Nuclear Safety Review for the Year 2004

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Nuclear Safety Review for the Year 2004

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Foreword

The *Nuclear Safety Review for the Year 2004* presents an overview of worldwide trends and issues in nuclear, radiation, transport and radioactive waste safety and emergency preparedness, highlighting developments in 2004.

This overview is supported by more detailed Annexes: *Safety Related Events and Activities Worldwide during 2004* (Annex I), *The Agency's Safety Standards: Activities during 2004* (Annex II) and *Providing for the Application of the Safety Standards: Activities during 2004* (Annex III). This report discusses security as it relates to safety. A separate annual report will cover nuclear security.

A *Draft Nuclear Safety Review for the Year 2004* was submitted to the March 2005 session of the Board of Governors in document GOV/2005/3. The final version of the *Nuclear Safety Review for the Year 2004* was prepared in the light of the discussion of the Board.

Executive Summary

In the nuclear area, challenges continue to emerge from the globalization of issues related to safety, technology, business, information, communication and security. Scientific advances and operational experience in nuclear, radiation, waste and transport technology are providing new opportunities to continuously improve safety and security by utilizing synergies between safety and security.

The prime responsibility for nuclear, radiation, waste and transport safety rests with users and national governments. The Agency continues to support a Global Nuclear Safety Regime based on strong national safety infrastructures and widespread subscription to international legal instruments to maintain high levels of safety worldwide. Central to the Agency's role are the establishment of international safety standards and the provision for applying these standards, as well as the promotion of sharing information through managing the knowledge base.

Nuclear power plant operational safety performance remains high throughout the world. Challenges facing the nuclear power industry include avoiding complacency, maintaining the necessary infrastructure, nuclear power plant ageing and long-term operation, as well as new reactor designs and construction. The research reactor community has a long history of safe operation. However nearly two-thirds of the world's operating research reactors are now over 30 years old and face safety and security challenges. In 2004, the Board of Governors approved the Code of Conduct on the Safety of Research Reactors to help address these challenges.

In 2004, there was international consensus on radionuclide activity concentrations in materials below which regulatory controls need not apply. Key occupational radiation protection performance indicators continued to improve in 2004. Challenges include new medical practices where workers can receive high exposures, industrial radiography and worker exposure to naturally occurring radioactive material. New medical techniques using radiation continue to pose patient safety challenges.

By the end of 2004, 69 countries had made a political commitment to work towards following the guidance contained in the Code of Conduct on the Safety and Security of Radioactive Sources. International initiatives by the Agency and others are also strengthening the control over radioactive sources, and in 2004 guidance was developed regarding the import and export of radioactive sources. The safety record for the transport of radioactive material continues to be excellent. Even with this record, there are continual challenges to limit the volume of radioactive material transport activities. The lessons from these challenges are being identified, analysed and shared so that the transport of radioactive material essential for medical and industrial applications will continue.

A number of countries continue to develop geological disposal facilities for spent fuel and high level radioactive waste and many countries operate near surface disposal facilities for low and intermediate level radioactive waste. With the delays in the development of permanent disposal facilities, increasing attention is being given to the safety of storage facilities. The lack of appropriate funding mechanisms for nuclear installation decommissioning remains a concern.

Although most countries operating nuclear installations have adequate emergency preparedness and response systems in place, others — particularly those without nuclear installations — still lack a basic level of radiological emergency preparedness.

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Analytical Overview

A. Introduction

During 2004, in the nuclear area, challenges continue to emerge from the globalization of issues related to safety, technology, business, information, communication and security. Safety considerations continue to have significant impact on the expanding peaceful uses of nuclear technology, including energy, medical and industrial applications, and the transport of nuclear and radioactive materials. Over the past several years, the nuclear power industry has had an excellent safety record. Today, in addition to sustaining this record and avoiding complacency, there are plans for new construction and extending the life of many existing facilities that will challenge designers, operators and regulators. Scientific advances in nuclear installation, radiation, waste management, transport and decommissioning safety are also providing new opportunities for improvement.

B. National safety infrastructures and nuclear regulatory systems

A strong and effective national safety infrastructure requires that — as an overriding priority — users, nuclear regulatory authorities, designers, service providers, research institutes and technical support organizations give safety issues the attention warranted by their significance. It is also essential that the nuclear workforce remains well educated and trained, particularly in view of the ageing of the current generation and the competition for staff that exists in the high technology sector. Universities and training centres are therefore essential components of any adequate safety infrastructure. The prime responsibility for safety rests with the users of the technology and national governments.

