]
- SSG-22 *Use of a Graded Approach in the Application of the Safety Requirements for Research Reactors* (2012) [E]
- SSG-24 *Safety in the Utilization and Modification of Research Reactors* (2012) [E]
- SSG-27 *Criticality Safety in the Handling of Fissile Material* (2014) [E]
- WS-G-2.1 *Decommissioning of Nuclear Power Plants and Research Reactors* (1999) [ACEFR]

B.3.3. Fuel Cycle Facilities

- NS-R-3 *Site Evaluation for Nuclear Installations* (2003) [ACEFRS]
- NS-R-5 (Rev.1) *Safety of Nuclear Fuel Cycle Facilities* (2014) [E]
- GS-G-1.1 *Organization and Staffing of the Regulatory Body for Nuclear Facilities* (2002) [CEFRS]
- GS-G-1.2 *Review and Assessment of Nuclear Facilities by the Regulatory Body* (2002) [CEFR]
- GS-G-1.3 *Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body* (2002) [CEFRS]
- GS-G-1.4 *Documentation for Use in Regulating Nuclear Facilities* (2002) [CEFRS]

- GS-G-3.5 *The Management System for Nuclear Installations* (2009) [ER]
- NS-G-2.11 *A System for the Feedback of Experience from Events in Nuclear Installations* (2006) [ERS]
- NS-G-2.13 *Evaluation of Seismic Safety for Existing Nuclear Installations* (2009) [ER]
- SSG-5 *Safety of Conversion Facilities and Uranium Enrichment Facilities* (2010) [E]
- SSG-6 *Safety of Uranium Fuel Fabrication Facilities* (2010) [E]
- SSG-7 *Safety of Uranium and Plutonium Mixed Oxide Fuel Fabrication Facilities* (2010) [E]
- SSG-9 *Seismic Hazards in Site Evaluation for Nuclear Installations* (2010) [E]
- SSG-12 *Licensing Process for Nuclear Installations* (2010) [ES]
- SSG-15 *Storage of Spent Nuclear Fuel* (2012) [E]
- SSG-18 *Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations* (2011), co-sponsorship: WMO [E]
- SSG-21 *Volcanic Hazards in Site Evaluation for Nuclear Installations* (2012) [E]
- SSG-27 *Criticality Safety in the Handling of Fissile Material* (2014) [E]
- WS-G-2.4 *Decommissioning of Nuclear Fuel Cycle Facilities* (2001) [CEFRS]

B.3.4. Radioactive Waste Disposal Facilities

- SSR-5 *Disposal of Radioactive Waste* (2011) [ACEFRS]
- GS-G-1.1 *Organization and Staffing of the Regulatory Body for Nuclear Facilities* (2002) [CEFRS]
- GS-G-1.2 *Review and Assessment of Nuclear Facilities by the Regulatory Body* (2002) [CEFR]
- GS-G-1.3 *Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body* (2002) [CEFRS]
- GS-G-1.4 *Documentation for Use in Regulating Nuclear Facilities* (2002) [CEFRS]
- GS-G-3.4 *The Management System for the Disposal of Radioactive Waste* (2008) [E]
- SSG-1 *Borehole Disposal Facilities for Radioactive Waste* (2009) [E]
- SSG-14 *Geological Disposal Facilities for Radioactive Waste* (2011) [E]
- SSG-23 *The Safety Case and Safety Assessment for the Disposal of Radioactive Waste* (2012) [E]
- SSG-29 *Near Surface Disposal Facilities for Radioactive Waste* (2014) [E]
- SSG-31 *Monitoring and Surveillance of Radioactive Waste Disposal Facilities* (2014) [E]

B.3.5. Mining and Milling

- RS-G-1.6 *Occupational Radiation Protection in the Mining and Processing of Raw Materials* (2004), co-sponsorship: ILO [ES]

WS-G-1.2 *Management of Radioactive Waste from the Mining and Milling of Ores* (2002) [ERS]

B.3.6. Applications of Radiation Sources

GSR Part 3 *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards* (2014), co-sponsorship: EC, FAO, ILO, OECD/NEA, PAHO, UNEP, WHO [E]

GS-G-1.5 *Regulatory Control of Radiation Sources* (2004), co-sponsorship: FAO, ILO, PAHO, WHO [AEFS]

RS-G-1.4 *Building Competence in Radiation Protection and the Safe Use of Radiation Sources* (2001), co-sponsorship: ILO, PAHO, WHO [ACEFRS]

RS-G-1.5 *Radiological Protection for Medical Exposure to Ionizing Radiation* (2002), co-sponsorship: PAHO, WHO [CEFRS]

RS-G-1.9 *Categorization of Radioactive Sources* (2005) [ACEFRS]

RS-G-1.10 *Safety of Radiation Generators and Sealed Radioactive Sources* (2006) [EFS]

WS-G-2.2 *Decommissioning of Medical, Industrial and Research Facilities* (1999) [ACEFRS]

WS-G-2.7 *Management of Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education* (2005) [CERS]

SSG-8 *Radiation Safety of Gamma, Electron and X Ray Irradiation Facilities* (2010) [E]

SSG-11 *Radiation Safety in Industrial Radiography* (2011) [AEFS]

SSG-17 *Control of Orphan Sources and Other Radioactive Material in the Metal Recycling and Production Industries* (2012) [AEFS]

SSG-19 *National Strategy for Regaining Control over Orphan Sources and Improving Control over Vulnerable Sources* (2011) [AES]

B.3.7. Transport of Radioactive Material

SSR-6 *Regulations for the Safe Transport of Radioactive Material: 2012 Edition* [ACEFRS]

SSG-26 *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition)* (2014) [E]

SSG-27 *Criticality Safety in the Handling of Fissile Material* (2014) [E]

TS-G-1.2 (ST-3) *Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material* (2002) [ERS]

