Nuclear Safety Review for the Year 2006

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for the Year 2006

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Foreword

The *Nuclear Safety Review for the Year 2006* reports on worldwide efforts to strengthen nuclear, radiation, transport and radioactive waste safety and emergency preparedness.

An analytical overview is supported by more detailed Appendixes: *Safety Related Events and Activities Worldwide during 2006* (Appendix 1) and *The Agency's Safety Standards: Activities during 2006* (Appendix 2).

A draft version of the *Nuclear Safety Review for the Year 2006* was submitted to the March 2007 session of the Board of Governors in document GOV/2007/2. The final version of the *Nuclear Safety Review for the Year 2006* was prepared in the light of the discussions in the Board.

Executive Summary

As the Agency begins its 50th year of service to the peaceful uses of nuclear energy, there are clear signs of renewed interest in the nuclear power option. Around the world there are plans for both new and reinvigorated nuclear power development and other uses of nuclear technology. It is essential that future planning for applications of nuclear energy and related efforts are complemented with equally ambitious plans for the establishment and enhancement of sustainable safety infrastructures. Plans must be made to transfer knowledge effectively from experienced staff that will soon retire from vendors, regulatory bodies and operating organizations. Equally important are plans for the education and training of the next generation of individuals with the knowledge and expertise to support nuclear and radiation safety.

In 2006, the International Nuclear Safety Group (INSAG) issued a report on the global nuclear safety regime which concludes that the regime is functioning at an effective level today, but its impact on improving safety could be enhanced by pursuing measured change.

In 2006, the Board of Governors approved the Safety Fundamentals upon which the IAEA Safety Standards are based. The Safety Fundamentals establish that the prime responsibility for safety rests with the person or organization responsible for facilities and activities that give rise to radiation risks. The Safety Fundamentals also state that an effective legal and governmental framework for safety must be established and sustained. The challenge now is to ensure that the IAEA Safety Standards are applied in an appropriate manner by the entire nuclear community.

Both in anticipation of expanding uses of nuclear energy and to conform to current international standards, legislative and regulatory reform is underway in a number of Member States.

Most Member States now recognize that stakeholders need to be involved in decisions involving nuclear technology. The challenge remains on how to engage the various stakeholders effectively and efficiently. Related to this is the need for operators, users and regulatory bodies to communicate with the public effectively and in an open and transparent manner.

The global nature of safety is reflected in the relevant international instruments, including conventions and codes of conduct, currently in place. All the international conventions related to safety welcomed additional contracting parties in 2006. During the year, the second review meeting took place for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

The newly established Integrated Regulatory Review Service (IRRS) is contributing to the enhancement of Member States' legislative and regulatory infrastructure and the harmonization of regulatory approaches in nuclear, radiation, radioactive waste and transport safety. It is also one of the most effective feedback tools on the application of Agency standards that will be used for the further improvement of existing standards and guidance. In addition, the approach evaluates not only the policies and strategies, but also how efficient and effective they are regarding protection against all types of exposure. Therefore it is also a tool for information sharing and mutual learning on good policies and practices that can be used to reach harmonization step by step.

Overall, the safety performance of the nuclear industry is good. However, there continue to be recurring events and there is a need to maintain vigilance. There is also a need for lessons learned to be transferred across the various sectors of the nuclear industry. Strong safety management and safety culture are vitally important for the continuation of this good performance. Leaders must ensure that personnel are properly trained and that adequate resources are available.

The nuclear power industry around the world remains a safe and sound one with no worker or member of the public receiving a significant radiation dose as a result of nuclear power plant (NPP) operation. There were no events at any NPP in 2006 that resulted in a release of radioactivity that would cause harm to the environment. While this continued strong safety performance is encouraging, there are also signs that this is resulting in a complacent attitude among some operators, regulators and governmental organizations.

The safe operation of research reactors continued through 2006. Work is now focused on implementing the recommendations from the December 2005 Open-ended Meeting on Effective Application of the Code of Conduct on the Safety of Research Reactors organized by the Agency.

There is a renewed emphasis on fuel cycle facility safety as the Agency prepares for its first Safety Evaluation During Operation of Fuel Cycle Facilities (SEDO) mission in early 2007. The anticipated expanded use of nuclear technology will also bring new safety challenges to be evaluated in many fuel cycle facilities.

Efforts to encourage a downward trend in occupational exposures are continuing through sustained emphasis on ALARA (as low as reasonably achievable) in the workplace. Attention is now being given to the problem of harmonized individual dose assessment and reporting, especially in connection with the growing number of itinerant workers in the nuclear field.

Demand for both established medical processes and cutting-edge medical techniques involving ionizing radiation is increasing in Member States. Although progress has been made in providing medical practitioners with information on controlling patient exposure, substantial effort is required to reach the millions of practitioners dealing with billions of patients around the world.

A general international framework for radiation protection of ecosystems is being considered and some methodologies for assessment of radiation doses are in the final stage of development. A general international system of biota protection is still under discussion.

Many Member States are working towards implementing the guidance contained in the Code of Conduct on the Safety and Security of Radioactive Sources and the supplementary Guidance on the Import and Export of Radioactive Sources. There is also increasing awareness of the role of source manufacturers in contributing to the safety and security of sources. However, there is still work remaining to be done, such as establishing national registers of Category 1 and 2 sources in every Member State.

The safety record of transport of radioactive material has been very good. Informal discussions among a group of eight coastal and shipping States, with Agency assistance, continued in 2006 with a view to maintaining dialogue and consultation aimed at improving mutual understanding, confidence building and communication in relation to safe maritime transport of radioactive material.

With denials of shipment — mostly for air transport — continuing to occur, the Agency has constituted an International Steering Committee on Denial of Shipments of Radioactive Material to help address this issue.

More Member States are giving attention to management and disposal options for radioactive waste and there is a continuing trend of considering waste management and disposal with a holistic view that takes into account all factors and considers the entire life cycle of the nuclear and radioactive material. However, delays in establishing and operating disposal facilities continue to pose challenges to the nuclear industry.

The number of nuclear installations reaching the end of their lifetime and that require decommissioning is increasing and there is increased recognition in Member States of the importance

of adequate planning, resources and regulatory control over decommissioning activities. However, in many cases, adequate funding is not yet in place for decommissioning activities.

The decommissioning of the destroyed Chernobyl Unit 4 and the safe management of radioactive waste in, and remediation of, the Chernobyl exclusion zone remain a significant challenge. There is increasing awareness of the need to address the issue of contamination at legacy sites and growing interest in the management of naturally occurring radioactive material (NORM) residue.

Although emergency preparedness and response plans are in place in areas near most nuclear installations, there remains much to be done at the national and international level for all Member States to have a strong level of preparedness for nuclear and radiation emergencies. In general, these plans need to take advantage of modern communication and information processing technologies, as well as of the relating international cooperative efforts and capabilities.

Both the Agency and individual Member States continue to refine the interfaces between safety and security, recognizing the need for a harmonized and synergistic approach so that both safety and security are adequately addressed.

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Analytical Overview

A. Introduction

The *Nuclear Safety Review for the Year 2006* presents an overview of worldwide trends and issues in nuclear, radiation, transport and radioactive waste safety and emergency preparedness, highlighting developments in 2006. This overview is supported by more detailed Appendixes[1]. This report also discusses nuclear security as it relates to nuclear safety. A separate report will cover nuclear security.

B. Global safety trends and issues

As the Agency begins its 50th year of service to the peaceful uses of nuclear energy, there are clear signs of renewed interest in the nuclear power option. Many Member States have announced or are planning ambitious expansions of nuclear power programmes and a number of Member States are now considering investing in nuclear power. The expansions are not limited to using nuclear energy to generate electricity. Industrial and medical uses of nuclear technology continue to grow around the world, with commensurate increases in transport of radioactive material and requirements for safe waste disposal.

It is essential that plans for both new and reinvigorated nuclear power development and other uses of nuclear technology are complemented with equally ambitious plans for the establishment and enhancement of sustainable safety infrastructures. By its nature a nuclear power project is a major undertaking. It requires a very significant investment up front, both in time, human resources, and finances. However, there are also other major projects in the energy, industrial or the transportation sector where the investment is comparable and the required project management capability is very demanding. What makes a nuclear power project unique are the safety aspects associated with its nuclear and radiological features. International legal instruments and internationally accepted safety standards are essential elements for establishing a sustainable safety infrastructure at the national level. Nuclear safety is the foundation upon which a nuclear power programme must be built and needs to be considered from the outset. An integral component of this is a robust safety culture.

Public confidence and acceptance are inextricably tied to safety which itself has a direct impact on operating the facility without incident. The active participation of all stakeholders in all appropriate phases of a nuclear power plant project is essential. Areas including site selection and evaluation, preparation of the environmental impact assessment and the demonstration of the feasibility of an emergency plan have very strong interfaces with 'non-nuclear' sectors. They are very visible activities that need strong involvement from all stakeholders, especially citizens who are directly affected. It is essential that this involvement is established in a transparent way and that public trust in the project is established at the earliest stage.

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[1] *Safety Related Events and Activities Worldwide during 2006* (Appendix 1) and *The Agency's Safety Standards: Activities during 2006* (Appendix 2).

In anticipation of the expansion of the use of nuclear technology and the introduction of new nuclear technology, and to bring activities into line with current international expectations, many Member States are undertaking legislative and regulatory reform.

The newly established Integrated Regulatory Review Service (IRRS) is expected to contribute to the enhancement of Member States' legislative and regulatory infrastructure and the harmonization of regulatory approaches in nuclear, radiation, radioactive waste and transport safety. It is also expected to be one of the most effective feedback tools on the application of Agency standards that would be used for the further improvement of existing standards and guidance. In addition, the approach used evaluates not only the policies and strategies, but how efficient and effective they are regarding protection against all types of exposures. Therefore it is also a tool for information sharing and mutual learning on good policies and practices that can be used to reach harmonization step by step.

In September 2006, the Board of Governors approved the revised and consolidated Safety Fundamentals upon which the IAEA Safety Standards are based. The Safety Fundamentals contain ten fundamental safety principles for a consistent and strategic approach to safety across the entire spectrum of nuclear activities. The Safety Fundamentals establish that the prime responsibility for safety rests with the person or organization responsible for facilities and activities that give rise to radiation risks. They also state that an effective legal and governmental framework for safety must be established and maintained. The aim now is to ensure that they are applied in an appropriate and harmonized way by the entire nuclear community of international, regional and national associations, regulatory bodies, designers, owners, operators and workers.

Conventions are international instruments of a legally-binding nature based on a common desire to achieve high levels of safety worldwide. All of the international conventions related to safety[2] welcomed additional contracting parties in 2006. Contracting Parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management met in Vienna for their second review meeting from 15 to 24 May 2006. They noted improvements from the first meeting in the areas of national strategies for spent fuel and radioactive waste management, engagement with stakeholders and the public, and the control of disused sealed sources. More details on each of the Conventions are included in Appendix 1.

Codes of Conduct[3] are international instruments of a non-legally binding nature that provide important guidance regarding safety. Support continues to grow for the two published Codes of Conduct and many Member States are adopting the provisions of their guidance. The Code of Conduct on the Safety of Research Reactors received wide support from regional meetings organized by the Agency. Member States participating in these meetings discussed mechanisms of application on a regional and voluntary basis.

At its July 2006 summit in St. Petersburg, Russian Federation, the G8 nations noted progress made to improve controls on radioactive sources and to prevent their unauthorized use. They reaffirmed commitment to fulfill the Agency's Code of Conduct on the Safety and Security of Radioactive Sources provisions, working to put into place the controls over the import/export of radioactive sources at the earliest possible date and urged all other States to adopt the Code. The G8 said it would

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[2] Convention on Early Notification of a Nuclear Accident; Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; Convention on Nuclear Safety; Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

[3] Code of Conduct on the Safety and Security of Radioactive Sources; Code of Conduct on the Safety of Research Reactors.

continue to support international efforts to enhance regulatory controls on radioactive sources, in particular the Agency's Regional Model Projects on Upgrading Radiation Protection Infrastructure.

Both the Agency and individual Member States continue to refine the interfaces between safety and security, recognizing the need for a harmonized and synergistic approach so that both safety and security are adequately addressed. Work also continues to define and maintain the balance between the openness and transparency needed so that the public is properly informed and the confidentiality requirements needed to keep sensitive information away from those who have malicious intentions.

Demand for both established medical processes and cutting-edge medical techniques involving ionizing radiation is increasing in Member States. While the benefits of these techniques are beyond question, the fact remains that patient exposure to ionizing radiation is, by far, the largest man-made source of population exposure and the potential for harm cannot be ignored. Significant progress has been made in providing medical practitioners with up-to-date accurate information on controlling patient exposure. It is clear, however, that substantial effort must continue in order to reach the millions of practitioners dealing with billions of patients around the world.

Plans for a new framework for the nuclear fuel cycle will have implications for transport safety due to the need for long distance transport of large amounts of nuclear materials. This is in addition to the increasing trends to convert research reactors from using high enriched uranium (HEU) to the use of low enriched uranium (LEU) and repatriate no longer needed nuclear and radioactive material to the country of origin.

In 2006, the INPRO activities related to safety were mainly dedicated to the revision of the chapters of the INPRO methodology manual dealing with safety of nuclear power plants and safety of fuel cycle facilities.

The safety record of transport of radioactive material continues to be very good.

Since denial of shipment — especially of short-lived radioisotopes for medical purposes — continues to occur, the Agency has constituted an International Steering Committee on Denial of Shipments of Radioactive Material to facilitate the coordination of effective international efforts designed to minimize delays and denials of shipments of radioactive material.

Although emergency preparedness and response plans are in place in areas near most nuclear installations, there remains much to be done at the national and international level. In general, these plans need to take advantage of modern communication and information processing technologies, as well as of international cooperative efforts and capabilities.

For several years, the Agency has been supporting efforts of Member States to establish and operate networks to share safety knowledge and operating experience among specialists and operators. This has prompted the call for more of these regional networks, which provide the opportunity for everyone to learn from everyone else. The sharing of operating experience at the international level would be enhanced if all Member States belonged to one or more of these regional networks and the information was shared at all levels.

The Chernobyl accident had a significant impact on how nuclear facilities and radioactive sources are designed, operated and regulated today and, two decades later, it is clear that efforts to build a global nuclear safety regime are paying off. However, Chernobyl serves as a reminder that there is a continuous need for vigilance, with no room for complacency and that "we are all in the same boat."

It has been stated many times that nuclear safety is not an issue that can ever be regarded as fixed. The strong, steady performance of recent years is reassuring. But the sporadic recurrence of events of

concern make clear that the promotion of a strong safety culture — for both operators and regulators — should always be viewed as a work in progress. Broad implementation of the multifaceted global nuclear safety regime, involvement of all the players, and partnership for global nuclear safety and security supported with appropriate legal instruments is the only way to ensure that the signs of renaissance by nuclear power will lead to the global implementation of the most modern technologies for the benefit of all.

C. Safety infrastructures

C.1. Trends and issues

Plans for nuclear power development and other uses of nuclear technology need to be complemented with equally ambitious plans for the establishment and enhancement of sustainable safety infrastructures. This infrastructure must do more than just take into account the actual nuclear activity under consideration; it must also address aspects of nuclear, radiation, transport and waste safety for ancillary activities that will be required to support the main activity.

The global nuclear safety regime continues to be the framework for achieving worldwide implementation of a high level of safety regarding nuclear technology. Its core is the activities undertaken by each Member State to ensure the safety and security of nuclear technology within its jurisdiction. These national efforts are augmented by the activities of a variety of international bodies that facilitate nuclear safety — intergovernmental organizations, multinational networks among operators and among regulators, the international nuclear industry, multinational networks among scientists, international standards setting organizations and other stakeholders such as the public, media and non-governmental organizations that are engaged in nuclear safety. All of these efforts should be harnessed to enhance the achievement of safety. In 2006, the International Nuclear Safety Group (INSAG) issued a report[4] that concluded: "the existing Global Nuclear Safety Regime is functioning at an effective level today. But its impact on improving safety could be enhanced by pursuing some measured change." The report recommended, inter alia, action in the following areas:

- Enhanced use of the review meetings of the conventions as a vehicle for open and critical peer review and a source for learning about the best safety practices of others;
- Enhanced utilization of IAEA Safety Standards for the harmonization of national safety regulations, to the extent feasible;
- Enhanced exchange of operating experience for improving operating and regulatory practices; and
- Multinational cooperation in the safety review of new nuclear power plant designs.

Countries that are considering increasing their reliance on nuclear technology should recognize that such a step includes some special responsibilities. Reliance on engineered safety systems is, by itself, insufficient to ensure safety. Nuclear technology is designed with conservative engineering and with reliance on defence in depth as a means to ensure safety. Care is also taken in design to ensure that pathways to serious incidents are, to the extent reasonably practicable, foreclosed by redundant and

[4] http://www-pub.iaea.org/MTCD/publications/PDF/Pub1277_web.pdf

diverse safety systems. However, human failures or institutional deficiencies can overcome, defeat, or circumvent the engineered safety systems. Safe operations can only be assured if there is an infrastructure in place to ensure that machine and man work together harmoniously. The elements of this infrastructure include operator competence, a legal foundation for safety, regulatory competence, financial stability, emergency preparedness, technical competence, and international connectivity. More details are provided in the INSAG report.

Public confidence in and acceptance of a nuclear power project are linked to its safety. Furthermore, the active participation of all stakeholders, both internal and external, in all appropriate phases of the project can help to enhance its chances for success. Essential issues such as site selection and evaluation, preparation of the environmental impact assessment and the demonstration of the feasibility of an emergency plan have very strong interfaces with 'non-nuclear' sectors. They are very visible activities and need strong involvement from all stakeholders, especially citizens who are directly affected. It is essential that this involvement is established in a transparent way and that public trust in the project is established at the earliest stage.

It is generally recognized that knowledge management remains a key issue. More Member States have taken concrete steps, such as restarting or introducing nuclear engineering programmes at the university level and developing educational and professional development programmes, to ensure that there will continue to be sufficient numbers of appropriately trained and experienced personnel to both regulate and operate nuclear facilities and activities. Regional safety networks have also had some success, but these are still neither widespread nor inclusive.

It is also important that adequate financial resources be provided for both operators and regulatory bodies over the entire life cycle of nuclear facilities, including provision for their safe decommissioning. Many regulatory bodies still face both human and financial resource constraints. In many cases, regulatory bodies and operators are competing for the same technical skills. Many Member States have recognized the need for increasing the number of technical specialists and have programmes in place to do this. The need for infrastructure is not limited to human or financial considerations. Facilities must be available to perform, study, and obtain data in support of nuclear activities.

More than 100 Member States receiving technical assistance from the Agency in radiation safety have made progress towards achieving the necessary infrastructure for ensuring sustainable radiation safety. This technical assistance will continue.

Many Member States are also facing the need to keep pace with new and emerging technologies utilizing radiation sources. This is particularly the case in the medical field, and the regulatory infrastructures need to have the capacity and capability to accommodate such changes. There is also an increased desire and need for harmonization at the international level. Many Member States are taking steps to implement the guidance provided in the Code of Conduct on the Safety and Security of Radioactive Sources. A number of Member States are actively working towards the completion of a national register of radiation sources and an information management system harmonized and compatible with current international requirements and guidance.

The implementation of the Action Plan for the Development and Application of IAEA Safety Standards has improved both the quality and the utilization of the standards by Member States. Recent reports by some countries and organizations confirm the wider use of IAEA Safety Standards as a benchmark for harmonization and as a basis for the review of national regulations or their

incorporation in the body of national regulations. The publication of Safety Fundamentals No. SF-1: *Fundamental Safety Principles*[5] brought together for the first time fundamental principles in all areas of nuclear safety. This is an important step for the wide utilization of the IAEA Safety Standards. All drafts and published standards and their translations are posted on the Agency website[6].