More countries now have the legal infrastructure needed to support independent and effective regulatory authorities. However, challenges continue to exist in some countries where improvement in promulgating new laws and in the independence and effectiveness of regulatory authorities is needed. Key challenges facing regulatory authorities include establishing the necessary policies and approaches to deal with ageing and long-term nuclear power plant (NPP) operation, new NPP construction, nuclear installation decommissioning and the storage and disposal of waste generated by it, various radiation protection issues and effective control over radioactive sources. More than 30 per cent of Member States receiving Agency assistance still need support to establish effective and sustainable radiation and waste safety infrastructures.

Maintaining and enhancing regulatory authority effectiveness and competence under financial and human resource constraints are challenges in many countries. Even so, regulatory authorities continue to improve their effectiveness and efficiency. Most now include self-assessment as part of their quality management system. Agency peer reviews and appraisals also provide an opportunity to stimulate improvement processes in line with the global application of the IAEA Safety Standards. The feedback from Member States regarding these Agency activities confirms that the most appropriate approach is to continue promoting national self-assessments and to develop international peer-review of these self-assessments.

While nuclear regulation is a national responsibility, nuclear regulatory authorities worldwide recognize that nuclear safety and security are global and transboundary issues. The international effort associated with the Agency's technical cooperation Model Projects on Upgrading Radiation Protection Infrastructure — with some 90 participating Member States — has played a major role in promoting conformance with international safety standards in general and the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (International BSS) in particular. By June 2004 more than 80% of participating countries had promulgated, or were close to promulgating, legislation conforming to the International BSS; 78% had adopted regulations covering the most hazardous practices and conforming to principal International BSS requirements; and 66% had established an independent and empowered regulatory authority.

Following past practice, the 2004 Senior Regulators Meeting was held in Vienna in conjunction with the Agency General Conference. Senior regulators from almost 50 Member States received technical briefings from the Chairmen of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the International Commission on Radiological Protection (ICRP) and discussed the application of the Code of Conduct on the Safety of Research Reactors and synergies between regulatory and security organizations.

B.1. Education and training

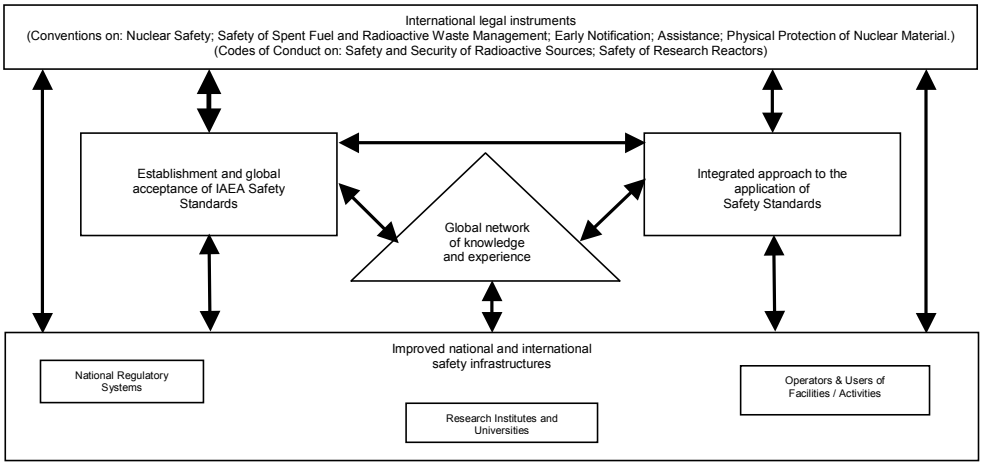
Sustainable education and training programmes, with quality training material and knowledgeable instructors, are key to using nuclear energy safely. Through networking, training centres can share experience and training material. The Intercentre Network for radiation and waste safety and the Asian Nuclear Safety Network are both pursuing the development of training centre networks.