C.2. International activities

There are a number of forums in which regulators can exchange information and experience with their counterparts in other countries such as the International Nuclear Regulators Association (INRA), the G8 Nuclear Safety and Security Group, the Western European Nuclear Regulators' Association (WENRA), the Ibero-American Forum of Nuclear Regulators, the Cooperation Forum of State Nuclear Safety Authorities of countries which operate water cooled water moderated power reactors (WWERs), the Network of Regulators of Countries with Small Nuclear Programmes (NERS) and the Senior Regulators from Countries Operating CANDU Type Nuclear Power Plants. Effective communications and the exchange of experience and expertise between regulators from Member States receiving Agency assistance is continuing through the Radiation Safety Regulators Network (RaSaReN). Similar and/or parallel forums also exist among nuclear operators.

For a number of years, the Agency has offered legal and governmental infrastructure related peer review services[7] to provide advice and assistance to Member States in strengthening and enhancing the effectiveness of their regulatory infrastructure and nuclear regulatory bodies. In line with the unified approach of the Safety Fundamentals, in 2006, the Agency began offering a new safety review service called Integrated Regulatory Review Service (IRRS), which covers the requirements for the legislative framework and the effectiveness of regulatory body activities in the areas of nuclear, radiation, waste and transport safety and is based on the IAEA Safety Standards. This new integrated review service is an effective feedback tool for the application of Agency standards. In addition the approach used evaluates not only the policies and strategies but how efficient and effective they are regarding protection against all types of exposures. Therefore it is also a good tool for information sharing and mutual learning on good policies and practices that can be used to reach harmonization step by step. In 2006, the Agency conducted an IRRS mission to Romania (IRRT and RaSIA[8] follow-up), a limited scope IRRS mission to the UK and a full-scope IRRS mission to France.

From 27 February to 3 March 2006, the Russian Federation hosted the International Conference on Effective Nuclear Regulatory Systems. This conference was the first to bring together senior nuclear safety, radiation safety and nuclear security regulators from around the world to discuss how to improve regulatory effectiveness. The conference made many recommendations for governments, regulatory bodies and international organizations and concluded that "the delivery of effective nuclear safety and security regulation is vital for the safe and secure use of nuclear energy and associated technologies both now and in the future and is an essential prerequisite for the achievement of global energy security and global sustainable development."

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[5] SF-1 is co-sponsored by Euratom, FAO, ILO, IMO, OECD/NEA, PAHO, UNEP and WHO.

[6] http://www-ns.iaea.org/standards/

[7] International Regulatory Review Team (IRRT); Radiation Safety and Security of Radioactive Sources Infrastructure Appraisal (RaSSIA); Transport Safety Appraisal Service (TranSAS); International Nuclear Security Advisory Service (INSServ); Emergency Preparedness Review (EPREV); Integrated Safety Assessment of Research Reactors (INSARR).

[8] Radiation Safety Infrastructure Appraisal

The USA has proposed a multi-national process to develop innovative approaches to leverage the resources and knowledge of national regulatory authorities that will be tasked with the review of new NPP designs. The process has been renamed the Multinational Design Evaluation Programme (MDEP). Stage 1 of the programme is underway and involves cooperation between Finland, France and the USA and focuses on the design review of the European pressurized water reactor (EPR). Stage 2 involves the multinational convergence of codes, standards and safety goals. Stage 3 will include the implementation of the Stage 2 products to facilitate licensing of new NPPs, including those being developed by the Generation IV International Forum. In September 2006, the terms of reference for Stage 2 were adopted by the participating countries[9]. Stage 2 will be governed by a Policy Group and implemented by a Steering Technical Committee, with the OECD/NEA as the technical secretariat. A working group on component manufacturing oversight has also been formed and is implementing its action plan. The Agency will take part in the work of MDEP Stage 2.

With the adoption of the Safety Fundamentals by the Board of Governors in 2006, the Agency reached a major milestone towards the completion of all actions established by the March 2004 Action Plan for the Development and Application of IAEA Safety Standards. Identified gaps in the coverage of safety standards are being addressed by new standards for regulatory functions, fuel cycle facilities, disposal of radioactive waste, research reactors and medical and industrial applications of radiation sources. The transition to a new safety standards structure has made good progress in all areas and the Commission on Safety Standards is now looking beyond the Action Plan to respond to the emerging needs of Member States while maintaining a manageable set of safety standards.

The Senior Regulators' Meeting was held in Vienna in September 2006 in conjunction with the General Conference. Senior regulators from more than 50 Member States discussed regulatory effectiveness and mutual learning. The need to increase the dialogue between nuclear regulators and industry was highlighted. The issue of operating experience feedback was discussed, including how to create an international system for operating experience that is useful for those who actually use nuclear technology. Senior regulators also discussed the balance between transparency and confidentiality. The public expects that regulators and operators will be open and transparent in how they address safety issues, yet there is a need to maintain confidentiality so that information is not given to those with malicious intentions.

Also in conjunction with the General Conference, INSAG held a forum on what elements of a national safety infrastructure are necessary for countries expanding their nuclear power programmes or considering nuclear power for the first time.

The Agency continues to provide training courses, seminars and workshops, as well as other advice and assistance, including technical equipment and information management tools such as Regulatory Authority Information System (RAIS 3.0), to support Member States' implementation of cradle to grave management of radiation sources. At the end of 2006, more than 90 Member States are either using RAIS 3.0 in their daily activities or are in the process of assessing it with a view to improving their existing national registers.

C.3. Future challenges

The major challenge facing many Member States continues to be establishing, maintaining and improving technical competence in the regulatory body and technical support organizations as experienced staff retire, facilities age and the use of nuclear technology expands. Many regulatory

[9] Canada, China, Finland, France, Republic of Korea, Russian Federation, South Africa, UK and USA.

bodies continue to face financial and human resource shortages even though the use of nuclear technology continues to grow. In many cases, this growth will result in regulatory bodies and operating organizations competing for the same technical staff. All this comes at a time when governments and the public expect regulatory bodies to be open, transparent and consistent. Comprehensive and multi-faceted approaches, including succession planning, educational and training programmes, processes established in a quality management setting and adequate financial resources are needed. Rather than being viewed as a potential burden, the commitment to safety needs to be seen as something that will help ensure the healthy and sustained growth of the industry.

As the Action Plan for the Development and Application of IAEA Safety Standards nears completion, the focus must now shift to maintaining a continuous improvement process and providing appropriate response to the needs of Member States. There are challenges to maintain a comprehensive set of up-to-date standards that will require the systematic incorporation of feedback from the application of the standards into the development of new standards and revision of existing standards. Another challenge is to have the IAEA Safety Standards understood and applied by industry, users and operating staff at all levels.

There has been limited progress in improving the feedback of operating experience at the international level. The exception to this is for high profile events, such as the unplanned shutdown event at the Forsmark nuclear power plant in Sweden, which resulted in extensive discussions around the world regarding the probability and consequences for similar events. There continue to be many opportunities in this area to increase knowledge sharing at the international level.

The effective independence of the regulatory body continues to be a significant challenge for many Member States. Management of promotional and regulatory functions in Member States with limited resources (qualified personnel, equipment and/or facilities) continues to be a challenge.

Although some progress has been made, the implementation of self-assessment methodologies by regulatory bodies as part of their quality management programme remains a challenge. More peer reviews are important to enhance national safety infrastructures.

Achieving greater consistency of Member States' regulations and regulatory approaches with the Agency's standards and guidance, including the Codes of Conduct and the Guidance on the Import and Export of Radioactive Sources, continues to be an Agency goal.

The establishment and maintenance of a complete national register of radioactive sources (containing at least Category 1 and 2 sources) remain a challenge in many Member States.

D. Incident and emergency reporting, preparedness and response

D.1. Trends and issues

Effective national and global response capabilities are essential to minimize the impacts from nuclear and radiological incidents and emergencies and to build public trust in the safety and security of nuclear technology. The increased use of nuclear technology and more acute security concerns require a proportionate increase in national, regional and international capabilities to respond to an incident or emergency. In this context, the Agency has undertaken to strengthen its Incident and Emergency Centre (IEC) to better support Member States in dealing with both emergencies and security incidents.

Nuclear and radiological events continue to occur. In 2006, 168 events were reported to the Agency. However, only a small portion of these events involved significant exposure or dangerous radioactive sources. The Agency receives reports from a variety of systems[10] according to reporting systems established in each Member State.

The events reported in 2006 appear to show two key trends. First, most of the events involving serious overexposures resulted from industrial radiography applications. Second, the main cause of these events appears to be a failure to follow established procedures and lack of training. According to preliminary analysis, workers either did not use provided radiation survey meters/dosimeters, ignored the reading of the instruments or lacked necessary equipment and/or experience. In general, there is a trend of reported incidents and emergencies to have similar causes. This illustrates that there is still a need to promote worldwide exchange of information on causes and lessons learned from incidents and emergencies to avoid recurrence.

In addition, events reported in 2006 showed a clear international dimension that has not been as prominent in previous years. For example, two key events involved the shipping of unshielded radioactive sources that exposed individuals in at least two countries and requiring a greater level of international cooperation.

Emergency preparedness and response arrangements are integral to the safety of workers and the public living in the vicinity of nuclear installations and wherever radioactive materials are used. Member States operating nuclear power plants continue to pursue emergency exercises. For example, in 2006, the Argentine Nuclear Regulatory Authority organized and conducted an emergency exercise involving the Embalse nuclear power plant, with participation of local and regional organizations and the local population.

In recent years, efforts have broadened to address a general concern regarding radiological incidents and emergencies, including the malicious use of radioactive materials and acts directed against a nuclear facility. In response, Member States are updating and adapting their emergency response programmes and increasing their requests for Agency support of national activities (e.g. training courses, exercises). Exercises conducted by Member States now tend to involve more complex scenarios. For example, in 2006 Sweden staged a decontamination and monitoring exercise that included several source search exercises, a radiological dispersion device scenario and contamination and decontamination of a house and its surroundings.

Member States have made a noticeable effort to increase and enhance their emergency response capabilities. Even so, emergency management systems between Member States are not sufficiently harmonized. Some systems are less than capable to respond to nuclear or radiological events and often do not meet international guidelines. It has been recognized that communication systems and assistance arrangements often differ among Member States. Over the past years Member States, in cooperation with the Agency, increased their efforts to harmonize international communication and assistance systems. In the framework of the International Action Plan for Strengthening the International Preparedness and Response System for Nuclear and Radiological Emergencies, experts from all over the world are in the process of formulating recommendations on how to harmonize communication and assistance systems worldwide.

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[10] Including the Illicit Trafficking Database (ITDB), the Nuclear Events Web-based System (NEWS) and the Early Notification and Assistance Conventions Website (ENAC).

Member States continue to broadly use the International Nuclear Event Scale (INES) as a basis for rating the safety significance of nuclear and radiological events. In 2006, the extended use of INES for events related to radiation sources and transport of radioactive material was endorsed by Member States.

D.2. International activities

In cooperation with Member States, the Agency is implementing the International Action Plan for Strengthening the International Preparedness and Response System for Nuclear and Radiological Emergencies.

The Nordic radiation protection and nuclear safety authorities have signed a memorandum of understanding about their willingness to endorse and implement the document *Co-operation, Exchange of Information and Assistance Between Nordic Authorities in Nuclear or Radiological Incidents and Emergencies* (Nordic Manual). The Nordic Manual replaces earlier documents related to the implementation of bilateral agreements relating to the Convention on Early Notification of a Nuclear Accident in the region and other relevant documents and decisions and describes practical arrangements and cooperative activities. The intent is to maintain the Nordic Manual by reflecting ongoing international developments and relevant IAEA Safety Standards and other guidance.

France has proposed to the competent authorities of its neighbouring countries (Belgium, Germany, Luxembourg and Switzerland) a standard bilateral protocol on alert, exchange of information and assistance in order to prepare and respond effectively and appropriately to a nuclear or radiological emergency situation.

In 2006, a working group, with participation from the competent authorities of Belgium, France, Germany, Luxembourg and Switzerland, began to consider cross-border harmonization of iodine prophylaxis in nuclear emergencies.

The Agency also cooperated with NATO during a number of radiological dispersal device emergency response exercises and the Global Health Security Action Group[11] has begun to benefit from the assistance arrangements established by the Agency.

In 2006, the European Commission (EC) and the Agency enhanced cooperation by developing an automated interface between the EC and Agency reporting systems, making the reporting of nuclear or radiological events in Europe more efficient.

D.3. Future challenges

In 2006, a revised and enhanced Response Assistance Network (RANET) was established. It is important that Member States adequately and accurately register national assistance capabilities with RANET so that efficient international assistance can be provided in case of a nuclear or radiological event. A related challenge is to ensure clear and common understanding among Member States about existing international arrangements and capabilities for preparedness and response. The General Conference encouraged Member States to consider joining the RANET.

In 2006, based on a recommendation from the competent authorities of the Early Notification and Assistance Conventions, the General Conference welcomed the initiative to develop a new code of conduct on international emergency management. From 11 to 15 December 2006, 72 representatives

[11] The group consists of representatives of Canada, France, Germany, Italy, Japan, Mexico, UK and USA.

from 45 Member States and two international organizations attended a technical meeting in Vienna convened by the Secretariat. During the meeting, a consolidated draft was prepared for further discussions. There is also a need to respond to the renewed interest being shown in adapting international response arrangements to security related events.

It is important that emergency reporting, preparedness and response plans — both in Member States and at the regional and international level — take advantage of modern communication and information processing technologies. The available and emerging technologies provide an opportunity to further harmonize and streamline reporting mechanisms. As requested by the General Conference at its 48th session, the Agency is working towards the establishment of a portal for reporting and disseminating information concerning incidents and emergencies which aims to streamline the Agency reporting mechanisms.

E. Nuclear power plant safety

E.1. Trends and issues

The nuclear power industry around the world remains safe, with no worker or member of the public receiving a significant radiation dose in 2006 as a result of nuclear power plant (NPP) operation. While this continued strong safety performance is encouraging, there are also signs that this is resulting in a complacent attitude among some operators, regulators and governmental organizations. Although a number of safety-significant events occurred during 2006, there were no events at any NPP that resulted in a release of radioactivity that would cause harm to the environment.

Most existing NPPs have safety enhancement plans in place and for the most part these plans are being implemented. Over the past few years, substantial safety improvements have taken place in the vast majority of NPPs around the world. However, the gap between strongest and weakest performer remains a concern. In some cases, assessment of the safety upgrades lack completeness and rigour.

In many regions, the average age of experts and workers in the nuclear industry continues to increase. Although this brings the benefit of accumulated knowledge, experience and mature judgement, it also presents the challenge of a continually ageing workforce. The need for knowledge management — including preserving, extending and renewing the existing knowledge base — is increasingly recognized around the world. The creation of new knowledge goes hand-in-hand with the need for new university programmes, which will also help renew the human resource capability. In many Member States, a lack of government support for nuclear education and training and changes in priorities of universities have resulted in the loss of nuclear programmes, faculties, and facilities, making this aspect of knowledge management more difficult. However, many Member States are establishing national training centres to provide continuing education and improved on-the-job training continues to be an essential part of developing and maintaining competencies. There is also a need for succession planning and workforce renewal to be more widespread.

Most NPP operating organizations have extensive programmes to analyse operating experience at the organization level and several Member States have programmes at the national level. At the international level, any safety significant event generates international attention and all major events are carefully examined in most Member States for implications in their own NPP programme. However, lower level events and near misses, which are important sources of operating experience as

precursors to major events, do not receive the same level of scrutiny at the international level. The quality and number of events reported to international incident reporting systems have remained at a minimal level, despite continued efforts to improve the commitment to sharing information. As a result, events with the same root causes still recur.

Long term operation of NPPs is defined as operation beyond an established timeframe originally set forth by licence term, design limits, standards, and/or regulations. Long term operation includes various practices such as licence renewal, life extension, continued operation and life management and must be justified by a safety assessment that considers life-limiting processes and features for systems, structures, and components. Although long term operation is primarily a decision of owners based on projected economic performance, the implications for safety must be thoroughly examined and accounted for. As more NPPs enter long term operation, international guidance, based on experience already obtained, will be invaluable.

Leadership in nuclear safety is a key issue in many Member States. For both operators and regulators, it is essential that staff at the most senior level demonstrate safety leadership and demand that others at all levels of the organization do the same. These efforts must be integrated into the management systems in place in organizations. Experience has shown that effective management systems based on safety as the fundamental principle are essential to support leadership and individuals to maintain nuclear safety and continuously enhance a good safety culture. Assessment tools and enhancement processes for safety culture are being developed and used. This development needs to continue as a basis for early actions to prevent failures.

E.2. International activities

The Convention on Nuclear Safety provides the framework for international efforts to enhance nuclear safety around the world. The obligations of the Convention provide Contracting Parties with a high level of assurance that their nuclear power industries are operated with due regard to safety. The Convention's requirement for the production of national reports and the review of these national reports during review meetings provide meaningful opportunities for self-assessment and peer review, both of which are essential for a strong safety culture.

The Agency's peer review services — such as Operational Safety Review Team (OSART) and Peer Review of Operational Safety Performance Experience (PROSPER) — and the World Association of Nuclear Operators' (WANO) peer evaluations continue to be important tools for assuring the safety of the design, operations and maintenance of NPPs. The Agency has also continued providing assistance to Member States for the application of safety standards on design and site evaluation of NPPs through the Engineering Safety Review Service (ESRS), conducted for assisting in the review of safety analysis reports for new installations as well as for safety re-evaluation programmes of existing ones. The Agency also offers a long term operation and ageing management peer review service and is developing safety standards and managing a coordinated research programme related to long term operation and ageing management. The Agency collaborates with WANO on a number of activities and communication processes are in place to ensure that Agency and WANO activities are complementary. The importance of the human and organizational aspects of safety and safety culture is widely accepted. The cultural aspects of safety are intangible and often unconscious within the organization, which shares that safety culture. This makes the reliable assessment of safety culture important. The Agency promotes the independent assessment of safety culture through the Safety Culture Assessment Review Team (SCART) service.

Responding to emerging trends, the Agency started the process of developing new safety standards in the area of advanced methods for safety assessment covering deterministic and probabilistic

approaches and risk informed decision making. The new standards will aim to ensure that the insights from the safety assessments are consistent and comprehensive and promote further safety enhancement effectively and efficiently. The Agency is also developing a Centre for Advanced Safety Analysis Tools (CASAT) to give Member States access to advanced safety assessment including a limited number of high quality probabilistic and deterministic analytical codes, models, databases, validation and verification information, analytical procedures, standards and guides. The Agency also offers extensive training and training materials in safety assessment methods.

INSAG published two reports in 2006: *Stakeholder Involvement in Nuclear Issues* (INSAG 20) and *Strengthening the Global Nuclear Safety Regime* (INSAG 21). The General Conference encouraged Member States to incorporate the concepts identified in these documents into their nuclear programmes as appropriate. All INSAG reports are available on the Agency's website[12].

The OECD/NEA is also undertaking important activities regarding NPP safety. In 2006, the OECD/NEA launched a new programme to establish databases and knowledge bases on two of the most important elements of ageing management: stress corrosion cracking and ageing of cable insulation. The ultimate goal is to produce the basis for commendable practices for ageing management. The OECD/NEA is also currently operating 14 joint projects on safety research, including one project started in 2006 regarding coping with room-to-room fire propagation under various conditions.