The Agency continues to assign high priority to education and training in nuclear, radiation, transport and waste safety. The Agency's strategy is to support sustainable education and training development in Member States and includes preparing standard training packages based on IAEA Safety Standards and training instructors at national and regional training centres. Standard training packages contain guidance for organizing courses, viewgraphs with associated text, and reference material to assist training centres and instructors. The Agency also organized several train-the-trainers workshops in 2004.

The Agency has also prepared and made available distance learning modules. These modules allow participants to complete the training while avoiding travel costs. The Agency uses these modules as prerequisites for some of its safety courses to ensure a common entry knowledge level.

C. The Global Nuclear Safety Regime

C.1. Overview



The Global Nuclear Safety Regime is a holistic approach of strong national safety infrastructures reinforced by widespread subscription to intergovernmental and regional instruments to promote high levels of safety worldwide. A comprehensive, coherent and authoritative suite of universally accepted safety standards embodies current best practices. Integrated and harmonized approaches are adopted in applying these safety standards and managing the knowledge base. Finally, self-sustaining regional and global networks of knowledge and experience allow for continuous improvement and learning. In 2004, the International Nuclear Safety Group (INSAG) — a group of senior international experts tasked by the Agency with providing advice regarding important nuclear safety issues — identified the Global Nuclear Safety Regime as one of its focus areas.

C.2. International legal instruments

The global nature of safety is reflected in the growing number of international legal instruments — including incentive instruments based on a common desire to achieve high levels of safety and security.

In March 2004, the Board of Governors approved the *Code of Conduct on the Safety of Research Reactors*.

Current binding international legal instruments now include:

- Convention on Nuclear Safety;
- Convention on Early Notification of a Nuclear Accident;
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency;
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention); and,
- Convention on the Physical Protection of Nuclear Material.

Current non-binding international instruments include:

- Code of Conduct on the Safety of Research Reactors; and,
- Code of Conduct on the Safety and Security of Radioactive Sources.

These international legal instruments continued to evolve in 2004 to better meet stakeholder needs. The General Committee of the Joint Convention met to discuss the experiences from the 1st review meeting and develop suggestions for improving the next review meeting. The contracting parties to the Convention on Nuclear Safety met to finalize arrangements for the 3rd review meeting. At the 2nd meeting of the Early Notification and Assistance Conventions, there was agreement to develop plans to strengthen the international nuclear and radiological emergency response system. And in 2004, experts finalized import/export guidance in support of the Code of Conduct on the Safety and Security of Radioactive Sources.

The International Expert Group on Nuclear Liability (INLEX), established by the Director General in 2003, has held three meetings in the course of which it finalized the discussion and review of explanatory texts (including an overview of the modernized IAEA nuclear liability regime) on the nuclear liability instruments adopted under Agency auspices (GOV/INF/2004/9-GC(48)/INF/5). These explanatory texts constitute a comprehensive study of the Agency's nuclear liability regime in order to aid the understanding and authoritative interpretation of that regime. The explanatory texts will also serve as a basis for the future work of INLEX, regarding in particular the further identification and exploration of issues pertaining to the application and scope of the nuclear liability instruments adopted under Agency auspices. In the context of recommending measures to be taken to enhance adherence to an effective nuclear liability regime, INLEX has, in cooperation with the Secretariat, developed, and sent to Member States, a questionnaire on the status of adherence by Member States to nuclear liability instruments adopted under Agency auspices. INLEX's work is still ongoing and a number of outreach activities are now on the agenda of INLEX, in particular the organisation of regional workshops on the subject of civil liability for nuclear damage in Asia, the Pacific and the Latin America regions.

C.3. International safety standards

A principal element of the Global Nuclear Safety Regime is a suite of harmonized and internationally accepted IAEA Safety Standards (the Standards) as a reference for the high level of safety required for nuclear activities worldwide. The Standards — developed with assistance from the CSS[1] and the four thematic committees[2] — reflect, in a consensual way, national regulatory rules and guidelines and embody current best practices. Industrial standards and codes complement the Standards. Other United Nations and international scientific organizations frequently co-sponsor the Standards, ensuring good coordination. In March 2004, the Board of Governors approved the *Action Plan for the Development and Application of IAEA Safety Standards.*

The Agency plans to seek feedback on the usefulness of the Standards from its safety review missions, from the CSS and the four committees, directly from Member State users via a dedicated website, and during activities associated with the intergovernmental instruments. The Agency will use this feedback to ensure the Standards continue to reflect international experience and good safety practice.