E.3. Future challenges

The most pressing challenge for the nuclear power industry is ensuring that adequate safety infrastructure is in place to support NPP design, construction, operation, maintenance and decommissioning, as well the regulatory activities associated with all of these. The issue of infrastructure was discussed in detail in Section D. Comprehensive plans to address both technical and human resource issues will be needed. As commercial nuclear power continues to grow, increasing demand and competition for scarce resources will challenge most Member State's nuclear safety infrastructure as they undertake new activities or activities such as siting that have not been performed for many years.

As new NPP designs are developed, there is an opportunity to ensure that appropriate security features are incorporated into their design, construction and operation. To do this successfully will require effective national strategies, supported by appropriate international guidance.

Although the need for knowledge management is recognized, a related issue is the capability of those that require the knowledge to access it in a timely manner. There is also the ongoing challenge to balance the openness and transparency requirements of such a knowledge management system with the need to maintain certain information confidential for security reasons. A key issue is ensuring vigour and long-term sustainability of these knowledge management systems.

The effective dissemination and utilization of operating experience is an ongoing challenge. The commitments to report issues and lessons learned and also to take action based on experience of others need to be enhanced to prevent events from recurring. Sharing of utility and regulatory actions in response to events, and also the sharing and replication of good practices, may assist in precluding the occurrence of significant issues.

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[12] http://www-ns.iaea.org/committees/insag.asp

Many regulatory bodies face the challenge of developing requirements and criteria to assess and grant life extensions and for the regulatory oversight of ageing management programmes as NPPs move to long term operation. These bodies must also, in many cases, re-establish processes for licensing the various phases of new plants. The Agency, through the development of the safety analysis report review plan, is assisting Member States in defining an acceptable methodology to re-establish this process.

F. Research reactor safety

F.1. Trends and issues

Research reactors are not only a cornerstone of national nuclear science and technology programmes, but are an important part of a national safety infrastructure. The safe operation of many research reactors continued through 2006. About 270 research reactors are currently operational in 56 countries (with 85 research reactors in developing countries). New research reactors (e.g. the University of Munich's 20 MW(t) FRM-II, and the 20 MW(t) Open Pool Australian Light Water (OPAL) Reactor) have incorporated significant improvements in safety systems and containment/confinement buildings. The Agency provided safety review services during the design, construction and commissioning of the OPAL Reactor. In July 2006, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) issued a licence for the operation of the OPAL Reactor. It achieved first criticality in August 2006, and was undergoing hot commissioning at the end of 2006.

However, about two-thirds of the existing research reactors are more than 30 years old. Ageing of equipment is one of the most important causes of the incidents reported to the Agency's Incident Reporting System for Research Reactors (IRSRR). Obsolescence of the instrumentation and control systems is an important issue for many facilities. Added to the problems with ageing of systems, structures and components is ageing of the research reactor workforce and a difficulty in recruiting new personnel. These problems are widespread in the nuclear enterprise worldwide, but often exacerbated in the case of research reactors by a lack of financial resources to hire and train new staff.

Thirty-five research reactors in 27 countries are subject to Agency project and supply agreements. Most of these agreements have not been updated since they were originally written, in many cases, decades ago. They do not reflect current Agency safety standards or other current international safety guidance, including the Code of Conduct on the Safety of Research Reactors.

The most frequent findings of recent safety review missions relate to out-of-date or incomplete safety documentation (safety analysis reports, operating limits and conditions, emergency plans, etc.), lack of a decommissioning plan, lack of a strategic plan and the accompanying utilization plan, lack of resources, and the lack of an effective and independent regulatory body. These problems need to be addressed in order to effectively implement the appropriate technical assistance to solve them.

Inadequate regulatory supervision of research reactors is an especially important continuing issue. In many Member States, the legal and governmental infrastructure is inadequate and/or the regulatory body does not satisfy international standards for independence and effectiveness. Staffing of the regulatory body with competent, trained people is also a problem, especially in Member States having a limited pool of qualified persons to staff both the regulatory body and operating organization.

F.2. International activities

Agency activities are now focused on implementing the recommendations from the December 2005 Open-ended Meeting on Effective Application of the Code of Conduct on the Safety of Research Reactors. The meeting participants called for periodic meetings to discuss topics related to the application of the Code of Conduct, exchange experience and lessons learned, identify good practices, and discuss future plans, difficulties encountered and assistance needed to reach full compliance. In addition, there was a call for the integration of the Code of Conduct into all Agency safety assistance and review activities and a recommendation that the Agency consider updating the project and supply agreements to reflect the provisions of the Code of Conduct. During 2006, the Agency conducted regional meetings on the Code of Conduct in Morocco for Member States in Africa and in Romania for Member States in Eastern Europe. These regional workshops are intended to help prepare the Member States for effective participation in the periodic international meetings and to identify opportunities for regional cooperation and ways in which the Agency can assist.

The work to complete the corpus of safety standards for research reactors will be continued in 2007. These will provide the key technical requirements and recommendations that are needed to implement the Code of Conduct and achieve enhanced safety. They also provide the basis for the Agency's safety review services.

The Agency's Integrated Safety Assessment of Research Reactors (INSARR) review service is offered in a modular format to fit the needs of the requesting Member State. An analysis of INSARR mission recommendations and the existing incident database is currently underway, aimed at identifying safety issues and trends, and the status of response to INSARR recommendations. This is in addition to a continuing programme of monitoring the safety of 'agreement' reactors, and assessing and collecting safety performance indicators.

The Incident Reporting System for Research Reactors (IRSRR) is an important tool for improving the safety of research reactors through the exchange of safety-related information on unusual events. By the end of 2006, 49 Member States with research reactors had joined the IRSRR.

In 2006, the Agency started a coordinated research project on source term calculations for research reactors.

F.3. Future challenges

A continuing challenge is to match international and regional assistance efforts with the needs of Member States. The Agency must seek and maintain frequent contacts with the facilities to identify the real safety problems and fully evaluate the needs of Member States. In many cases, practical assistance, including expert coaching missions, is needed to implement recommendations from safety missions. There is a need for prioritization of recommendations and preparation of implementation schedules according to the importance to safety.

Joint missions integrating safety, security and regulatory reviews are needed so that effort is not duplicated and that recommendations are complementary and consistent. Self-assessment should become a prerequisite for all review services, so that the review team can focus on areas of concern that have been identified, as well as seeking out areas that have not been found. Although some Member States have self-assessment capabilities for the safety review of research reactors, effort is needed to ensure that all Member States with research reactors have this capability.

There is a continuing need to ensure that safety aspects associated with the core conversion from the use of high enriched uranium (HEU) to the use of low enriched uranium (LEU) fuel are adequately addressed.

As mentioned in previous *Nuclear Safety Reviews*, research reactors under project and supply agreements present a special challenge in view of the Agency's specific safety related responsibilities with respect to these reactors. While many of these reactors have received safety missions, regularly scheduled safety review missions need to become the norm.

International organizations such as International Organization for Standardization (ISO) and the European Commission have activities regarding the safety of research reactors and coordination with Agency activities is needed. The topical groups within the framework of the Asian Nuclear Safety Network also have many activities underway regarding the safety of research reactors in participating Member States.

G. Fuel cycle facility safety

G.1. Trends and issues

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, making much of the process and technology information commercially sensitive. In the past, this sensitivity often extended into the safety area. However, this is changing and there is now more sharing of information on specific technical safety practices.

New fuel designs will be needed for the innovative and future reactor designs under consideration. The safety of these new fuels and of commercial fuel cycle facilities needs to be addressed.

Fuel cycle facilities face unique safety challenges such as criticality control, confinement of hazardous materials, chemical hazards and susceptibility to fires and explosions. In some Member States, many facilities and regulatory bodies lack human and financial resources. Efforts are being made to improve the situation by developing a complete set of safety standards and providing training. The approach to safety must be graded and based on potential hazards. The international safety guidance currently available for such facilities is incomplete and needs to be further developed.

G.2. International activities

Guidelines for the Agency's Safety Evaluation During Operation of Fuel Cycle Facilities (SEDO) safety peer review service are available and a preparatory mission was conducted in 2006 for the first SEDO mission — a pilot mission to Brazil — which is scheduled for March 2007.

The Agency cooperates closely with the OECD/NEA on fuel cycle facility safety. At a technical meeting in 2006, the Agency demonstrated a first prototype web-based system for the Fuel Incident Notification and Analysis System (FINAS) which will be implemented in the Agency. A common web platform covering the incident reporting systems for NPPs (IRS), research reactors (IRSRR) and fuel cycle facilities (FINAS) is being developed.

The OECD/NEA Fuel Cycle Safety Group of the Committee on the Safety of Nuclear Installations (CSNI) has issued the third edition of *The Safety of the Nuclear Fuel Cycle*, which represents the most up-to-date analysis of the safety aspects of the nuclear fuel cycle and provides information on operating practices, operating experience and the lessons learned from major incidents.

G.3. Future challenges

The Agency continues the work to complete the corpus of safety standards dedicated to fuel cycle facilities — including the Safety Requirements for fuel cycle facilities — and to work with Member States in developing training programmes.

Based on the experience of the pilot mission to Brazil and taking into account the final version of the Safety Requirements for fuel cycle facilities, the SEDO guidelines will be finalized and Member States will be encouraged to take advantage of the SEDO service for improving the safety of their fuel cycle facilities.

H. Radiation protection

H.1. Trends and issues

The Agency's *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (BSS) are regarded as the global point of reference for standards for protection against ionizing radiation. They are based on the data of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) on the health consequences of radiation exposure, and, to the extent possible, on the recommendations of the International Commission on Radiological Protection (ICRP).

The Agency, in cooperation with the cosponsoring international organizations, completed a review of the BSS during 2005 and 2006, and the Agency safety standards committees and the Commission on Safety Standards agreed in late 2006 that a revision of the BSS should proceed, with a target publication date of late 2009.

H.2. International activities

In May 2006, UNSCEAR celebrated the 50th anniversary of its first session. The Committee approved a scientific report addressing aspects of the biological effects of radiation, which was presented to the United Nations General Assembly in October 2006. The report and detailed scientific annexes are now being prepared for publication. The overall view of UNSCEAR is that the data reviewed do not necessitate changes in its overall current risk estimates for the carcinogenic and hereditary effects of radiation. Further information on the activities of UNSCEAR can be found in Appendix 1.

The current ICRP recommendations were finalized in 1990, and the ICRP initiated a review of them several years ago. In June 2004, the ICRP issued a draft set of revised recommendations for public comment. The ICRP developed an updated draft of the recommendations, prepared taking into account the comments received and issued for public comment in June 2006. Seven hundred and thirty five pages of comments were received. The draft recommendations emphasized more clearly that the three basic principles of protection are maintained and that the dose limits in the BSS remain unchanged. The ICRP distinguished three exposure situations: planned, emergency, and existing. The ICRP draft

recommendations stated that dose constraints are to protect the most exposed individuals from specified sources; are to apply to all exposure situations for occupational and public exposures; and are to be used at the start of an optimization process. Further information on the activities of the ICRP can be found in Appendix 1.

The review report on the BSS, prepared by the Agency during 2006, identified reasons for proceeding with a revision of the BSS. These include the need to link a revised BSS to the new Safety Fundamentals, to take account of the new ICRP recommendations, and of recent international agreements such as the Code of Conduct on the Safety and Security of Radioactive Sources and associated Guidance on the Import and Export of Radioactive Sources. There is also a need to ensure consistency and cross-referencing with other Safety Requirements publications in the IAEA Safety Standards, and with recent key Safety Guides such as RS-G-1.7[13], which presented activity concentration values for bulk quantities of material that could be used for exclusion, exemption and clearance. There were also many other improvements that could be made to the text of the BSS, including improvements in clarity, providing greater detail in some parts; introducing new material where shortcomings were identified, and removing some detailed material that might be more suitable for Safety Guides.

H.3. Future Challenges

A key challenge is the completion of the revision of the BSS.

The revised BSS should underpin the approaches to radiation safety in every domain, including medicine, general industry, nuclear industry, radioactive waste management, and transport; cover occupational exposure, medical exposure and exposure of members of the public; and provide a basis for other facility and thematic Safety Standards.

I. Occupational radiation safety

I.1. Trends and issues

Efforts to reduce occupational exposures are continuing through sustained emphasis on the ALARA concept in the workplace. International and regional activities such as the European ALARA Network, the Regional European and Central Asian ALARA Network and the Information System on Occupational Exposure are important contributors to these efforts.

More and more Member States, in many cases with Agency assistance, are putting in place the necessary regulatory measures to control occupational exposure. Suitable workplace and individual monitoring systems — supported by appropriate quality management systems and intercomparison exercises — continue to be implemented.

Attention is now being given to the problem of harmonized individual dose assessment and reporting, especially in connection with the growing number of itinerant workers in the nuclear field.

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[13] *Application of the Concepts of Exclusion, Exemption and Clearance.*

The protection of pregnant workers and the foetus is an issue of great interest and is being addressed through the development of more specific guidance in an Agency safety report.

The issue of compensation for radiation-induced health effects in the workplace and the related issue of probability of causation are receiving attention through collaborative effort between the Agency, the International Labour Organization (ILO) and the World Health Organization (WHO).

A considerable amount of new information on doses received by exposed workers in naturally occurring radioactive material (NORM) industries is being gathered by the Agency, and this is facilitating the development of guidance for regulators and other stakeholders.

I.2. International activities

The Action Plan for Occupational Radiation Protection, which is being implemented by the Agency in collaboration with the ILO, WHO and other international bodies, is generating important outputs in the form of safety-related documents, education and training materials and material to improve worker awareness. It is also helping to promote the harmonized implementation of occupational radiation protection standards.

The Agency is supporting the harmonization of individual dose assessment and reporting by promoting the implementation of quality management systems in service organizations for radiological monitoring. Based on an upcoming safety standard, the Agency has introduced a quality management system into its own monitoring testing laboratories. In 2006, this system received third-party accreditation to standard ISO17025 and is being offered to Member States as a model for their installations.

Working relationships between the Agency and other international and intergovernmental bodies such as the ILO, WHO, ICRP and the European Commission are being further strengthened in several areas, including occupational radiation protection, leading to greater harmonization of standards and their application.

Education and training in the field of occupational radiation protection are continuing to receive priority attention at the international level by the Agency and at regional level by bodies such as the European Commission. In 2006, the Agency prepared training material on workplace monitoring and educational material for labour representatives.

The Agency continues to actively support the ILO in its ongoing efforts to strengthen the implementation of the Convention concerning the Protection of Workers against Ionising Radiations (ILO Convention 115). The ILO also has a code of practice on the radiation protection of workers (ionizing radiations) and recently finalized a review of this code of practice, concluding that no changes needed to be considered for the time being.

I.3. Future challenges

For many years, performance indicators have been used, with varying success, to determine the effectiveness of occupational radiation safety efforts. A challenge is to establish a complete set of appropriate performance indicators, as well as the means to accurately and comprehensively collect the information for the performance indicators.

Current efforts tend to treat radiation safety in isolation from other workplace safety issues. The challenge is to create a holistic approach to workplace safety where not only individual hazards — both radiological and non-radiological — receive appropriate attention and control, but interactions between potential workplace hazards are also addressed.

There is a need to foster regional centres of excellence that will support Member States' efforts to achieve sustainable, indigenous capability to address occupational radiation protection issues.

Although workers and users of ionizing radiation are key stakeholders in any occupational radiation protection programme, their involvement in the development and application of the IAEA Safety Standards and other international guidance has been limited. A continuing challenge is to improve their awareness and involvement in radiation protection programmes. Related to this is the need to share experience, both positive and negative, in the area of occupational radiation protection.

Meeting the radiation protection needs of health care professionals also continues to be a challenge owing to the rapid pace of development of the use of ionizing radiation in that industry.

Clearer guidance is needed to assist Member States in creating a pragmatic and graded approach to occupational radiation protection regulation, especially concerning exposure to NORM. This includes identifying activities involving exposure to natural radiation that may need to be controlled, as well as generating and disseminating additional sector-specific information.

J. Radiological protection of patients

J.1. Trends and issues

The Agency's activities in training medical professionals in radiological protection of patients have resulted in a significant increase in awareness about radiation risks and the need to protect patients, particularly for professions that have not been using radiation equipment.

The technology and techniques associated with diagnostic radiology, nuclear medicine and radiotherapy are evolving at an ever increasing rate. Faster imaging capabilities in computed tomography have made new applications possible. In addition, interventions guided by X-rays and performed by different types of medical professionals — many of whom have no formal training in radiation protection — now involve large amounts of radiation. Each new application results in new patient protection issues.

This technology is not limited to those Member States with extensive radiation protection and regulatory infrastructure. While the Agency is continuing its efforts to establish this infrastructure, there is an immediate need to reach professionals at large so that they are aware that international standards exist and that information regarding patient protection is available. Professionals must also be able to access this information and even contribute to the body of knowledge as required.

J.2. International activities

The International Action Plan for the Radiological Protection of Patients is bringing together the efforts of the Agency, the Pan American Health Organization, WHO and international professional bodies.

In 2006, the Agency launched a website[14] for radiological protection of patients. This website is quickly becoming a valuable source for worldwide knowledge on patient protection.

Technical cooperation activities related to the thematic area of radiological protection of patients are making good progress in bringing experts from recipient countries together with others to expand the knowledge base.

In 2006, the Agency continued to provide training courses for interventional cardiologists in radiation protection. Interventional cardiologists are among the highest users of X-ray fluoroscopy, but many have minimal or no training in radiation protection. The Agency has focused its attention on radiation protection issues to assist new professional groups that have had no training in radiation protection before but are now expanding their use of radiation techniques.

Under the International Action Plan for the Radiological Protection of Patients, a range of activities was pursued that resulted in training material for courses presented on CD (radiation protection in diagnostic and interventional radiology, in radiotherapy, and in nuclear medicine) and supported by the ILO, PAHO, WHO and corresponding international professional societies[15]. The Agency held training courses in 2006 for all technical cooperation regions.

In 2006, the ICRP made considerable progress with specific recommendations for radiation protection in the areas of multidetector computed tomography, interventional cardiology procedures using X-rays, new radiotherapy technology and techniques, and paediatric radiology. These recommendations will have an impact on the IAEA Safety Standards and other Agency guidance, training material, assistance projects, monitoring of radiation protection issues associated with new technologies and techniques, and other material for dissemination through the Agency's dedicated website.

J.3. Future challenges

If new medical applications using radiation are of substantial benefit to patients, experience shows that they will be put into widespread clinical use rapidly. Once established, a technique may result in exposing millions of patients in one year. Providing timely guidance on optimization of protection will make a substantial difference in population exposure. There is a need to establish mechanisms — such as panels of experts and the dissemination of knowledge gained by pioneers — to provide this advice. The challenge is to disseminate this advice to millions of medical professionals worldwide efficiently and quickly.

The radiological protection of patients website is currently aimed at regulatory bodies and medical professionals at large. The Agency is considering extending the website so that it is useful to patients themselves.

There continues to be a demand in Member States to substantially reduce patient exposure and avoid radiation injuries, while maintaining diagnostic information. The challenge remains for the coming years to achieve a large-scale outcome.

A new training programme for doctors performing fluoroscopic procedures, other than cardiologists and radiologists, was launched in 2006. Since an increasing number of non-radiologists (e.g. urologists, gastroenterologists, and orthopaedic surgeons) use X-ray fluoroscopy in their practice, with

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[14] http://rpop.iaea.org

[15] International Society of Radiology (ISR), International Organization for Medical Physics (IOMP), and the International Society of Radiographers and Radiological Technologists (ISRRT).

the potential for high patient exposure, such training programmes have become essential and will need to be expanded in coming years.

K. Protecting the public and the environment

K.1. Trends and issues

The development of an agreed international system for environmental protection to counter the effects of ionizing radiation continues. The basis for this development is work done over the last 30 years on both human health considerations and on the possible harm to non-human biota. It includes the cooperative work of a number of international, regional and national organizations and must take into account the fact that radiation is only one of many environmental stressors. The ultimate goal is to agree on a set of assessment tools, references, and impacts of concern to assist in validating the environmental protection provided for uses of radiation and radioactive material. However, it is important that the implications of any proposed changes are thoroughly understood. Methodologies for the assessment of radiation doses are now in the final stage of development, however the general international framework for radiation protection of biota is still under discussion. Some countries — including Canada, France, Germany, Sweden and the United Kingdom — and organizations such as the ICRP, the International Union of Radioecology, OECD/NEA, UNSCEAR and the European Commission have made substantial progress in the field. Other Member States are moving in the same direction.

Other international or regional instruments aimed at protecting the marine environment from radioactive wastes — through the prohibition of the disposal of radioactive materials at sea (London Convention 1972) or the progressive reduction or elimination of radioactive discharges to the sea (OSPAR Convention 1992) — focus on key themes such as sustainable development and the reduction or elimination of pollution. The Agency will continue to collaborate with the contracting parties of these conventions.

Naturally occurring radioactive material (NORM) can become concentrated, in areas not normally controlled by regulatory bodies, to levels beyond the concentration limits set for practices. Such activities include both in-situ and heap leaching, as well as conventional mining and processing of ores by various means. At present, there is no defined international guidance for the proper management of NORM residues. New guidance is being developed.

K.2. International activities

The web-based version[16] of the Agency's Database on Discharges of Radionuclides to the Atmosphere and the Aquatic Environment (DIRATA) was launched in 2006. DIRATA is a worldwide centralized repository of data submitted by Member States. Each facility dataset includes annual discharge and detection limits, regulatory limits (where available) and limited information on the site location. The third Technical Meeting on DIRATA, held in Vienna from 26 to 28 June 2006, initiated the online submission of official national records on radioactive discharges.

[16] http://dirata.iaea.org

The Agency also continued to maintain databases on the inventory from dumping activities and from accidents at sea.

The 29th session of the Codex Alimentarius Commission adopted revised guideline levels for radionuclides in foods following accidental nuclear contamination for use in international trade (as reflected in document ALINORM 06/29/41). The draft document was prepared by the Agency in collaboration with a number of other international organizations.

The first Technical Meeting on Monitoring Radionuclides in Foodstuffs Traded Internationally, held in Vienna from 11 to 15 December 2006, discussed the strategy for routine and emergency monitoring of radionuclides in foodstuffs and ways of implementing ALINORM 06/29/41. The meeting concluded that the justification and optimization of the extent of monitoring radionuclides in foodstuffs, as well as procedures for interpreting monitoring data, need further international harmonization and that the Agency should have an active role in these activities.

ICRP Committee 5 is developing a combined approach to the protection of humans and other biota within an overall framework that recognizes the different but complementary aims and objectives that this involves. Committee 5 is also developing methodologies to assess radiation doses in reference plants and animals as an instrument for biota protection.

The Agency has started implementation of its Plan of Activities on the Radiation Protection of the Environment and in 2006 established the Coordination Group on Radiation Protection of the Environment. The Group will serve as a mechanism to facilitate the coordination of activities among international and regional organizations in this field. The main aims of the Plan of Activities are to promote collaborative work that enhances current approaches in radiation protection by taking explicit account of non-human biota in developing an approach for the assessment and management of radionuclides entering or present in the environment and to provide assistance to Member States in their efforts to protect the environment.

The EU research project Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA), to be completed in early 2007, aims to provide an integrated approach to the assessment and management of environmental risks from ionizing radiation using practical tools at the European level.

K.3. Future challenges

The implementation of the new ICRP recommendations, with emphasis on constraints and the new definition of the effective dose, will necessitate extensive consultation with Member States and international organizations.

The Safety Fundamentals include generic statements regarding the protection of people and the environment against radiation risks. Explicit requirements on environmental radiation protection are not yet included at the level of safety requirements, but are being considered during the revision process of the BSS that was recently initiated. Further improvement of environmental radiation protection issues within the system of the IAEA Safety Standards and detailed guidance will be developed once the ICRP recommendations are issued.

There continues to be a need to explore further the nature of the risks that may apply to other biota, how such risks may be quantified, and thus how it can be positively demonstrated in the legal context that other biota are not put at risk.

L. Radioactive source safety and security

L.1. Trends and issues

As Member States undertake substantial efforts to establish and implement national strategies for regaining and maintaining control of vulnerable and orphan sources, the magnitude of the problem becomes clearer. It is now evident that the problem is larger than previously thought.

The IAEA Safety Standards are playing an increasingly important role in the safety and security of radioactive sources. For example, the guidance included in Safety Guide RS-G-1.9 *Categorization of Radioactive Sources* is now widely used by regulatory bodies, producers, suppliers and users in Member States.

There is increasing awareness of the role of source manufacturers in contributing to the safety and security of sources. Their professional organization — the International Source Suppliers and Producers Association (ISSPA) — is now actively involved in relevant IAEA activities. The Board of Governors also approved the inclusion of ISSPA among the non-governmental organizations represented by observers at the General Conference.

L.2. International activities

International support for the non-legally binding Code of Conduct on the Safety and Security of Radioactive Sources (the Code) continues to grow (88 States as of the end of 2006) and, a number of Member States have amended, or are in the process of strengthening, their national legislation to take into account the recommendations given in the Code. The number of Member States agreeing to implement in a harmonized manner the Code's supplementary Guidance on the Import and Export of Radioactive Sources (the Guidance) continues to grow (37 States at the end of 2006). As demonstrated at the International Conference held in 2005 in Bordeaux[17], the degree of implementation of the Code by States varies widely. Although many Member States are working towards implementing the Code and the Guidance, work still remains to be done, such as establishing national registers of Category 1 and 2 radioactive sources as listed in Annex 1 to the Code of Conduct.

From 31 May to 2 June 2006, the Agency organized an open-ended meeting of technical and legal experts where consensus was reached on a formal mechanism for a voluntary, periodic exchange of information for all Member States to share experiences and lessons learned in implementing the Code and Guidance. In September 2006, the recommended mechanism was endorsed by the Board of Governors and noted by the General Conference. The voluntary nature of the information mechanism is consistent with the non-legally binding nature of the Code and is primarily based on a single international meeting open to all States held every three years, subject to the availability of funding.

The import and export of radioactive sources subject to the Guidance relies upon the exchange of information between importing and exporting countries. To facilitate this bilateral exchange of information, the Secretariat has made available on its website[18] the details of officially nominated national contact points. Furthermore, standardized forms in the six United Nations official languages have been made available to those contact points via a password protected website.

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[17] http://www-pub.iaea.org/MTCD/Meetings/PDFplus/2005/cn134-findings.pdf

[18] http://www-ns.iaea.org/downloads/rw/meetings/import-export-contact-points.pdf

The Agency continues to provide assistance to Member States to improve their capability to safely manage radioactive sources, including working closely with donor States on projects in specific regions of the world, such as the European Union initiative that focuses on countries in Eastern Europe, the Middle East and North Africa. In addition to the Agency's efforts, Australia is leading a similar effort in East Asia and the Pacific region.

Throughout 2006, the European Commission continued to emphasize the implementation of the Council Directive 2003/122/Euratom of 22 December 2003 on the control of high-activity sealed radioactive sources and orphan sources (HASS Directive), which is legally binding for EU members.

The Agency and the ISO have been collaborating on the development of a new internationally recognizable warning symbol for dangerous sources to convey the message of "Danger – Run Away – Do Not Touch." The new warning symbol is intended to supplement, not replace, the radiation trefoil. It is currently draft ISO standard 21482 and final voting by ISO members closed at the end of 2006.

L.3. Future challenges

Much effort is still required to ensure that every Member State has developed and can maintain national expertise to effectively deal with the safety and security of radioactive sources.

Continuing effort will be required to ensure that the many bilateral, multinational and international activities under way to strengthen controls for radioactive sources and manage the legacy of past activities are coordinated and coherent, in order to maximize the effective use of resources.

Although the recycling of radioactive sources should be pursued to the extent possible, the lack of appropriate disposal options is a worrying gap in the radioactive source management system. Although manufacturers and suppliers can have a supporting role in dealing with disused sources, this does not replace the need for national or regional disposal options for sources.

Radioactive sources provide essential benefits to society, and the challenge is to ensure that this continues in the light of concerns over the safety and security of sources.

M. Safety of transport of radioactive material

M.1. Trends and issues

The good safety record for the transport of radioactive materials continued in 2006. The *Regulations for the Safe Transport of Radioactive Material* (the Transport Regulations)[19] provide the basis for the safe transport of radioactive materials around the world. The continued involvement of Member States and international organizations in the review process contributes to the high level of confidence in the Transport Regulations.

Renewed interest in nuclear power generation, and increasing need for sterilization, diagnostic and therapeutic radioactive sources, will result in the need to transport more and more radioactive material safely and efficiently.

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[19] TS-R-1: *Regulations for the Safe Transport of Radioactive Material*, 2005 Edition.

Denial of shipments of radioactive materials intended for use in medical diagnosis and treatment continued to be a major issue in 2006. The vast majority of denials were for air transport, which is, in most cases, the only practical method to ensure these materials reach their intended destinations in a timely manner.

There is continuing interest in Member States regarding the development of radiation protection programmes for the transport of radioactive material and many sought Agency assistance in this regard.

M.2. International activities

In 2006, in accordance with the Agency's policy for reviewing and revising the Transport Regulations, the review of the 2005 edition of the Transport Regulations was completed and the Transport Safety Standards Committee (TRANSSC) determined that there was no need for an immediate revision of the Transport Regulations. The Commission on Safety Standards confirmed this assessment at its June 2006 meeting.

The Agency continued its efforts to finalize a draft safety guide on compliance assurance for the safe transport of radioactive material based on the Transport Regulations. The draft was circulated to Member States for comment in 2006 and a revised version, taking the comments into account, will be submitted to the first TRANSSC meeting in 2007.

Work also continued to establish recommendations for security during the transport of radioactive materials. Security levels and physical protection measures have been proposed and should be finalized in early 2007.

In May 2006, the International Air Transport Association (IATA) developed a DVD explaining the importance of radioisotopes for medical purposes, including the need for expeditious transport, and the significance of air transport in achieving this. IATA has distributed the DVD to its Member States and the Agency is working with IATA to provide even broader distribution.

In May 2006, the Agency held a technical meeting of experts to discuss further the progress on the issue of denials of shipments of radioactive material. The experts recommended the establishment of a steering committee on denials of shipments of radioactive material. The mandate and role of the steering committee is to identify, evaluate and implement actions to alleviate denials of shipment on the basis of an action plan. At the first meeting of the steering committee in Vienna in November 2006, an action plan was developed, which includes: increasing awareness among international organizations and Member States regarding the events, their consequences, the underlying issues and their resolution; training service providers; communication to educate service providers; promoting a positive image of the use of radioactive material; economic assessment and measures to identify and reduce economic burdens causing sustainability problems; and harmonization of international requirements where industry should notify (in the form of generic denial reports) the UN.

In September 2006, a group of eight coastal and shipping States, with Agency assistance, had a second round of informal discussions in Vienna with a view to maintaining dialogue and consultation aimed at improving mutual understanding, confidence building and communication in relation to safe maritime transport of radioactive material.

M.3. Future challenges

It is an ongoing challenge to ensure that the Agency guidance related to the safe transport of radioactive materials is harmonized with the guidance of other international organizations.

As the use of nuclear technology continues to grow, the potential for denial of shipment will increase unless specific actions are taken to address the issue. A key to achieving this will be increasing stakeholder awareness of the Agency's transport safety requirements. The IAEA Safety Standards related to transport need to be understood, accepted and used by everyone involved in the transportation of radioactive material.

Where two or more regulatory bodies have the mandate to regulate the transport of radioactive materials depending on the mode of transport, it is a continuing challenge to ensure that their roles and interfaces are clear.

N. Civil liability for nuclear damage

N.1. Trends and issues

The importance of having effective civil liability mechanisms in place to insure against harm to human health and the environment, as well as actual economic loss caused by nuclear damage, has become a subject of increased interest among States. At the same time, there remains uncertainty and debate related to the implementation of the existing international nuclear liability instruments. In addition, whereas a number of States are parties to these instruments, many are not and the compatibility of the provisions of the various instruments and the relationships between them are considered complex.

The International Expert Group on Nuclear Liability (INLEX), established by the Director General in 2003, continues to consider and address concerns of States regarding the nuclear liability instruments, with a view to contribute towards a better understanding of, and adherence to, the international nuclear liability regime as a whole.

N.2. International activities

INLEX held a further meeting in July 2006 during which its expert members, inter alia, exchanged views on new developments in the field of civil liability for nuclear damage and considered the need to further develop the nuclear liability regime, in particular by discussing and analyzing concrete steps that could be taken to address possible gaps in the scope and coverage of the liability instruments. Further, they considered whether there is a need for harmonization of the liability instruments and relevant international legal instruments adopted under the auspices of the Agency and considered possible future action of the Board of Governors with regard to the establishment of the maximum limits for the exclusion of small quantities of nuclear material from the scope of application of the relevant nuclear liability instruments. In this regard, a document on the issue will be prepared for the consideration of the Board of Governors in 2007.

Also in 2006, in the context of INLEX's outreach activities, the second Regional Workshop on Liability for Nuclear Damage was held in Lima, Peru, from 11 to 13 December. The workshop, which followed a standard programme developed by INLEX, was attended by 20 Member States of the Latin American region. The main purpose of the workshop was to provide information on the existing international liability regime for nuclear damage. It also provided a platform for both fostering adherence to the international nuclear liability regime and providing a forum for open discussions on possible difficulties, concerns or issues which States in the region may have with the regime. A third Regional Workshop is scheduled to be held in South Africa, later in 2007.

N.3. Future challenges

The work of INLEX is ongoing and it is expected that it will continue to play an important role both as a forum of expertise for discussions between shipping and coastal States and in terms of providing authoritative advice on the nuclear liability instruments adopted under Agency auspices. The next meeting of INLEX is scheduled for July 2007.

O. Safety of radioactive waste management and disposal

O.1. Trends and issues

With the increasing focus being given to nuclear energy and plans to expand national programmes or introduce nuclear energy generation programmes, many countries are also giving more attention to the back end of the fuel cycle and to management and disposal options for radioactive waste. As part of discussions on advanced fuel cycles, the prospect of 'burning' longer lived actinides in purpose designed reactors has been raised. However, this remains conceptual at this stage and no firm programmes to investigate the prospect have been widely discussed at the international level.

The trend of considering waste management and disposal with a holistic view that takes into account all factors and considers the entire life cycle of the nuclear and radioactive material continued in 2006.

In March 2006, the United States National Academy of Sciences issued a report that suggested changes in the way that low activity wastes are regulated. The report recommends that low activity waste should be regulated according to the risk it poses, rather than the industry which generated it; many of the regulations currently applied are inconsistent and efforts are required to achieve standardization. The report recognized that low activity waste has been, and continues to be, safely disposed of under the current US regulations. The report also suggested that the use of international consensus standards as a basis for US regulations could help gain public support for any changes.

In April 2006, the Belgian Government, following consideration of a submission by a partnership with local authorities, agreed to site a near-surface disposal facility for low level waste in the community of Dessel.

The subject of geological disposal for high level waste is difficult and different approaches to safety demonstration are being adopted in Member States. In March 2006, the Swiss Federal Office for Energy issued a draft implementation plan for the siting of deep geological repositories for all classes of radioactive waste in Switzerland. The draft plan was the subject of public consultation during the summer of 2006, with a final version expected by summer 2007. In France, a new waste bill was passed supporting reversible geological disposal for high level waste and spent fuel at a site to be confirmed, licensed by 2015 and in operation by 2025. The UK Government has accepted all of the recommendations of its committee on waste management as regards future management of high level wastes.

A noticeable trend in recent years has been the move by some countries to disposal of low and intermediate level waste in underground facilities. In July 2006, Atomic Energy of Canada Limited announced a proposal to dispose of low and intermediate level waste from its Chalk River Laboratory site in a deep repository in crystalline rock in the Canadian Shield.

A significant development in disposal of non-heat generating waste was the decision in the USA in October by the New Mexico Environment Department to issue a revised hazardous waste facility permit for the Department of Energy's Waste Isolation Pilot Plant (WIPP). Remote-handled transuranic-wastes will be placed in horizontal boreholes in the walls of the disposal rooms in the facility. So far, the facility has only been licensed for lower activity wastes.

Most spent fuel storage systems were designed for short-term application. The time periods for storage systems have been extended because of the unavailability of disposal facilities. An important safety issue is how to ensure safety in the long-term and to provide confidence in the continued integrity of the fuel, its container, the structure of the waste store and the maintenance of sub-criticality. A combination of monitoring, inspection and research may be appropriate, which needs to be reflected in safety standards.

The fact that many Member States have comparatively small volumes of radioactive waste requiring geological disposal and the disproportionate cost for each of them to develop their own geological repository remains. Various initiatives to examine the feasibility of a regional repository in which the waste from several countries could be placed have been taken, but no potential site has yet been identified. The issue will need to be further considered in the light of its potential impact on the further implementation of national disposal projects.

Consideration continues to be given to the development of small diameter borehole type facilities for the disposal of small amounts of radioactive waste, in particular disused sealed sources. Many countries are faced with the problem of managing such sources and whilst return to supplier countries is indicated as a good option, legal and logistical practicalities often prevent this option. The safety of the borehole option is under consideration internationally, including the development of safety standards and of a generic safety assessment methodology that can be customized to local sites.

O.2. International activities

The Second Review Meeting of the Contracting Parties of the Joint Convention was held in Vienna from 15 to 24 May 2006 with 41 Contracting Parties, including eight for the first time, participating. Despite a large diversity of national situations, all Contracting Parties shared the view that progress had been made since the First Review Meeting. They demonstrated commitment to improving policies and practices, particularly in the areas of national strategies for spent fuel and radioactive waste management, engagement with stakeholders and the public, and the control of disused sealed sources. Challenges continue in a number of areas, including the implementation of national policies for the long-term management of spent fuel, disposal of high level wastes, management of historic wastes, recovery of orphan sources, knowledge management and human resources. The need to ensure that Contracting Parties' financial commitments are consistent with the extent of liabilities was also recognized. Many Contracting Parties see the benefit of enhancing international cooperation through the exchange of information, experience and technology. In particular, needs for sharing knowledge and assistance were emphasized by Contracting Parties with limited radioactive waste management and research programmes.

The International Conference on Management of Spent Fuel from Nuclear Power Reactors was held in Vienna from 19 to 22 June 2006. The scope was broader than previous conferences and included policy, safety and security aspects. Spent fuel is still differently regarded by Member States — as a resource by some and as waste by others — and the strategies for its management vary, ranging from reprocessing to direct disposal. Conference participants generally agreed that disposal deep in geological formations is the most appropriate final solution. Many technical aspects of spent fuel

storage were also reviewed during the conference, including burn-up credit, extended operating periods for these spent fuel storage systems, and fuel behaviour in dry storage.

The projects within the Agency's programme of work that provide for development and inter-comparison of safety assessment methodology related to radioactive waste safety are continuing. The programmes dealing with application of safety assessment methodologies for near-surface waste disposal facilities and safety assessment driven waste management solutions continue to generate considerable interest amongst Member States.