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[1] The Commission on Safety Standards, comprising senior officials of Member State regulatory authorities

[2] Nuclear Safety Standards Committee (NUSSC), Radiation Safety Standards Committee (RASSC), Transport Safety Standards Committee (TRANSSC), Waste Safety Standards Committee (WASSC)

IAEA Safety Standards published in 2004 include the *Regulations for the Safe Transport of Radioactive Material 1996 edition, as amended 2003*. The Agency also published eleven safety guides in 2004 and the Board of Governors approved the *Regulations for the Safe Transport of Radioactive Material 2005 edition*.

In addition to the IAEA Safety Standards, the Agency issues other safety and security-related publications reflecting best international practices in specific areas. In 2004, the Agency approved a new document series to provide information on prevention, detection and response to malicious actions. The IAEA Safety Standards and other safety-related publications also include security matters relevant to nuclear safety.

C.4. Application of safety standards and international peer review

International peer review brings broader expertise, perspective and transparency to national safety assessment and verification processes and ultimately improves public confidence. In fact, for the effective implementation of international legal instruments, such as the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, international peer reviews are essential.

During 2004, the Agency continued to provide safety and security peer reviews and safety appraisals upon Member State request. These activities promote national self-assessments and independent technical review and use the IAEA Safety Standards and security guides as references.

International peer reviews are also conducted by other organizations. For example, the World Association of Nuclear Operators (WANO) conducts reviews at nuclear power plants.

C.5. Global network of knowledge and experience

It is generally agreed that existing safety knowledge has not been fully elicited and analysed to extract and share the lessons learned and embed them in the knowledge and behaviour of nuclear organizations. In his concluding remarks, the chair of a nuclear knowledge management conference in Saclay, France in September 2004 stated that "knowledge management is at the heart of safety culture and that the development of individuals is central to the process of knowledge management."[3] At that same conference, the Agency submitted that a challenge remains to "make a safety improvement anywhere a safety improvement everywhere."

The conference also noted that knowledge management methods are increasingly attractive tools to identify, retain, use and share existing knowledge and to encourage innovation to create new knowledge. A key challenge is to manage not only explicit knowledge, such as databases, documents and processes, but also tacit knowledge, such as personal knowledge, skills and aptitudes. For long-term viability, it is essential to foster a corporate culture where sharing safety knowledge is a priority.

The effectiveness of operational experience feedback exchange mechanisms is also an important challenge. This is primarily the responsibility of operating organizations and one of the priorities is to better share knowledge already accumulated in international databases through effective regional and international networking.

To strengthen the sharing of existing knowledge and expertise as well as creating and sharing new nuclear safety knowledge, the Agency is promoting and facilitating the establishment of regional nuclear and radiation safety networks. Prominent examples are the Asian Nuclear Safety Network and

[3] http://www.iaea.org/km/cnkm/papers/closingstatement.pdf

the Ibero-American Radiation Safety Network. There are also two radiation safety information exchange networks — the European ALARA Network (EAN) and the Central and Eastern European ALARA Network (CEEAN) — covering workers in all types of facilities.

The Agency administers the Regulatory Authority Information System (RAIS). RAIS is an information management tool that allows the national regulatory authority to manage its daily activities and includes areas such as infrastructure information, facilities, radioactive sources and associated equipment, authorizations, inspections, enforcement, radiological incidents and accidents, occupationally exposed persons and technical services.

D. Nuclear power plant (NPP) safety

D.1. Trends and issues

NPP operational safety performance, in general, remains high throughout the world. Insights from industry performance indicators show that worldwide NPP performance continues to be at high levels in the majority of areas. It has been noted that operational performance in areas such as reliability and availability seems to have levelled off, although marginal improvements continue in some Member States. The recognition that safe and economic operations are mutually supportive has motivated some operators to learn from events of minimal safety significance and to often go beyond regulatory requirements when addressing safety issues. More generally, the nuclear power industry is sharing peer review results in a more transparent manner. There is also an increased emphasis on in-service inspection and predictive and preventive maintenance.

The globalization of the energy market and the resulting changes in licensee structure and management have led regulatory authorities to pay more attention to organizational performance in achieving and maintaining a high level of safety.