Increasingly, Member States are requesting the Agency to arrange for international peer review of waste disposal facilities against international standards. Two such appraisals were undertaken related to the siting of disposal facilities for low and intermediate level waste in Republic of Korea and Lithuania.

Following its work related to the identification of safety reference levels for NPPs, the West European Nuclear Regulators' Association (WENRA) has extended its work to radioactive waste and spent fuel storage and decommissioning. The intention is to develop a harmonized approach to safety demonstration for all nuclear facilities and activities within the region. The reference levels are based on IAEA Safety Standards and WENRA is working with the Agency to ensure a coherent and consistent approach to using the standards and to providing feedback on experience gained.

Arising from the WENRA work, a group of Western European countries have established a pilot study to explore the development of similar reference levels for geological disposal facilities. Use is being made of the recently developed international safety standards for geological disposal and the Agency and the European Commission are both actively collaborating in the study.

A new project funded by the European Commission to assess the feasibility of European regional waste repositories is about to start, indicating a recognition that implementing 25 national repositories is optimal neither economically nor for safety and security reasons. Following a European Commission funded pilot study in 2005, the SAPIERR-2[20] project will propose a practical implementation strategy and the organizational structures required for concrete plans to proceed from 2008.

International projects are ongoing to help remove the global problem of disused sealed radiation sources using the borehole disposal technique. Such a disposal concept offers, for some Member States, the prospect of a disposal option commensurate with the hazard potential of such radioactive waste. However, further work is needed to demonstrate the safety of the concept and to develop the regulatory capacity necessary for their licensing.

O.3. Future challenges

Consideration continues to be given to the disposal of certain waste types that are unsuitable for near surface disposal in facilities at intermediate depths. The additional benefits in terms of isolation and containment offered by disposal at these greater depths are being considered further in the safety standards programme.

The safety implications of the extended storage of radioactive waste still need further elaboration and systematic evaluation and there may be a need for specific safety standards for extended storage. These evaluations are taking into account not only legacy waste, but waste that will be generated in the

[20] Support Action: Pilot Initiative for European Regional Repositories

future. The implications for extended storage over various timeframes need to be further elaborated and consensus developed as to the sustainability of such options and the ability to assure safety.

Developments in international recommendations on radiation safety arising from the review and revision of recommendations of the ICRP have identified the need for improved guidance on dealing with situations of existing exposure. Such situations are commonly associated with waste containing NORM, particularly in circumstances not associated with the nuclear fuel cycle. Increasingly, situations are being identified where this waste should be managed as radioactive waste. A rational approach to the management of such waste needs to be developed, both for existing waste and waste that may arise from future activities.

P. Decommissioning

P.1. Trends and issues

The number of facilities using radioactive material (NPPs, research reactors, fuel fabrication plants, research centres, laboratories, etc.) reaching the end of their lifetime and approaching decommissioning is increasing worldwide. This has led to an expansion of decommissioning activities in Member States and increased recognition that adequate planning, resources and regulatory control are needed to ensure safe decommissioning. In particular, more research reactors have been identified that have been, or will be, shut down in the near future and more consideration of early decommissioning planning is taking place. However, for many facilities, decommissioning funding remains a concern and many Member States lack adequate appropriate regulatory and operational infrastructure to support decommissioning, including adequate waste disposal solutions.

There is increasing recognition worldwide of the importance of early planning for safety during initial planning, siting, and operation, as well as for the transition from operation to decommissioning, during decommissioning and following completion of decommissioning activities.

It is now recognized that the evaluation and demonstration of the safety of decommissioning activities are essential and work is under way to collect experience, lessons learned and good practices for the development and review of safety assessments, as well as application of the graded approach.

Decommissioning projects worldwide have demonstrated that the majority of decommissioning waste is below clearance values and can be released from regulatory control. However, to do this consistently requires clearly defined criteria and procedures for monitoring for compliance. Safety Guide RS-G-1.7[21] provides guidance, but additional guidance is needed for surficial contamination (or appropriate surrogate) levels. There is also a need for improved consistency in the application of these criteria in Member States. In addition, improvements and consistency in the strategies for monitoring of compliance with these values is needed, particularly for materials commonly traded between countries, such as scrap metal.

Adequate cost estimates and funding mechanisms become increasingly important for the successful completion of decommissioning. This is of specific importance for small facilities either state owned, or already shut down, for which the funding mechanism for decommissioning is not defined.

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[21] *Application of the Concepts of Exclusion, Exemption and Clearance.*

Worldwide experience from decommissioning shows that maintaining competent and qualified staff after facility shutdown and during decommissioning is a challenge. This affects the preservation of knowledge about the facility design, modifications, operation and its transfer to future generations. Member States are now putting measures in place in order to preserve existing knowledge.

P.2. International activities

In September 2006, the Board of Governors approved Safety Requirements WS-R-5 *Decommissioning of Facilities Using Radioactive Material*, which provides thematic safety requirements that must be fulfilled in the planning and implementation of decommissioning for the termination of practices and for the release of facilities from regulatory control.

In 2006, the Agency also published Safety Guide WS-G-5.1: *Release of Sites from Regulatory Control on Termination of Practices*, which provides guidance on the safety aspects related to the release of sites from regulatory control for unrestricted or restricted use, including the safety considerations for the introduction of a new practice on a released site.

The importance of establishing adequate funding mechanisms for decommissioning and management of decommissioning liabilities is being widely recognized. In 2006, the European Commission adopted a new recommendation that contains measures to ensure adequate and properly managed financial resources for nuclear decommissioning activities and the safe management of spent fuel and radioactive waste. Ukraine has established a decommissioning fund for the decommissioning of NPPs with WWER reactors. In addition, Croatia plans to establish a decommissioning fund for Krsko NPP and Canada has made a decision for a five-year financial commitment to begin cleanup of 'nuclear legacy liabilities' resulting from research and development activities dating back to the beginning of nuclear technologies and medicine in Canada.

The International Conference on Lessons Learned from the Decommissioning of Nuclear Facilities and the Safe Termination of Nuclear Activities was held from 11 to 15 December 2006 in Athens, Greece. It provided a forum for more than 300 experts from operating organizations, regulatory bodies, technical support organizations, and other interested specialists to exchange knowledge, experience and good practice in regulation, planning and implementation of decommissioning activities, waste management, decommissioning technologies, social and economic aspects, and decommissioning of small facilities. The outcomes of the Conference will be incorporated in the planned review and revision of the International Action Plan on Decommissioning of Nuclear Facilities.

The Agency is exploring the possibilities for improving the exchange of information and lessons learned from decommissioning in Member States through the establishment of international centres of excellence on decommissioning.

International support and technical assistance on decommissioning and cleanup of former nuclear sites in Iraq is being provided through a new Agency project that started in 2006. The project aims to reduce the overall radiological risk to the public and the environment through the decommissioning of the former Iraq nuclear complex and the remediation of contaminated areas and disposal sites. At least ten sites — each with from one to 40 facilities — have been identified where the current situation will need to be analysed and the need for implementation of remediation activities assessed.

In 2006, the Agency initiated an international Research Reactor Decommissioning Demonstration Project to assist Member States in adequate planning and implementation of the safe decommissioning of research reactors. The Project is supported through technical cooperation and the Asian Nuclear Safety Network and will provide operators and regulators with hands-on planning, implementation and

regulation of research reactor decommissioning activities. The Project will also facilitate the exchange of information and experience, education and training, and serve as a model for decommissioning projects in other Member States. The Philippines Government has offered the Philippine Research Reactor PRR-1 (TRIGA) reactor in Manila, which is shut down and for which the immediate dismantling strategy has been selected, to be used as a model for the Project. As part of the first phase, the project is assisting the regulatory body in developing its capability to review the necessary approach being proposed by the operator and ensure that international safety standards are being appropriately applied. Two technical meetings were held in Manila in 2006, focusing on legal and regulatory aspects and decommissioning planning.

During the second Review Meeting of the Joint Convention, it was noted that many Contracting Parties, especially those having NPPs, have established funding schemes for decommissioning. It was also noted that Contracting Parties' strategies vary from 'immediate' decommissioning (starting from zero to about ten years after final shutdown) to 'delayed' decommissioning after a long safe enclosure phase. Contracting Parties recognized that maintaining knowledge and memory of the installation was of crucial importance, especially in the case of delayed decommissioning.

The WENRA Working Group on Waste and Decommissioning is developing reference levels for decommissioning based on the relevant IAEA Safety Standards and regulatory experience from European countries. The aim is to reach agreement between the regulatory bodies on the reference levels presented currently in the draft report *Decommissioning Safety Reference Levels* and to ensure that these reference levels are incorporated in the respective regulatory systems before 2010.

P.3. Future challenges

With the increased consideration and planning of new nuclear facilities worldwide, there is a need for consolidation of lessons learned from the decommissioning of existing facilities and the development of recommendations for the improvement of the design of new facilities. International safety standards need to be updated to take into account the significant worldwide experience already accumulated in decommissioning activities.

Existing international mechanisms addressing decommissioning safety, such as the Joint Convention, need to be used more effectively to increase awareness of the need for early planning, adequate funding, governmental support and long-term management strategies for decommissioning.

Decommissioning of small facilities in Member States with limited resources will continue to challenge the international community.

Q. Remediating contaminated sites

Q.1. Trends and issues

Throughout Africa, Asia and Australia there are many legacy sites from previous uranium mining and processing activities. Whilst some of these are being remediated, the situation remains most critical in the Central Asian countries of the former Soviet Union. Here there are many abandoned mine sites, former processing facilities, and a number of locations with associated residues. These residues include mill tailings and waste rock as well as scrap metal dumps and abandoned infrastructure. All

these locations represent potential hazards to the safety of the population and the environment in radiological, chemical and physical terms.

A developing issue is legacy sites which are now being examined for their potential to be re-opened for the resumption of uranium production. In many cases, this is happening with little apparent planning for the remediation of the existing situation. The poorly developed regulatory infrastructure associated with many of these locations has the potential to result in an increase in the safety associated risks to unacceptable levels.

As a consequence of the recent increases in world market prices for uranium and the ongoing shortfall in uranium supply with respect to demand for power generation, a number of former uranium production sites are being studied with a view to re-starting production. These activities have been reported mainly from Africa, North and South America and Asia. The long period of low activity for the uranium production sector means that there is now a shortage of skills in all areas of the uranium mining and processing sector. This is affecting both producers and regulators. There will need to be a series of training and education activities put in place to help Member States address this issue. It is vital that all such re-started activities address the dual issues of working to current agreed international safety standards, as well as the remediation of former legacies at the same locations.

Q.2. International activities

The results of the Chernobyl Forum[22] were presented during various events held in connection with the 20th anniversary of the accident. These results are now the reference for environmental, health, social and economic consequences attributable to the accident for the last 20 years.

Under an Agency regional technical cooperation project, a series of workshops was held in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan with the objective of improving systems of surveillance and monitoring and planning methods in remediation of legacy uranium mining and processing sites. In addition to the workshops, the project supplied suitable equipment to enhance the surveillance and monitoring capabilities of the authorities in each of these Member States and a programme of scientific visits to remediated sites in Europe was organized and implemented. The project also involved liaison with other agencies carrying out associated projects in the region. There will be a follow up to this work in an extension of the original project as well as the development of a number of country-specific national projects amongst the participating Member States.

Q.3. Future challenges

The decommissioning of the destroyed Chernobyl Unit 4 and the safe management of radioactive waste in the Chernobyl exclusion zone, as well as its gradual remediation remains a significant challenge for the foreseeable future. Work was completed in 2006 to stabilize the Chernobyl shelter constructed 20 years ago. The construction of a new shelter structure should start in 2007.

The Central Asian regional project on management of uranium mining residues will be extended to further the development of some specific plans for remediation of tailings and other residue-affected sites. This will require an increased effort to develop appropriate regulatory institutions and infrastructure to oversee the implementation of the remediation strategies that will be needed. The

[22] The Forum participants were eight UN system organizations (IAEA, WHO, United Nations Development Programme (UNDP), FAO, United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), United Nations Environment Programme (UNEP), UNSCEAR and the World Bank) as well as the competent authorities of Belarus, Russian Federation and Ukraine.

liaison with other international, regional and national organizations working in the region on programmes with similar objectives will have to be further developed in order to optimize the limited resources being applied to the various technical assistance programmes.

As part of the increasing awareness worldwide of the importance of NORM in the radiation safety sphere, there is growing interest in the management of NORM residues. Particular attention is being paid to their use in other applications rather than a straightforward declaration that they are waste. There is a need to develop international guidance on the options available for the minimization of NORM waste, including alternative uses for NORM residues and recycling of scrap material. This work will need to deal with issues of transport and worker safety as well as environmental and public protection. Some guidance in these areas is already being developed.

Appendix 1

Safety related events and activities worldwide during 2006

A. Introduction

This report identifies those safety related events or issues during 2006 that were of particular importance, provided lessons that may be more generally applicable, had potential long-term consequences, or indicated emerging or changing trends. It is not intended to provide a comprehensive account of all safety related events or issues during 2006.

B. International instruments

B.1. Conventions

B.1.1. Convention on Nuclear Safety (CNS)

In 2006, Estonia, Kuwait and the Former Yugoslav Republic of Macedonia acceded to the CNS, which now has 59 Contracting Parties, including all Member States operating nuclear power plants.

The fourth Review Meeting of the Contracting Parties will be held in Vienna from 14 to 25 April 2008. The organizational meeting in preparation for this meeting will start in Vienna on 24 September 2007.

B.1.2. Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Early Notification and Assistance Conventions)

In 2006, Cameroon ratified and Euratom acceded to the Early Notification Convention, which had 99 parties at the end of 2006.

In 2006, Cameroon and Iceland ratified and Euratom acceded to the Assistance Convention, which had 97 parties at the end of 2006.

In 2006, no notification messages were submitted under the provisions of the Early Notification Convention. However, in relation to four events, advisory messages were exchanged under the *Emergency Notification and Assistance Technical Operations Manual* (ENATOM) arrangements. The ENATOM arrangements were originally designed to exchange notifications under the Convention, but are now used for a broader range of events.

In seven cases, the Agency was requested to provide assistance pursuant to the Assistance Convention. In one of these cases, the Agency deployed a fact-finding and assistance mission in cooperation with the State Party. In the other cases, the Agency facilitated multi-lateral or bi-lateral discussions.

In eight cases where events with radiological consequences were reported either officially or communicated through open sources, the Agency offered its good offices under the Assistance Convention.

B.1.3. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention)

The Joint Convention applies to spent fuel and radioactive waste resulting from civilian nuclear activities and to planned and controlled releases into the environment of liquid or gaseous radioactive materials from regulated nuclear facilities. In 2006, Brazil, Estonia, Italy, and the Russian Federation ratified the Joint Convention and China, Iceland, Kyrgyzstan, and South Africa acceded to the Joint Convention (for Kyrgyzstan, the Joint Convention will enter into force on 18 March 2007; for South Africa 13 February 2007). At the end of 2006, the Joint Convention had 42 parties. Considering that the vast majority of Member States have some requirements for radioactive waste management, it is hoped that more States adhere to the Joint Convention. The Agency continued to conduct seminars where Member States receive presentations regarding the benefits of adherence to the Joint Convention.

The Second Review Meeting of the Contracting Parties to the Joint Convention was held at the Agency's Headquarters from 15 to 24 May 2006. The President of the Review Meeting was Mr André-Claude Lacoste, France. All 41 Contracting Parties, including eight new Contracting Parties, with nearly 500 delegates, were in attendance and participated actively in the peer review. In addition, the Contracting Parties agreed to allow China to fully participate in the Review Meeting. China had not yet deposited its instrument of accession, but had requested to be invited as a full participant. The Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA) was present as an observer.

Areas for which the need for further work was identified at the First Review Meeting were addressed by the Contracting Parties and reflected in their National Reports and oral presentations during the Second Review Meeting.

Contracting Parties also demonstrated their commitment to improving policies and practices particularly in the areas of:

- National strategies for spent fuel and radioactive waste management;
- Engagement with stakeholders and the public;
- The control of disused sealed sources.

Challenges continue in a number of areas including the implementation of national policies for the long-term management of spent fuel, disposal of high level wastes, management of historic wastes, recovery of orphan sources, knowledge management and human resources. The need to ensure that Contracting Parties' financial commitments are consistent with the extent of liabilities was also recognized.

Many Contracting Parties see the benefit of enhancing international cooperation through the exchange of information, experiences and technology. In particular, needs for sharing knowledge and assistance were emphasized by Contracting Parties with limited radioactive waste management and research programmes.

Three topics were discussed by the open-ended working group established at the opening plenary session:

- Ways to increase membership;
- Improvements in the review process;
- Roles of safety standards in the review process.

Concerning the role of the IAEA Safety Standards, the Contracting Parties shared the view that they constituted a useful source of guidance, among others, to which a Contracting Party could refer, on a voluntary basis, in preparing its National Report.

The third review meeting will be held from 11 to 22 May 2009.

B.2. Codes of Conduct

B.2.1. Code of Conduct on the Safety of Research Reactors

In response to a recommendation from the 2005 open-ended meeting to discuss how best to assure effective application of the Code of Conduct on the Safety of Research Reactors, regional meetings were held in Morocco (Africa) and Romania (Eastern Europe) in December 2006 on the application of the Code. These meetings brought together senior experts from Member States having or planning research reactors so they would understand the background, content and legal status of the Code, and to discuss the status of research reactor safety and exchange of information.

B.2.2. Code of Conduct on the Safety and Security of Radioactive Sources

By the end of 2006, 88 States had expressed their political support and intent to work toward following the Code of Conduct on the Safety and Security of Radioactive Sources.

From 31 May to 2 June 2006, the Agency organized an open-ended meeting of technical and legal experts where consensus was reached on a formal mechanism for a voluntary, periodic exchange of information for all States to share experiences and lessons learned in implementing the Code and its supplementary Guidance on import and export. The recommended mechanism was endorsed by the Board of Governors in September 2006. This endorsement was noted by the General Conference taking into consideration concerns expressed by Member States on the legal and financial aspects. The voluntary nature of the information mechanism is consistent with the non-binding nature of the Code. The mechanism is primarily based on a single international meeting open to all States held every three years, subject to the availability of funding.

From 13 to 15 December 2006, a group of senior experts from Latin America met in Mexico City to share experiences in implementing the Code and discuss matters related to the harmonization of procedures for the supplementary Guidance on import and export. The Agency organized the meeting, which was hosted by the Government of Mexico through the National Commission of Nuclear Safety and Safeguards (CNSNS). Participants from Argentina, Brazil, Cuba, Mexico, Panama, Peru, Uruguay and Venezuela attended the meeting.

C. Cooperation between national regulatory bodies

There are a number of forums in which regulators can exchange information and experience with their counterparts in other countries. Some of these are regional, some deal with particular reactor types and

others are based on the size of the nuclear power programme. All of these forums meet regularly to exchange information of common interest and some are developing exchange mechanisms involving the Internet for more rapid means of communication. In 2006, the Agency organized an International Conference on Effective Nuclear Regulatory Systems, which is discussed in greater detail in section G.2. In addition, selected safety issues of wide interest to regulators are discussed at a meeting of senior regulators held in association with the Agency's General Conference each year.

C.1. International Nuclear Regulators Association (INRA)

INRA comprises the most senior officials of a number of well-established national nuclear regulatory organizations in Europe, America and Asia who wish to exchange perspectives on important issues with the purpose of influencing and enhancing nuclear safety and radiological protection from a regulatory perspective. INRA met twice in 2006 under French chairmanship.

In 2006, INRA members informed each other on recent developments regarding nuclear safety regulation and radiological protection in their countries and exchanged views on issues including, inter alia, waste management, follow up to the review meetings of the Convention on Nuclear Safety and the Joint Convention and harmonisation of regulatory requirements. INRA members discussed in depth the issue of safety and radiological protection and decided to improve interaction with the ICRP regarding the revision of the ICRP recommendations.