After many years, the re-evaluation of the seismic safety of existing NPPs in countries operating WWER-type reactors is complete and significant progress has been made in upgrading the seismic safety of these plants.

The application of probabilistic methods is underway in many Member States to complement the design, operational assessment, maintenance, and regulatory decision-making processes. Efforts are underway to adapt rules and regulations to adequately consider quantitative risk implications.

There has been a reduction in the number of events reported internationally. This appears to be the result of, on one hand, safer NPP operations and, on the other hand, the establishment of higher thresholds for reporting events, both between operating organizations and between countries. Events at all levels indicate that lessons learned from past events have not been fully assimilated into everyday NPP management practices and regulatory oversight processes.

Of those events that were reported, analysis shows that there are possibilities to further improve NPP safety. Off-site electrical reliability is one such area. Foreign materials have resulted in contamination of coolant systems and damage to components. Also, more attention needs to be paid to irradiated fuel handling. These last two insights are important because, more and more, any unplanned release of radioactive material due to faulty operation or design is a cause for public concern. Operator errors continue to be a primary contributor to operational events, but design weaknesses, maintenance errors

and management factors have increased the gravity of some events. These incidents highlight the need for continued vigilance in procedural compliance and training of operators in integrated plant operations. Some events emphasized that non-nuclear hazards must be properly managed to protect workers and assure public confidence. The transfer and sharing of knowledge continues to be an issue as experienced staff members retire. Documenting experience and adequately planning sufficient overlap between incoming and outgoing personnel will help assure effective solutions.

More than 50% of current NPPs have been in operation for more than 20 years and more operators are considering continued operation beyond the original design life. Safe long-term operation requires a demonstration that the NPP will continue to operate within its design envelope. To do this, there is a need for a sound knowledge of the current design basis, accurate information on the actual state of the plant, and verification that adequate design margins will be maintained. Long term operations must consider the concept of ageing management in its broadest context, addressing both material and personnel issues.

D.2. International activities

The nuclear power industry has formed many and varied networks to address the issues noted above. For regulatory authorities, there are a number of associations based on region, reactor type and size of the nuclear programme. Regulators are also cooperating, mostly through bilateral arrangements, in the review and licensing of new reactor types. During the Agency's 2004 International Conference on Topical Issues in Nuclear Installation Safety, the importance of harmonization of regulatory processes was emphasized and the concept of international design certifications was introduced. The Agency will follow-up these initiatives during the coming biennium.

At its current rate WANO will have completed safety peer reviews at every NPP in the world by the end of 2006. This industry initiative complements the Agency's Operational Safety Review Team (OSART). The Agency has completed over 120 OSART missions — including seven during 2004 — since the programme's genesis in the 1980s. The Agency and WANO coordinate their activities to minimize overlap and duplication and these peer reviews provide important opportunities to share lessons and learn from others. OSART reviews have confirmed improvements in the material condition of systems and components, and in management and training programmes. Most review recommendations centre on procedure and policy implementation, adherence to industrial safety work practices, management controls, enforcement of nuclear safety work practices and implementation of operating experience programmes for low-level events and near misses.

Owners' groups for the major reactor types have been effective in providing fora for addressing technology specific safety issues. Bilateral agreements between countries to facilitate the exchange of information and the provision of mutual assistance have also been seen as serving the industry and the international regulatory community well.

The Convention on Nuclear Safety is an especially effective avenue for the international nuclear community to work at achieving high levels of safety. During 2004, preparations were made for the conduct of the 3rd review meeting — in April 2005 — of the 55 contracting parties to the Convention. Plans were made to put a greater emphasis on the assessment and sharing of information, as opposed to the listing of events and occurrences, and to make the Convention a living process where information exchange is continuous, rather than taking place only during the triennial review meetings.

The Agency has put considerable effort into developing standards for all safety thematic areas and for all types of nuclear installations. This is especially relevant to the activities being considered for innovative and evolutionary reactor designs. Efforts are underway in several countries to develop

technology neutral licensing processes for new reactors. Additionally, under the auspices of the Generation IV[4] and INPRO[5] projects, there is a need to establish internationally accepted guidance for the design, safety assessment and licensing of all advanced reactors. INSAG is also developing guidance in the area of safety principles for the more innovative designs. The challenge is to provide accepted, relevant and user-friendly guidance that is harmonized with national regulations and industrial standards. The Agency has initiated topical studies to assist in the development of such guidance, capitalizing on the insights provided by various countries and focusing on specific safety issues identified by analysing events.