In 2006, Republic of Korea was welcomed as a member of the Association. INRA intends to continue to act as a leadership organisation in the field of nuclear safety and radiological protection.

C.2. G8-Nuclear Safety and Security Group (G8-NSSG)

Under the presidency of the Russian Federation, the G8-NSSG met three times in 2006. The Agency, European Commission, OECD/NEA and the European Bank for Reconstruction and Development also attend these meetings. The G8-NSSG discussions focussed on: the safety of the NPP in Armenia; the Chernobyl shelter including stabilization of the sarcophagus and construction of a new safe confinement; Chernobyl's dry storage facility for spent fuel and liquid radioactive waste treatment facility; implementation of the Code of Conduct on the Safety and Security of Radioactive Sources and the additional guidance on import/export control; and safety aspects of multinational approaches to the nuclear fuel cycle. The group provided input on safety and security issues to the G8 summit held in July 2006 in St. Petersburg, Russian Federation.

At the last meeting in November 2006, the main themes to be addressed during the 2007 German G8 presidency were introduced. Ratification of safety and security conventions, strengthening non-binding international instruments and the import/export control guidelines and a global network for nuclear safety are some of the themes proposed by Germany.

C.3. Western European Nuclear Regulators Association (WENRA)

WENRA was established in 1999 and currently includes the heads of nuclear regulatory authorities of 17 European countries with at least one nuclear power plant in construction, operation or decommissioning phase. One of its main objectives is to develop a harmonized approach to selected nuclear safety and radiation protection issues and their regulation, in particular within the European Union. In November 2006, the Czech Republic took over the chairmanship of WENRA for the next three years.

At present, WENRA is developing common reference safety levels in the fields of reactor safety, decommissioning safety, radioactive waste and spent fuel management facilities in order to benchmark

national practices by the year 2010. For this purpose, two working groups have been established: the Reactor Harmonization Working Group (RHWG) and the Working Group on Waste and Decommissioning (WGWD). Both groups have developed the safety reference levels and started to work towards their finalization by means of benchmarking (WGWD) and revision based on comments received from relevant stakeholders (RHWG).

C.4. The Ibero-American Forum of Nuclear and Radiological Regulators

The Forum met in June 2006 in Madrid, Spain, with the chief regulators from Argentina, Brazil, Cuba, Mexico, Spain and Uruguay attending. At that meeting, the Forum reviewed ongoing projects, including the implementation of the Ibero-American Radiation Safety Network. At the meeting, the Forum presidency was transferred from Spain to Mexico. The Forum also established an office in Argentina in charge of projects' preparation and evaluation.

The Agency continued to support the activities of the Forum in the frame of an extrabudgetary programme dedicated to nuclear and radiation safety. Ongoing projects include a probabilistic safety assessment applied to radiotherapy treatment with linear accelerators, methodology for self-assessment of the regulatory system for protection of patients against radiation exposure and harmonization of procedures for import/export of radioactive sources.

C.5. Cooperation Forum of State Nuclear Safety Authorities of Countries which operate WWER[23] Reactors

The Forum provides an opportunity for senior staff of regulatory bodies in countries operating WWER reactors to exchange information on various regulatory issues and share recent experiences. The 13th Annual Meeting of the Forum was held in June 2006 in Yerevan, Armenia and was attended by the Chairpersons and key experts of the regulatory authorities of Armenia, Bulgaria, Czech Republic, Finland, Hungary, India, Islamic Republic of Iran, Russian Federation, Slovakia and Ukraine. Observers from the German technical support organization (GRS), the French Institute for Radiological Protection and Nuclear Safety (IRSN) and the Agency also attended. Forum members presented their national reports on recent changes in nuclear legislation, exchanged information related to regulation of nuclear safety and atomic energy utilization, operational events of common interest and measures undertaken based on event investigation results. The forum also considered the activities of its working groups on regulatory use of probabilistic safety assessment, evaluation of operating experience of WWER regulators and digital instrumentation and control systems.

C.6. Network of Regulators of Countries with Small Nuclear Programmes (NERS)[24]

The current membership of NERS includes Argentina, Belgium, Czech Republic, Finland, Hungary, Netherlands, Pakistan, Slovakia, Slovenia, South Africa and Switzerland. The Ninth Annual Meeting of NERS was held in Bled, Slovenia from 7 to 9 June 2006 and the meeting agenda included the following items:

- Ageing and lifetime management;
- Regulatory control of radioactive waste management;
- Regulatory control of transport of radioactive materials;
- Regulatory control of radioactive sources.

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[23] water cooled, water moderated power reactor

[24] www.ners.info

The Netherlands will be the next chair of NERS with the next meeting scheduled for June 2007.

C.7. The senior regulators from countries which operate CANDU-type nuclear power plants

The annual meeting of senior regulators from countries which operate CANDU-Type NPPs (Argentina, Canada, China, India, Republic of Korea, Pakistan and Romania) was hosted by the Pakistan Nuclear Regulatory Authority in Karachi, Pakistan in November 2006. The meeting agenda included: generic safety issues; a standardized approach to probabilistic safety assessment; severe accident management guidelines and symptom based emergency operating procedures; regulatory experience with construction and commissioning; regulatory issues related to new pressurized heavy water reactor design; impact of safety R&D initiated by regulatory bodies; and reporting for the next review meeting of the Contracting Parties for the Convention on Nuclear Safety.

C.8. The International Nuclear Event Scale (INES)

More than 60 Member States are currently members of INES and use the INES to communicate the safety significance of events at the national level. Member States also used the INES to communicate on events that are rated at Level 2 or higher or that are of international media interest — through the Nuclear Event Web-based System (NEWS) — to the media, the public and to the international scientific community.

Since the publication of the INES Manual 2001 edition[25], the use of the INES has expanded. Two documents on clarification of the rating of fuel damage events and the additional guidance for rating events related to radioactive sources and to the transport of radioactive material were endorsed at the 2006 INES National Officers' Meeting. A revision to the INES Manual is in progress. At the request of the Netherlands, in 2006 the Agency conducted a training seminar on the INES methodology.

D. Activities of international bodies

Several international expert bodies issue authoritative findings and recommendations on safety related topics. The advice provided by these bodies is an important input to the development of the Agency's safety standards and other international standards and is frequently incorporated in national safety related laws and regulations. The recent activities of a number of these bodies are reviewed in this section.

D.1. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)

UNSCEAR, a United Nations committee that reports to an international body reporting to the United Nations General Assembly, includes the leading specialists in the field. UNSCEAR reviews epidemiological studies and results from fundamental radiobiological research to assess the health risks from radiation exposure. UNSCEAR's extremely detailed reports ― globally acknowledged as being authoritative ― are a synthesis of thousands of peer-reviewed references. These reports provide

[25] http://www-ns.iaea.org/downloads/ni/ines/INES-2001-E.pdf

the scientific basis for radiation protection schemes and basic standards formed by international and national organizations. In 2006, UNSCEAR celebrated the 50th anniversary of its first session.

At its 54th session, held in Vienna from 29 May to 2 June 2006, UNSCEAR summarized the main conclusions of five scientific annexes for inclusion in its report for 2006. The annexes are entitled *Epidemiological studies of radiation and cancer*, *Epidemiological evaluation of cardiovascular disease and other noncancer diseases following radiation exposure*, *Non-targeted and delayed effects of exposure to ionizing radiation*, *Effects of ionizing radiation on the immune system*, and *Sources-to-effects assessment for radon in homes and workplaces*. The overall view of UNSCEAR is that the data reviewed for its 2006 report do not necessitate changes in its current risk estimates for the cancer and the hereditary effects of radiation.

UNSCEAR also scrutinized draft documents on exposures of the public and workers to various sources of radiation, exposures from radiation accidents, exposures from medical uses of radiation and effects of ionizing radiation on non-human biota.

UNSCEAR was a participant in the Chernobyl Forum, and in 2006 the Committee expressed its intention to clarify further the assessment of potential harm owing to chronic low-level exposures among large populations and also the attributability of health effects. It also recognized that some outstanding details merited further scrutiny and that its work to provide the scientific basis for a better understanding of the radiation-related health and environmental effects of the Chernobyl accident needed to continue. Owing to its participation in the Chernobyl Forum, UNSCEAR should now extend the work on updating its own assessments of the health and environmental consequences of the Chernobyl accident in order to scrutinize information that had become available more recently. To do so effectively, UNSCEAR would need to increase the participation of scientists from Belarus, the Russian Federation and Ukraine. The work could not be conducted properly without additional resources.

D.2. International Commission on Radiological Protection (ICRP)

The ICRP is an independent group of experts that issues recommendations on the principles of radiation protection. ICRP Recommendations have provided the basis for national and international standards including the Agency's International Basic Safety Standards (BSS). Appointments to the ICRP and its Committees are made for periods of four years, and the current cycle began in July 2005. Five committees deal with radiation effects, doses from radiation exposure, protection in medicine, application of ICRP Recommendations, and protection of the environment.

The current version of the ICRP Recommendations was issued in 1990 and in June 2004, the ICRP issued a draft revision for public consultation. In 2006, the ICRP issued an updated draft and the second round of consultation was completed in September 2006. The ICRP is currently considering the comments received.

In 2006, the ICRP published Publication 99: *Low-dose Extrapolation of Radiation Related Cancer Risk*.

D.3. International Commission on Radiation Units and Measurements (ICRU)

The ICRU, a sister organization of the ICRP, provides internationally acceptable recommendations concerning concepts, quantities, units, and measurement procedures for users of ionizing radiation in medicine, basic science, industry, and radiation protection. The current ICRU programme is focused on four areas:

- Diagnostic radiology and nuclear medicine;
- Radiation therapy;
- Radiation protection;
- Radiation in science.

In 2006, the ICRU published reports on *Sampling of Radionuclides in the Environment* (report 75) and *Measurement Quality Assurance for Ionizing Radiation Dosimetry* (Report 76).

D.4. International Nuclear Safety Group (INSAG)

The INSAG is a group of experts with high professional competence in the field of safety working in regulatory organizations, research and academic institutions and the nuclear industry. It was chartered by the Director General to be an independent body to provide authoritative advice and guidance on nuclear safety approaches, policies and principles. In particular, INSAG will provide recommendations and opinions on current and emerging nuclear safety issues to the Agency, the nuclear community and the public.

INSAG met twice in 2006, including one meeting in the Republic of Korea and continued its discussion on the following areas:

- Global Nuclear Safety Regime: INSAG issued its report on Strengthening the Global Safety Regime (INSAG 21) in 2006.
- Operational Safety: There are opportunities for continuing improvement of operational safety at existing plants. In 2006, INSAG devoted considerable effort to examining operating experience feedback processes and methods.
- Stakeholder Involvement: Various stakeholders have a legitimate expectation that they will be informed of nuclear matters and their active involvement can enhance nuclear safety. In 2006, INSAG published its report on Stakeholder Involvement in Nuclear Issues (INSAG 20).
- Safety/Security Interface: The threat presented by terrorism has reinforced the importance of ensuring that the world's nuclear infrastructure has adequate security to withstand plausible threats. Safety and security are intimately connected with each other and care is needed to ensure that modifications to enhance security are made in a way that enhance, or at least do not degrade, safety margins.
- Infrastructure for Nuclear Safety: In some parts of the world, construction of NPPs has not been undertaken for many years. In addition, countries with no past experience with nuclear power have indicated an interest in adding NPPs to their generation capacity. In both cases, there is a need to ensure that countries have the infrastructure necessary to ensure that NPPs are designed, constructed, operated and maintained safely. The necessary infrastructure to start and maintain a successful nuclear programme includes legal and regulatory capability, educated staff, research skills, access to industrial capacities, and financial strength. There is also a need to ensure the availability of technical support and a reliable supply of equipment and services for the lifetime of the plant. INSAG intends to continue to examine this issue.

E. Activities of other international organizations

E.1. Institutions of the European Union

The final report by the Working Party on Nuclear Safety (WPNS) of the Council of the European Union (the Council) is close to publication. It will be an extensive experts' document on nuclear safety in the EU, which will also point to possible developments in the future. It is the result of two years of continuous efforts by the WPNS. Once issued, it will be available on the Council website[26]. In the European Commission (EC), two important documents were finalized in 2006 that have nuclear and radiation safety as one of their targets: Council Directive 2006/117/EURATOM on the supervision and control of shipments of radioactive waste and spent fuel and the recommendation on the efficient use of nuclear decommissioning funds.

In addition to legislative efforts, the European Commission carried out numerous radiation protection inspections in EU Member States and commissioned studies on regulations governing radioactive waste disposal in EU countries, the situation concerning uranium mine and mill tailings in an enlarged EU, an inventory of best practices in the decommissioning of nuclear installations, preparatory work for the definition, organisation and planning of a system devoted to the development of safety and industrial standards for nuclear installations in the EU, analysis of environmental, economic and social issues linked to the decommissioning of nuclear installations, and comparison among different decommissioning funding systems. All studies are in the final stages of preparation and will be available at the EC website[27].

E.2. Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA)

The Nuclear Energy Agency is a semi-autonomous body within the OECD maintaining and developing, through international cooperation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy. It operates mainly through a number of committees covering specific areas.

In 2006, the Committee on the Safety of Nuclear Installations (CSNI) and the Committee on Nuclear Regulatory Activities (CNRA) completed appraisal activities in accordance with the OECD/NEA Strategic Plan. A group of recognised senior experts on safety, research and regulation assessed the effectiveness of the committees' work and made recommendations to address future challenges. CSNI and CNRA have incorporated the recommendations into their operating plans. The OECD/NEA continues to act as the Technical Secretariat for Stage II of the Multinational Design Evaluation Programme[28] (MDEP). The CNRA also approved a report produced by a senior-level expert group on the *Regulatory Challenges in Using Nuclear Operating Experience*. The primary focus of this report is on how regulatory bodies can assure that operating experience is used effectively by operating organisations to promote the safety of NPPs. The eighth international workshop on regulatory

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[26] http://www.consilium.europa.eu/cms3_fo/showPage.asp?id=254&lang=EN&mode=g

[27] http://ec.europa.eu/energy/nuclear/index_en.html

[28] Formerly known as Multinational Design Approval Program (MDAP)

inspection practices took place in May 2006 in Canada and covered the following issues: how regulatory inspections can promote, or not promote, good safety culture; inspection of interactions between the licensee and its contractors; and future challenges for inspectors.

A peer review — conducted by an international review team of senior level experts established by the OECD/NEA — of the report by the Spanish Nuclear Safety Council on the lessons learnt from the Vandellós II event was published in 2006.

The Radioactive Waste Management Committee (RWMC) Long-term Safety Criteria Group reviewed the definitions used as a basis for setting long-term safety criteria, and in particular addressed the question of consistency, in a topical session at its annual meeting in March 2006. In 2006, the RWMC Regulators' Forum published a synopsis of the regulatory function for radioactive waste management that presents the national situations and covers the management of radioactive waste from all types of nuclear installation. In 2006, the Working Party on Decommissioning and Dismantling issued a status report on decommissioning funding that provides an overview of underlying principles, the implementation of funding schemes and the associated uncertainties. In 2006, the RWMC also prepared a report that examines the roles that storage plays, or might play, in radioactive waste management in OECD member countries, and draws conclusions on the roles of storage, especially for times beyond about 100 years. In the area of decommissioning, in 2006, the OECD/NEA published policy-level reports on releasing the sites of nuclear installations from regulatory control and on selecting the appropriate decommissioning strategies.

Two new studies from the Committee on Radiation Protection and Public Health (CRPPH) are being finalised documenting the Committee's views on the trends and issues that will be the most significant over the next 10 to 15 years. One study examined emerging risk management issues (social, political, regulatory, operational, etc.), while another examined emerging risk assessment issues (challenges to our scientific understanding of radiation-induced detriment). Also in 2006, the CRPPH organised workshops to discuss impact and usability of the proposed ICRP Recommendations in Prague, Tokyo and Washington. The OECD/NEA is also publishing a new study on radiological protection of the environment that provides a baseline survey and analysis of legislation in OECD/NEA member countries and internationally. The CRPPH has also finalised two reports on challenges to radiological protection policy, regulation and application that may emerge in the coming years. As 2006 marked the 20th anniversary of the Chernobyl accident, the OECD/NEA published a report *Stakeholders and Radiological Protection: Lessons from Chernobyl 20 Years After* on the lessons that the radiological protection community has learnt to help improve living conditions in the areas affected by the accident.

In May 2006, the OECD/NEA held an evaluation workshop that focused on the International Nuclear Emergency Exercises (INEX) exercise that was conducted in 2005 and early 2006 by 15 countries. Participants from 20 countries collectively analysed the outcomes of the exercise and identified key issues in consequence management.

E.3. World Association of Nuclear Operators (WANO)

Every organization in the world that operates a nuclear power plant is a member of WANO. This association is set up purely to help its members achieve the highest practicable levels of operational safety by giving them access to the wealth of operating experience from the world-wide nuclear community. WANO is non profit making and has no commercial ties. It is not a regulatory body and has no direct association with governments. WANO has no interests other than nuclear safety.

WANO conducted peer reviews at 38 NPPs during 2006, altogether 316 since the programme began in 1992. WANO's long-term goal is to conduct a WANO peer review of member NPPs such that each unit is reviewed at least once per six years, either as an individual unit or as part of a peer review that includes other units at an NPP. In addition, each NPP is encouraged to host an outside review at least every three years.[29]

WANO continues to emphasize technical support missions, which focus on providing assistance in selected areas, with more than 125 technical support missions undertaken during 2006.

A central operating experience team with representatives from all four WANO regional centres continues to develop operating experience products and information for members. This team produces Significant Event Reports, Significant Operating Experience Reports, and Hot Topics to keep members informed of important events and trends occurring in the industry. In addition, WANO maintains a 'Just in Time Training' database that gives plant staff access to relevant operating experience immediately prior to undertaking specific operations and maintenance activities.

WANO's workshop/seminar/training course programme has developed both in scope and in numbers. During the 2006, a WANO Plant Managers' Conference was held in London, United Kingdom. More than 120 plant managers attended this successful two-day conference, with the theme of operational decision making. In addition, each region conducted workshops and seminars on a variety of topics related to NPP operations.

F. Safety legislation and regulation

In June 2006, the French government adopted the Law on 'Transparency and Security in the Nuclear Field'. The Law transforms the former Nuclear Safety Authority into an independent administrative authority with a Commission of five commissioners. The Commission had its first meeting on 13 November 2006. The new Law sets up a renewed, comprehensive and solid legislative basis for nuclear safety. The new authority is charged with controlling civilian nuclear activities in France and informing the public in this field. In 2006, the French parliament also adopted the '2006 Programme Act on the sustainable Management of Radioactive Materials and Wastes'. This Act sets the regulatory framework of waste repositories and expands the missions of the French nuclear waste management agency. It also sets legal provisions for the funding of decommissioning and waste management.

The Russian Federation introduced a number of new regulations in 2006 including, inter alia, 'Near-Surface Final Disposal of Radioactive Waste: Safety Requirements', 'Rules for Arrangement and Safety Operation of Equipment and Pipelines for Nuclear Fuel Cycle Facilities' and 'Rules for Evaluation of Compliance for Equipment, Utility, Materials and Semi-Products to be supplied to Nuclear Facilities'. The Russian nuclear regulatory body also convened international seminars to collect experience for the development of its 'General Technical Regulations on Nuclear and Radiation Safety'.