Countries have made an increased effort to integrate safety and security approaches relevant to the protection of nuclear installations against sabotage. In particular, the Agency — with input from major nuclear power countries having backgrounds in both nuclear safety and security — prepared a general guidance document related to the protection of nuclear installations against sabotage, which will be published in 2005. This document will serve as a basis for other, more specialized publications.

D.3. Future challenges

The nuclear power industry and regulatory authorities remain challenged in maintaining the infrastructure — technical and human — necessary to ensure that safety performance remains acceptable. Economic pressures and changing government policies and reforms have resulted in new management and administrative approaches and diligent attention is required to ensure that nuclear safety principles continue to receive the highest priority. The initiation of commercial NPP programmes in countries with limited technical resources and no previous operational experience will require enhanced international cooperation, at both the operating and regulatory levels, to assure the necessary focus both in decision-making and providing resources on safety and security.

Many countries around the world, particularly in Asia and Eastern Europe, are pursuing the construction of new reactors. Concurrent with this expansion of the nuclear option are efforts to develop reactor designs that are better equipped to handle abnormal event scenarios and are more inherently safe. When taken into consideration with the advancements that are being made in technology and in risk characterization, the safety principles based on the defence in depth concept are being re-evaluated. Additionally, security concerns are now of significant interest, from both public and regulatory perspectives. It will be essential for the entire nuclear industry to work together to redefine what defence in depth means so that both currently operating installations and future proposed designs can be pursued with a proper safety focus.

The feedback, retention and assimilation of knowledge and experience must be improved. In an operational context, the process for identifying, reporting and trending low-level and near-miss events must be stimulated and the lessons learned shared with all members of the nuclear community. Barriers to sharing safety-related information need to be eliminated. This will require addressing proprietary, technical, organizational and political factors that stand in the way of information sharing. Knowledge must be shared during the design, construction and decommissioning phases of all facilities (NPP, research reactor and fuel cycle facilities). Likewise, lessons learned are not unique to any particular industry.

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[4] The United States Department of Energy Generation IV initiative is an international project directed toward deployment of innovative reactors in the next 25-40 years.

[5] The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) is an Agency-led activity.

Continuous improvement programmes such as self-assessment and corrective actions are important contributors to avoiding events with safety challenges. Early termination of operation and delayed construction of NPP require adequate programmes to handle staff motivation and the more broad socio-economic implications related to the nuclear industry.

New technologies in both hardware and software are contributing to more efficient and safer plant operations. Examples include advanced fuels, new instrument and control systems, improved and automated inspection and diagnostic equipment, better training simulators and risk-informed decision making techniques. However, the introduction of new technologies has also led to challenges, such as compatibility with existing NPP equipment, the potential for common mode failures, the need to develop new coping methodologies and strategies and how best to develop the necessary expertise in using the technology. This is being seen most notably in the area of long-term operations. NPPs are being re-evaluated for operation for periods beyond their initial design assumptions. Consistent and universally accepted methods for operating organizations to attain and manage the material and organizational needs to justify such operations, and for regulatory authorities to authorize such operations, are necessary. The efforts that have been started by the Agency to develop and provide guidance in this area will continue. Decisions regarding NPP operation are based upon technical, economic and political considerations. The technical data must be consistent, adequate, accurate and reliable.

E. Research reactor safety

E.1. Trends and issues

The research reactor community has a long history of effective and safe operation. During 2004, there were no reported events with major nuclear or radiation safety significance at research reactor facilities. Design considerations with existing and new research reactors and associated facilities continued to receive attention, especially for those issues associated with the application of new standards and vulnerabilities to external events, including sabotage.

However, even with this positive operational record, nearly two-thirds of the world's operating research reactors are now over 30 years old and although some have been refurbished to meet today's technological standards and safety requirements, safety challenges remain. In dealing with research reactor safety, it is evident that these facilities do not pose the same concern as do NPPs, due to the much more limited impact that they can produce. However, the need for adequate protection from terrorist acts or sabotage is essential. During international meetings concerning both safety and security issues, the fact that research reactors do pose challenges has been recognized. This risk varies greatly from site to site and from reactor type to type and therefore the appropriate design, operational, managerial and regulatory responses must be graded.