The UK Nuclear Installations Inspectorate (NII) issued revised Safety Assessment Principles in 2006. NII inspectors use these Safety Assessment Principles to guide their regulatory decision making. The

[29] Outside reviews include WANO peer reviews, WANO follow-up peer reviews, OSART and national organizational reviews such as those conducted by the Institute of Nuclear Power Operators and the Japan Nuclear Technology Institute.

2006 version of the Safety Assessment Principles was, inter alia, benchmarked against the IAEA Safety Standards and expanded to address emergency arrangements, remediation and decommissioning. The Safety Assessment Principles apply to the assessment of safety cases for both existing and new nuclear facilities.

G. Safety significant conferences in 2006

G.1. Safety of Transport of Radioactive Material: A Seminar on Complex Technical Issues

A seminar on communication of the complex technical issues related to the safety of transport was held from 11 to 12 January 2006 in Vienna. The various presenters discussed all aspects of transport of radioactive material with special emphasis on complex technical issues. The participants had an open and constructive dialogue and gained a shared understanding of key transportation technical issues. Seminar participants concluded that both the Secretariat and the Member States had done an outstanding job in the development of the international transportation standard, the Agency's *Regulations for the Safe Transport of Radioactive Material*. The international adoption and implementation of this standard has resulted in an effective and safe programme for the transport of radioactive material worldwide. Participants agreed that the objectives of the seminar were met.

G.2. International Conference on Effective Nuclear Regulatory Systems

The conference was hosted by the Russian Federation in Moscow from 27 February to 3 March 2006, with 216 participants from 57 countries and six organizations, plus seven observers, in attendance. The conference was the first to bring together senior nuclear safety, radiation safety and nuclear security regulators from around the world to discuss how to improve regulatory effectiveness.

The conference made many recommendations[30] for governments, regulatory bodies and international organizations including, inter alia, that the Agency:

- Strengthen the IAEA Safety Standards in relation to leadership in regulatory bodies, regulatory management systems, resource evaluation and stakeholder engagement;
- Improve, in collaboration with the OECD/NEA, the system for fostering international cooperation in regulatory effectiveness and the sharing of good nuclear safety and security regulatory practices;
- Further develop the Integrated Regulatory Review Service (IRRS) process;
- Develop its programmes to assist Member States in human resource development by organizing training courses in radiation protection, waste safety, nuclear safety and security training courses at international, regional, sub-regional and national level;
- Consider how its activities and those of other international organizations can be coordinated to enable the most effective participation by regulators.

Conference participants also drew the following conclusions:

[30] http://www-pub.iaea.org/MTCD/Meetings/PDFplus/cn150/PresidentReport.doc

- Effective nuclear safety and security regulation is vital for the safe and secure use of nuclear energy and associated technologies and is an essential prerequisite for the achievement of global energy security and global sustainable development;
- Regulators work for the benefit of society and therefore play a vital role. To be effective, they must be independent and able to make regulatory decisions without pressure from those who are responsible for the promotion of the use of nuclear energy and associated technologies or those who are opposed to its use;
- Regulators must be competent and have adequate resources to deliver their mission. The safety and security of nuclear facilities and nuclear and radioactive materials requires effective coordination of safety and security regulation;
- Continued and improved international cooperation is important to develop comprehensive international standards for safety and guidance for security. The importance of wider participation and fuller implementation of international instruments such as conventions and codes of conduct was stressed;
- Head regulators should meet again within three years to review progress and identify new emerging regulatory challenges.

G.3. International Conference on Improving Nuclear Safety through Operational Experience Feedback

This conference was held in May 2006 and was organized by the OECD/NEA jointly with the Agency and WANO. The conference — hosted by the German research organisation GRS and the German utilities — was an opportunity to discuss how to improve the support that international organisations provide to member countries, and how incident reporting systems can be used more efficiently to extract the right lessons and to avoid recurring events. A number of specific proposals were agreed at the meeting.

G.4. International Conference on Management of Spent Fuel from Nuclear Power Reactors

This conference was organized by the Agency and held in Vienna from 19 to 22 June 2006. Compared to previous international conferences on spent fuel management, the scope of this conference was broader and included policy, safety and security aspects. Spent fuel is still differently regarded by Member States — as a resource by some and as a waste by others — and the strategies for its management vary, ranging from reprocessing to direct disposal. In all cases, a final disposition solution is needed and it is generally agreed that disposal deep in geological formations is the most appropriate solution.

In all countries, spent fuel or high level waste from reprocessing is currently being stored, usually above ground, awaiting the development of geological repositories. While these arrangements have proved satisfactory, it is generally agreed that they are interim and do not represent a final solution.

Recent fuel cycle initiatives by USA and Russia have similar overall goals of improving control over the increasing amounts of spent fuel, reducing proliferation and security risks, and assisting new countries to develop nuclear power. The initiatives rely on reprocessing and recycling, but with advanced technologies to reduce proliferation risks and minimize radioactive waste generation. The multilateral approaches also promise better assurances of security and proliferation resistance. It was proposed that the international agencies should continue to be involved and to evaluate these

approaches further and it was also suggested that the Agency could be a monitoring agency to oversee the safety and other aspects of any multilateral initiatives that may be implemented

The Joint Convention and the IAEA Safety Standards provide a framework for the international safety regime for spent fuel management. The transport of radioactive material, including spent fuel, provides a well-established example of this international safety regime through the near-universal application of the Agency's *Regulations for the Safe Transport of Radioactive Material*. It was noted that other IAEA Safety Standards in the area of spent fuel management are in the process of being updated and elaborated. Conference participants made a number of proposals on topics that warrant the development of new safety standards.

Presentations at the conference indicated that substantial benefits can be obtained from burn-up credit[31]. However, much of the assessment and development work is for pressurized water reactor and boiling water reactor fuels and there is a need to extend this work to other fuels.

Although most spent fuel storage systems were designed for short term application pending reprocessing or disposal, the unavailability of disposal facilities has resulted in extended operating periods for these storage systems in most countries. An important issue is how to establish the safety of these facilities on a longer term.

Conference participants noted a trend towards dry storage. While specialists expressed confidence in the technical development of storage facilities and containers, it was agreed that more research and development on fuel behaviour in dry storage is needed.

Looking to the future, the presentations at the conference show some clear tendencies which can provide a basis for more international cooperation:

- The need for geological repositories for radioactive waste;
- The development of advanced reprocessing;
- The burning of actinides in fast reactors;
- The necessity to increase the duration of interim storage;
- The unavoidable increase of transport of both spent fuel and radioactive waste.

G.5. International Conference on Lessons Learned from Decommissioning of Nuclear Facilities and the Safe Termination of Nuclear Activities

The International Conference on Lessons Learned from the Decommissioning of Nuclear Facilities and the Safe Termination of Nuclear Activities was held in Athens, Greece from 11 to 15 December 2006 and attended by about 300 experts from 50 Member States. More details of this conference are provided in document GOV/INF/2007/1.

H. Safety significant events in 2006

Through the various reporting mechanisms, the Agency was informed of 168 events involving or suspected of involving ionizing radiation. In all cases, the Agency took actions, such as authenticating

[31] Burn-up credit makes use of the change in the isotopic composition of fuel, and hence its reactivity, due to irradiation to allow denser storage of spent fuel

and verifying information, providing official information or assistance to the requesting party, or offering the Agency's good offices. Most of the events were found to have no safety significance and/or no radiological impact to people or the environment.

Twenty-five events involved 'dangerous' radioactive sources, whereas 23 events occurred at nuclear facilities. An event at an irradiation facility in Belgium (see paragraph 85 below) was rated at level 4 on the INES scale. In eight events associated with radiography activities, workers received — or were suspected of receiving — doses in excess of regulatory limits.

The Nuclear Events Web Based System (NEWS) is a joint project of the Agency, OECD/NEA and WANO that provides fast, flexible and authoritative information on the occurrence of nuclear events that are of interest to the international community. NEWS covers all significant events at NPPs, research reactors, nuclear fuel cycle facilities, as well as occurrences involving radiation sources and the transport of radioactive material. The general public can access information submitted during the previous six months through the Agency's website.[32]

The Incident Reporting System (IRS), operated jointly with the OECD/NEA, was set up in 1983 to exchange information on unusual events at NPPs and increase awareness of actual and potential safety problems. In 2006, the Web-based IRS was created to facilitate data input and report availability. As a consequence, the number of reports has increased and the dissemination delays have reduced. Activities within the IRS extend beyond the exchange of IRS reports. The Agency and the OECD/NEA have meetings and working groups of experts who meet regularly and discuss the safety relevance of events.

The exposure to Polonium-210 in the United Kingdom in 2006 and the related public contamination was an unprecedented event. The UK response to the incident brought together specialists from a wide range of fields in an integrated national effort. At the request of the UK authorities, the Agency facilitated the exchange of information between the UK Health Protection Agency and a number of countries where follow-up actions with individuals who might have been exposed to Polonium-210 contamination was recommended.

The 2006 joint Agency-OECD/NEA meeting of the IRS national coordinators discussed lessons learned from 39 recent events. Some of the participants also gave presentations on 'extreme natural phenomena' events which occurred. Although, in general, plants responded safely to these challenges, there are still some questions without reply: are importance and frequency increasing? Is there a need to look at existing safety design features to protect the plant against these phenomena? Is there a need to re-examine the design criteria for such systems? Are specific human factors aspects to be considered?

In addition, meeting participants discussed two events in detail:

- *Forsmark 1, Sweden (Boiling Water Reactor)*: (2006-07-25). This event involved a protection system in the 400kV switch yard which did not work as expected during the opening of a section disconnector. As a result, the magnitude of the electrical transient was higher than expected. If the line breakers had, as anticipated, opened earlier, the short circuit would have been disconnected in approximately 100 milliseconds, and the transient behaviour would have been 'normal'. The conclusion of the analysis led to an improved solution to the protection system which has been designed, tested and approved. The modifications involve changing over-voltage setpoint values in

[32] http://www-news.iaea.org/news/default.asp

the protection system of the AC-DC rectifiers and the DC-AC inverters and increasing the delay before tripping of the inverters. This setup will ensure that in the event of a very large voltage transient, the rectifier protection system will actuate, while the inverter will remain available to supply power to the 220VAC bus bar from the Uninterrupted Power Supply (UPS) battery. The new design criterion for the UPS is that it should withstand a voltage transient from 20% to 130% of design value assuming the fastest possible voltage increase. A positive conclusion from the analysis is the performance of the control room operators during the incident. Use of instructions and trained routines worked to minimize the consequences of the event.

- *Catawba, USA (Pressurized Water Reactor)*: (2006-05-23) This event had some similarities with the Forsmark event. An electrical fault in the Catawba switch yard caused several electrical circuit breakers to open, resulting in a loss of offsite electrical power to both reactors of Catawba NPP. Both units underwent automatic shutdowns from 100 percent power when their reactor protection systems reacted to the loss of offsite power as designed. The internal fault occurred on a current transformer associated with a power circuit breaker and the resulting current/voltage surge caused the failure of the second transformer.

The majority of the presented events can be classified in the following categories:

- Events related to repair and replacement;
- Events related to loss of off-site power;
- Events related to erosion-corrosion issues;
- Events related to blockage of control rods;
- Events related to human factors issues;
- Events related to loss of ultimate heat sink.

Other events of interest that were reported to the Agency include:

- *Texas A&M University, USA (Research Reactor)*: (2006-02-24) In January 2006, an employee received 758 mSv to the extremities and in February a further 375.4 mSV to the extremities. The employee was involved in neutron activation analysis work. A provisional INES rating of level 2 has been assigned to this event.
- *Fleurus, Belgium (Irradiation Sterilization Facility)*: (2006-03-11) The facility uses gamma radiation emitted from a sealed cobalt-60 source. When not in operation, the source is stored in a water pool. Safety locks prevent the system from taking the source out of the pool when the door of the irradiation cell is open. Upon entering the room where the cell is located, the employee observed that the gamma monitor was in high level alarm, with the door of the cell open and the cell empty. The employee reset the monitor and verified that the alarm did not reappear. The employee decided to close the door of the cell, which required entering the cell to verify that the cell was empty. The employee remained in the cell for about 20 seconds. Some time later, the employee experienced nausea and vomiting, but did not attribute this to work. Three weeks later, he experienced massive hair loss. Blood tests confirmed that the employee was exposed to high radiation dose. Following hospitalization in a French facility highly specializing in treatment of radiation exposure, the employee appears to have recovered from the event. Although the investigation is still underway, provisional results show that the source may have been slightly out of the water pool. This event has been assigned an INES level 4 rating.
- *Kozloduy 5, Bulgaria (Pressurized Water Reactor)*: (2006-03-01) Following the trip of one main circulation pump, the reactor automatic power reduction

system actuated and the reactor power reduced to 67%. Following the power reduction, control room personnel identified that three control rods did not move as required. Following procedures, reactor power was reduced to hot standby state and all control rod drives were tested, where it was identified that 22 out of 61 control rods did not move. The initial investigation concluded that the direct cause was sticking of the contact surfaces of the fixating electromagnets of the drive moving system. This event has been assigned a rating of INES level 2.

- *Thane, India (Industrial Radiography)*: (2006-05-22) An industrial gamma radiography exposure device containing about 0.5 TBq of iridium-192 was lost during transport by taxi. The device, along with radiography accessories, was being carried by a trainee radiographer to the worksite from the storage location. En-route, the radiographer changed taxis, but inadvertently forgot to shift the radiography device to the second taxi. Despite extensive search operations, the source was not located. No radiation injuries have been reported and it is presumed that the source continues to be inside the exposure device. The device has adequate shielding and locking mechanisms in place to prevent inadvertent removal of the radioactive source. This event was assigned a rating of INES level 2.
- *Belgium-Romania (International Transport)*: (2006-07-24) A type A package containing radioactive material was lost during its transport between Brussels and the consignee in Romania. The package contained a limited quantity of iodine-131 (a total of 222 GBq). The package has still not been found by the airline. This event has been assigned an INES level 2 rating.
- *France-Germany (International Transport)*: (2006-12-01) An excepted package of three flasks containing a limited quantity of carbon-14 (a total of 1308 MBq) was sent to the Sanofi Aventis research laboratory in Frankfurt, Germany. The consignee discovered that one of the flasks was not properly screwed and leaked in the plastic bag which contained it. Fortunately, the package was not contaminated. The leakage was not the only problem noticed; the transport document mentioned only one flask instead of three. In addition, due to its activity, the package should have been type A instead of excepted. This event has been assigned an INES level 1 rating.

I. Safety Networks

I.1. Asian Nuclear Safety Network (ANSN)

During 2006, the ANSN continued to develop with hubs in China, Japan and Republic of Korea and national centres in Indonesia, Malaysia, Philippines, Thailand and Vietnam. Australia, France, Germany, Japan, Republic of Korea and the USA provide in-kind and/or financial support.

The ANSN Steering Committee, chaired by Australia, met twice in 2006 to coordinate ongoing work and to prepare the strategic plan for 2007-2009.

In December 2006, the strategic plan and the 2007 activities were approved at the review meeting of the Extrabudgetary Programme on the Safety of Nuclear Installations in East Asia, Pacific and Far East Countries (EBP Asia).

There is a shared view among the countries participating in the ANSN that this network should be, in the future, a platform for addressing policy and technical safety issues for maintaining sustainable nuclear safety in the Asian Region.

Two new topical groups started to work in 2006 dealing respectively with emergency preparedness and response and radioactive waste management. A new topical group on safety management of research reactors was agreed and should be activated in 2007. The topical groups are expected to have more important roles, in particular for the management of EBP Asia activities, the selection of new knowledge to be posted in the ANSN, and the consolidation of existing knowledge.

It has also been decided to increase the use of ANSN for more effective and efficient EBP Asia management. A specific web page has been prepared on ANSN to share information related to EBP Asia, such as: requests from the Member States, Agency evaluations, results of the technical meetings and the 2007 work plan. The Steering Committee has its own web page for communication between its members.

To increase the ANSN outreach, the bi-weekly ANSN Newsletter is widely distributed worldwide. In 2006, promotional meetings (Caravans) were conducted in China and the Philippines to introduce the ANSN to those countries' scientific communities. The ANSN was also promoted at the Pacific Basin Nuclear Conference in Sydney in October 2006.

Efforts will also continue to link the ANSN to other relevant networks.

I.2. Ibero-American Nuclear and Radiation Safety Network

The development of the Ibero-American Nuclear and Radiation Safety Network version 1.0 was completed in 2006. The work was carried out by Colegio de Fisicos of Spain, under the Agency's Extrabudgetary Programme (EBP) of Nuclear and Radiation Safety in Ibero-America. The EBP Steering Committee — composed of representatives of Argentina, Brazil, Cuba, Mexico, Spain and the Agency — defined the users' requirements for the Network and tested the system operability. The Steering Committee met four times in 2006.

The Network contains technical knowledge of regulatory interest in areas such as radiological protection of patients, safety of radioactive sources, national and Agency safety standards, national legislation and education and training. The Network is populated with resources provided by participating countries. Resources are classified and uploaded according to an agreed taxonomy that allows efficient interrogation and retrieval by registered users.

The Network is currently hosted by the Colegio de Fisicos, which also functions as system administrator. At its last meeting in Vienna in September 2006, the Steering Committee discussed future steps to migrate the Network for hosting by one of the participating countries. A decision on this matter is to be taken by the Forum plenary in 2007.

Appendix 2

The Agency's safety standards: activities during 2006

A. Introduction

Article III.A.6 of the IAEA Statute authorizes the Agency "to establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property (including such standards for labour conditions), and to provide for the application of these standards to its own operation as well as to the operations making use of materials, services, equipment, facilities, and information made available by the Agency or at its request or under its control or supervision; and to provide for the application of these standards, at the request of the parties, to operations under any bilateral or multilateral arrangements, or, at the request of a State, to any of that State's activities in the field of atomic energy."

The categories in the Safety Standards Series are Safety Fundamentals, Safety Requirements and Safety Guides. The most important achievement was the approval by the Board of Governors, at its September 2006 meeting, of the Safety Fundamentals No. SF-1: *Fundamental Safety Principles*. It establishes a unified set of principles representing a common philosophy across all areas of application of the IAEA Safety Standards and supersedes the previously published three Safety Fundamentals No. 110, No. 111-F and No. 120 respectively on the safety of nuclear installations, on the safety of radioactive waste management and on radiation protection and the safety of radiation sources. This important document published in November 2006 was co-sponsored by Euratom, FAO, ILO, IMO, OECD/NEA, PAHO, UNEP and WHO.

In 2006, the Board of Governors also approved the publication of Safety Requirements No. GS-R-3: *The Management System for Facilities and Activities* and WS-R-5: *Decommissioning of Facilities Using Radioactive Material*.

The Agency conducted a review of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS). The review concluded that, while there was no major issue requiring urgent revision, there was a case to be made for the revision of the BSS in order to take account of the many improvements that have been suggested. The DPP for the revision was endorsed by the Safety Standards Committees and the Commission on Safety Standards (CSS). In 2006, the General Conference noted that the revision of the BSS is to be coordinated by a secretariat established by the Agency with the participation of the co-sponsors, and urged that secretariat to carefully consider and justify potential changes, taking into account their implications in national regulations.

Since the establishment of the CSS and the Committees in 1995, a total of 79 IAEA Safety Standards have been endorsed by the CSS for publication; of those, 76 (one Safety Fundamentals, 13 Safety Requirements and 62 safety guides) have been published; and 54 further standards (five requirements and 49 safety guides) are being drafted or revised. A list of IAEA Safety Standards, indicating their

status as of 31 December 2006, is included at the end of this Appendix, and up-to-date status reports can be found on the Agency's website[33]. The full text of published IAEA Safety Standards is also available on the website[34].

B. Commission on Safety Standards (CSS)

The CSS, chaired by Mr. A.-C. Lacoste, Chairman of the Nuclear Safety Authority in France, met twice during 2006, in June and in November.

Of utmost importance in the year 2006 was the endorsement and the publication of the unified Safety Fundamentals *Fundamental Safety Principles*. As a result, the CSS particularly focussed its activities in 2006 on addressing the implications of the publication of the Safety Fundamentals on the whole Safety Standards series.

At its June meeting, the CSS discussed a report on the implementation of the Action Plan for the Development and Application of IAEA Safety Standards, the feedback of experience in the use of safety standards and new challenges in relation to the safety standards. The CSS acknowledged that the implementation of the action plan has improved the quality of the safety standards and their utilization by Member States. The report also included proposals for meeting these challenges and steps to be taken, including consideration of the overall structure by the Secretariat in consultation with the Safety Standards Committees.

The CSS welcomed the increasing use of the IAEA Safety Standards by Member States. The strategic interest of achieving better international recognition and use of the IAEA Safety Standards as a reference calls for greater stability. The CSS therefore supported the proposals from the Secretariat and, in a statement issued at its June meeting, requested the Secretariat to elaborate on them further and to propose at the November CSS meeting a policy paper together with a revised overall structure for the safety standards, which should: propose a vision on what the entire series would comprise in the future (the concept of a 'closed set' of safety standards); establish a logical relationship between the unified Safety Fundamentals and the various Safety Requirements, as well as logical relationships between the Safety Requirements and the subsequent Safety Guides; and, maintain a manageable number of publications and take into account the need for efficiency and timeliness for the future development of the Series.

At its November 2006 meeting, the CSS discussed a new report from the Secretariat on 'Beyond the Action Plan for the Development and Application of the IAEA Safety Standards: Overall Structure of Safety Standards' and generally agreed that the report provides a good basis for further work. A subgroup of the CSS, with participation of the chairs of the Safety Standards Committees and the Secretariat, was established to: identify the set of necessary Safety Requirements, including consideration of the harmonization and integration of all thematic requirements; propose a unified format for the drafting of Safety Requirements and consider development of a better distinction between what is a requirement and what is considered as guidance; and develop criteria for managing

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[33] http://www-ns.iaea.org/downloads/standards/status.pdf

[34] http://www-ns.iaea.org/standards/

the transition period with a clear plan of action for minimizing the burden on the Member States and the committees for review of draft standards.

In addition to the endorsement of the Fundamental Safety Principles, the CSS endorsed in 2006 the submission of the Safety Requirements *Decommissioning of Facilities using Radioactive Material* to the Board of Governors for approval and of the following Safety Guides for publication: *Remediation Process for Past Activities and Accidents*; *Commissioning of Research Reactors*; *Maintenance, Periodic Testing and Inspection of Research Reactors*; and, *Radiation Protection Programmes for Transport of Radioactive Material*.

The CSS also approved document preparation profiles (DPPs) for nine Safety Guides in 2006.

C. Nuclear Safety Standards Committee (NUSSC)

NUSSC, chaired by Mr. Lasse Reiman of the Radiation and Nuclear Safety Authority (STUK) of Finland, met twice during 2006.

In 2006, three Safety Guides were published: NS-G-2.11: A System for the Feedback of Experience from Events in Nuclear Installations, NS-G-4.1: Commissioning of Research Reactors and NS-G-4.2: Maintenance, Periodic Testing and Inspection of Research Reactors.

At its meetings in March and September 2006, NUSSC approved three draft IAEA Safety Standards for submission to the CSS, namely the unified *Safety Fundamentals, the Safety Requirement on Decommissioning of Facilities using Radioactive Material*, and the *Safety Requirement on Safety of Fuel Cycle Facilities.*

In addition NUSSC reviewed and commented on six draft Safety Standards dealing with various nuclear safety issues, such as ageing, decommissioning, safety assessment and management systems.

In 2006, NUSSC approved DPPs for nine new safety standards.

NUSSC also reviewed a report from the Secretariat on 'Beyond the Action Plan for the Development and Application of IAEA Safety Standards: Overall Structure of Safety Standards' at its September meeting. NUSSC discussed the proposal for a new structure and considered it to be a good starting point. However, some concerns were raised and NUSSC intends to consider the topic further and review a detailed transition plan at its next meeting. NUSSC performed a preliminary review and provided comments on all safety standards included in the 'closed set' of standards proposed by the Secretariat.

NUSSC also decided to have joint meetings with RASSC and WASSC in order to enhance synergism and to avoid duplication of work on the growing number of joint safety standards.

D. Radiation Safety Standards Committee (RASSC)

RASSC, chaired by Mr. Sigurdur Magnussson of the Icelandic Radiation Protection Institute, met in April and October in 2006. Both meetings included a joint session with WASSC to discuss issues of common interest.

In 2006, one Safety Guide was published: RS-G-1.10: Safety of Radiation Generators and Sealed Radioactive Sources.

In 2006, RASSC approved the Safety Fundamentals: *Fundamental Safety Principles*, the Safety Requirements on Fuel Cycle Facilities, a Safety Guide on Application of the Management System for Technical Services in Radiation Safety, a Safety Guide on Implementation of the Remediation Process for Past Activities and Practices; and a Safety Guide on Radiation Protection Programmes for the Transport of Radioactive Material.

RASSC also reviewed the report from the Secretariat on 'Beyond the Action Plan for the Development and Application of IAEA Safety Standards: Overall structure of Safety Standards'. RASSC members concluded that further work needs to be carried out to finalise the structure. It recommended that a working group made up of representatives of all Committees be set up to assist the Secretariat in developing further the overall structure of safety standards

RASSC received reports from the Secretariat on the review and revision of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (the BSS). At its October meeting, RASSC endorsed a proposal from Secretariat to revise the BSS. It is expected that the revision of the BSS will be completed by late 2009.

In 2006, RASSC approved DPPs for five new Safety Guides.

E. Transport Safety Standards Committee (TRANSSC)

TRANSSC, chaired by Mr. Jarlath Duffy of the Radiological Protection Institute of Ireland, met in March and September in 2006.

In 2006, TRANSSC approved three draft IAEA Safety Standards for submission to the CSS, namely the unified *Safety Fundamentals*, the Safety Guide on *Radiation Protection Programmes for Transport of Radioactive Waste*, and the Safety Guide on *Management Systems for the Safe Transport of Radioactive Material*.

TRANSCC also approved DPPs for three new safety standards in 2006.

TRANSSC reviewed the report 'Beyond the Action Plan for the Development and Application of IAEA Safety Standards: Overall Structure of Safety Standards' at its September 2006 meeting.

In 2005, the Board of Governors approved the new policy for reviewing and revising the Agency's *Regulations for the Safe Transport of Radioactive Material* (Transport Regulations). In 2006,

TRANSSC developed and approved criteria to determine if proposals for changes are sufficiently important to recommend the publication of a new edition of Transport Regulations. Six principles were identified to be used in evaluating proposed changes stemming from the review:

- Optimization;
- Efficiency, practicality, regulatory stability;
- Compliance with dose limits;
- Socio-economic considerations;
- Harmonization with regulations from other international organizations;
- Clarification.

Applying these criteria, TRANSSC determined that the proposed amendments were not sufficiently important for safety to warrant immediate publication of a revision of the Transport Regulations. Thus there would be no 2007 edition of the Transport Regulations. The proposals for change which were accepted will be considered for inclusion in the next revision.

F. Waste Safety Standards Committee (WASSC)

WASSC, chaired by Mr. Thiagan Pather, of the National Nuclear Regulator of South Africa, met in April and October in 2006. Both meetings included a joint session with RASSC to discuss issues of common interest.

In 2006, two Safety Requirements and two Safety Guides were published: WS-R-4: *Geological Disposal of Radioactive Waste*; WS-R-5: *Decommissioning of Facilities Using Radioactive Material*; WS-G-5.1: *Release of Sites from Regulatory Control on Termination of Practices*, and WS-G-6.1: *Storage of Radioactive Waste*.

At its meeting in April, WASSC approved the *Fundamental Safety Principles* and the Safety Guide on *Remediation Process for Past Activities and Accidents* for submission to the CSS.

In 2006, WASSC approved two Safety Requirements and three Safety Guides for submission to Member States for comments.

At its meeting in April, WASSC approved proposals for four new Safety Guides.

In 2006, WASSC also discussed extensively SF-1: Safety Fundamentals: *Fundamental Safety Principles*, and the review and revision of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (the BSS).

WASSC also reviewed a report from the Secretariat on 'Beyond the Action Plan for the Development and Application of IAEA Safety Standards: Overall Structure of Safety Standards' at its October meeting. WASSC considered that one meeting was not enough to approve the new structure. WASSC agreed to discuss the issue again at the meeting in April 2007.

The IAEA Safety Standards as of 31 December 2006

Safety Fundamentals

SF-1	Fundamental Safety Principles (2006) **Co-sponsorship:** Euratom, FAO, ILO, IMO, OECD/NEA, PAHO, UNEP, WHO

Thematic Safety Standards

Legal and Governmental Infrastructure

GS-R-1	Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety (2000)
GS-G-1.1	Organization and Staffing of the Regulatory Body for Nuclear Facilities (2002)
GS-G-1.2	Review and Assessment of Nuclear Facilities by the Regulatory Body (2002)
GS-G-1.3	Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body (2002)
GS-G-1.4	Documentation for Use in Regulating Nuclear Facilities (2002)
GS-G-1.5	Regulatory Control of Radiation Sources (2004) **Co-sponsorship:** FAO, ILO, PAHO, WHO

Emergency Preparedness and Response

GS-R-2	Preparedness and Response for a Nuclear or Radiological Emergency (2002) **Co-sponsorship:** FAO, OCHA, OECD/NEA, ILO, PAHO, WHO
50-SG-G6	Preparedness of Public Authorities for Emergencies at Nuclear Power Plants (1982) (under revision)
50-SG-O6	Preparedness of the Operating Organization (Licensee) for Emergencies at NPPs (1982) (under revision)
98	On-Site Habitability in the Event of an Accident at a Nuclear Facility (1989) (under revision)
109	Intervention Criteria in a Nuclear or Radiation Emergency (1994) (under revision)

Two Safety Guides on: preparedness for emergencies (combining G6, O6 and 98); and criteria for use in planning response to emergencies (replacing 109) are being developed.

Management System

GS-R-3	The Management System for Facilities and Activities (2006)
GS-G-3.1	Application of the Management System for Facilities and Activities (2006)

Safety Guides (2001)

Q8	Quality Assurance in Research and Development (under revision)
Q9	Quality Assurance in Siting (under revision)

Q10	Quality Assurance in Design (under revision)
Q11	Quality Assurance in Construction (under revision)
Q12	Quality Assurance in Commissioning (under revision)
Q13	Quality Assurance in Operation (under revision)
Q14	Quality Assurance in Decommissioning (under revision)

Six Safety Guides on management system (for regulatory bodies, technical services in radiation safety, radiation safety for users, waste disposal, treatment of waste and nuclear facilities) are being developed.

Assessment and Verification

GS-G-4.1	Format and Content of the Safety Analysis report for NPPs (2004)

A Safety Requirement on safety assessment and verification and a Safety Guide on risk informed decision making are being developed.

Site Evaluation

NS-R-3	Site Evaluation for Nuclear Installations (2003)
NS-G-3.1	External Human Induced Events in Site Evaluation for Nuclear Power Plants (2002)
NS-G-3.2	Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants (2002)
NS-G-3.3	Evaluation of Seismic Hazard for Nuclear Power Plants (2003)
NS-G-3.4	Meteorological Events in Site Evaluation for Nuclear Power Plants (2003)
NS-G-3.5	Flood hazard for Nuclear Power Plants on Coastal and River Sites (2004)
NS-G-3.6	Geotechnical Aspects of NPP Site Evaluation and Foundations (2005)

Radiation Protection

115	International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (1996) **Co-sponsorship:** FAO, ILO, OECD/NEA, PAHO, WHO (under revision)
RS-G-1.1	Occupational Radiation Protection (1999) **Co-sponsorship:** ILO
RS-G-1.2	Assessment of Occupational Exposure due to Intakes of Radionuclides (1999) **Co-sponsorship:** ILO
RS-G-1.3	Assessment of Occupational Exposure due to External Sources of Radiation (1999) **Co-sponsorship:** ILO
RS-G-1.4	Building Competence in Radiation Protection and the Safe Use of Radiation Sources (2001) **Co-sponsorship:** ILO, PAHO, WHO
RS-G-1.5	Radiological Protection for Medical Exposure to Ionizing Radiation (2002) **Co-sponsorship:** PAHO, WHO
RS-G-1.7	Application of the Concepts of Exclusion, Exemption and Clearance (2004)
RS-G-1.8	Environmental and Source Monitoring for Purposes of Radiation Protection (2005)
RS-G-1.9	Categorization of Radioactive Sources (2005)
RS-G-1.10	Safety of Radiation Generators and Sealed Radioactive Sources (2006) **Co-sponsorship**: ILO, PAHO, WHO

Two Safety Guides on protection of the public against exposure to ionizing radiation from natural sources and on justification of practices are being developed.

Radioactive Waste Management

WS-R-2	Predisposal Management of Radioactive Waste, including Decommissioning (2000) (under revision)
111-G-1.1	Classification of Radioactive Waste (1994) (under revision)
WS-G-2.3	Regulatory Control of Radioactive Discharges to the Environment (2000)
WS-G-2.5	Predisposal Management of Low and Intermediate Level Radioactive Waste (2003)
WS-G-2.6	Predisposal Management of High Level Radioactive Waste (2003)
WS-G-2.7	Management of Waste from the Use of Radioactive Materials in Medicine, Industry and Research (2005)
WS-G-6.1	Storage of Radioactive Waste (2006)
WS-G-1.2	Management of Radioactive Waste from Mining and Milling of Ores (2002)

One Safety Requirements on management of radioactive waste and three Safety Guides on safety assessment, management of waste containing naturally occurring radioactive material and on classification of radioactive waste are being developed.

Decommissioning

WS-R-5	Decommissioning of Facilities Using Radioactive Material (2006)
WS-G-2.1	Decommissioning of Nuclear Power Plants and Research Reactors (1999)
WS-G-2.2	Decommissioning of Medical, Industrial and Research Facilities (1999)
WS-G-2.4	Decommissioning of Nuclear Fuel Cycle Facilities (2001)
WS-G-5.1	Release of Sites from Regulatory Control on Termination of Practices (2006)

One Safety Guide on safety assessment for decommissioning of nuclear facilities is being developed.

Rehabilitation

WS-R-3	Remediation of Areas Contaminated by Past Activities and Accidents (2003)

One Safety Guide on implementation of remediation process for areas affected by past activities and accidents is being developed.

Transport Safety

TS-R-1	Regulations for the Safe Transport of Radioactive Material 2005 Edition (2005)
TS-G-1.1	Advisory Material for the Regulations for the Safe Transport of Radioactive Material (2002) (under revision)
TS-G-1.2	Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material (2002)

Five Safety Guides on advisory material for the regulations, management systems for the safe transport of radioactive material, compliance assurance, schedule of provisions and management system are being developed.

Facility Specific Safety Standards

Design of Nuclear Power Plants (NPPs)

NS-R-1	Safety of NPPs: Design (2000)
NS-G-1.1	Software for Computer Based Systems Important to Safety in NPPs (2000)
NS-G-1.2	Safety Assessment and Verification for NPPs (2002)
NS-G-1.3	Instrumentation and Control Systems Important to Safety in NPPs (2002)
NS-G-1.4	Design of Fuel Handling and Storage Systems in NPPs (2003)
NS-G-1.5	External Events Excluding Earthquakes in the Design of NPPs (2004)
NS-G-1.6	Seismic Design and Qualification for NPPs (2003)
NS-G-1.7	Protection Against Internal Fires and Explosions in the Design of NPPs (2004)
NS-G-1.8	Design of Emergency Power Systems for NPPs (2004)
NS-G-1.9	Design of the Reactor Coolant System and Associated Systems in NPPs (2004)
NS-G-1.10	Design of the Reactor Containment Systems for NPPs (2004)
NS-G-1.11	Protection Against Internal Hazards Other than Fire and Explosions (2004)
NS-G-1.12	Design of the Reactor Core for NPPs (2005)
NS-G-1.13	Radiation Protection Aspects of Design for Nuclear Power Plants (2005)
79	Design of Radioactive Waste Management Systems at NPPs (1986)

Four Safety Guides on safety classification of structures, systems and components, on development and application of level and level 2 PSA and on verification and validation of computational tools for accident analysis are being developed.

Operation of NPPs

NS-R-2	Safety of NPPs: Operation (2000)
NS-G-2.1	Fire Safety in Operation of NPPs (2000)
NS-G-2.2	Operational limits and conditions and operating procedures for NPPs (2000)
NS-G-2.3	Modifications to NPPs (2001)
NS-G-2.4	The Operating Organization for NPPs (2002)
NS-G-2.5	Core Management and Fuel Handling for NPPs (2002)
NS-G-2.6	Maintenance, Surveillance and In-Service Inspection in NPPs (2002)
NS-G-2.7	Radiation Protection and Radioactive Waste Management in the Operation of NPP (2002)
NS-G-2.8	Recruitment, Qualification and Training of Personnel for NPPs (2003)
NS-G-2.9	Commissioning of NPPs (2003)
NS-G-2.10	Periodic Safety Review of NPPs (2003)
NS-G-2.11	A System for the Feedback of Experience from Events in Nuclear Installations (2006)

Four Safety Guides on conduct of operations, ageing management, seismic evaluation of existing nuclear power plants and on severe accident management are being developed.

Research Reactors

NS-R-4	Safety of Research Reactors (2005)
NS-G-4.1	Commissioning of Research Reactors (2006)
NS-G-4.2	Maintenance, Periodic Testing and Inspection of Research Reactors (2006)
35-G1	Safety Assessment of Research Reactors and Preparation of the Safety Analysis Report (1994) (under revision)

35-G2	Safety in the Utilization and Modification of Research Reactors (1994) (under revision)

Seven Safety Guides on: operational limits and conditions; operating organization, recruitment, training and qualification; radiation protection and waste management; core management and use of graded approach are being developed.

Fuel Cycle Facilities

116	Design of Spent Fuel Storage Facilities (1995) (under revision)
117	Operation of Spent Fuel Storage Facilities (1995) (under revision)

One Safety Requirements on safety of fuel cycle facilities, and six Safety Guides on: safety of uranium fuel fabrication; MOX fuel fabrication; conversion facilities; reprocessing facilities; fuel cycle R&D and storage of spent fuel are being developed.

Radiation Related Facilities

107	Radiation Safety of Gamma and Electron Irradiation Facilities (1992) (under revision)
RS-G-1.6	Occupational Radiation Protection in the Mining and Processing of Raw Materials (2004)

Three Safety Guides on medical uses, on industrial radiography and on gamma, electron and X ray irradiation facilities

Waste Treatment and Disposal Facilities

WS-R-1	Near Surface Disposal of Radioactive Waste (1999) (under revision)
WS-R-4	Geological Disposal of Radioactive Waste (2006)
WS-G-1.1	Safety Assessment for Near Surface Disposal of Radioactive Waste (1999) (under revision)
111-G-3.1	Siting of Near Surface Disposal Facilities (1994) (under revision)
111-G-4.1	Siting of Geological Disposal Facilities (1994) (under revision)

One Safety Requirement on radioactive waste disposal and four Safety Guides on: geological disposal of radioactive waste; borehole disposal of radioactive waste; near surface disposal of radioactive waste; and monitoring and surveillance of disposal facilities are being developed.