Perhaps even more than with NPPs, the ageing of technology, components and staff at these facilities poses serious concerns. Many facilities are facing decreasing governmental support, a lack of management commitment, and infrastructures whose resources are inadequate for safe, secure and effective operations. There are known instances where infrastructure deficiencies are negatively impacting staffing levels and qualifications. Current research reactor utilization does not develop a consistent flow of capital that can be reinvested in maintenance or upgrading needs. This, combined with the financial challenges facing national authorities and academic institutions, means that research

reactor facilities cannot pursue the technological advances (such as probabilistic safety assessments and digital instrumentation and control systems) that are becoming the norm in NPPs. Thus, there are concerns with maintaining configuration control and replacing outmoded equipment.

Strategic plans, including sound utilization programmes, are not always an inherent part of the decision-making process when determining the future of research reactors. Many research reactor facilities are in a minimally used or extended shutdown status. This, in itself, is not a concern. However the protection of the public and the environment requires investing resources to assure that facility staffs remain competent, that systems, structures and components necessary for safe operations remain functional and reliable and that the facility is adequately secure. The 2001 survey on research reactor safety identified numerous locations where these prerequisites were not being met. Agency review missions have confirmed this at several facilities.

E.2. International activities

At the end of 2003, an International Conference on Research Reactor Utilization, Safety, Decommissioning, Fuel and Waste Management was held in Santiago, Chile. In March 2004, the Board of Governors approved a *Code of Conduct on the Safety of Research Reactors*. Also, the US and Russian backed Global Threat Reduction Initiative (GTRI) was initiated, with an emphasis on improving the security of research reactor facilities as an essential means of improving overall research reactor safety. These three initiatives are setting the direction for international research reactor safety.

The most immediate outcomes of the Santiago conference were the completion of the Code of Conduct, the wide support of the principles of GTRI, and the Agency's promotion of regional programmes to address research reactor utilization and coping strategies. The General Conference has unequivocally endorsed the Code of Conduct and new research reactor construction projects are focusing on assuring that facilities are built in compliance with both the IAEA Safety Standards and the precepts of the Code.

As a result of ongoing programmes to replace high-enriched fuel with low-enriched fuel at many research reactor facilities, research reactor fuel (both spent and fresh) has been returned to the countries of origin. Additional focus on issues associated with overall reactor safety, especially as it relates to sabotage, continues to be pursued by the Agency under its safety and security programmes.

As with the entire nuclear industry, operators and Member States must deal with the loss of personnel and material resources by establishing management of ageing programmes. This is especially relevant for the modernization of instrumentation and control systems. Several Member States are working on the development of regional mechanisms to facilitate the solution of safety issues at a regional level and to complement other activities. Currently, regional activities are focused on training and experience feedback issues and the sharing of technical and scientific expertise.

E.3. Future challenges

It is essential that the Code of Conduct on the Safety of Research Reactors be adequately applied. The Agency must enhance its programmes to assure that the Code of Conduct is accepted and applied internationally. Part of this challenge will be the preparation of a set of documents to support the Code of Conduct, including both Safety Requirements and a number of Safety Guides. Also, open communications of lessons learned from events and occurrences must be aggressively pursued. The Incident Reporting System for Research Reactors has been instituted and is being used; however, the sharing of information for low-level and near-miss events must be increased.

An area of particular interest is the protection of research reactors against sabotage. This must be done using a graded approach, where protective measures are related to the potential consequences of postulated accidents. Some Member States have proposed a grading system for their research reactors and have also evaluated the security of these installations using the draft document *Self Assessment of the Engineering Safety Aspects of the Physical Protection of Nuclear Facilities Against Sabotage*. Agency International Physical Protection Advisory Service missions continue to include sabotage aspects of nuclear installations. Workshops and seminars are being organized at a national level in many countries with the objective of using an integrated safety and security approach for the protection of nuclear installations from sabotage.

Finally, the concept of "regionalization" needs to be considered. The challenges associated with inadequate utilization strategies and insufficient financial and personnel resources, combined with associated security concerns, are best addressed at a regional level. This may involve more resource concentration and the decommissioning of under-utilized reactors. The challenges that will be experienced in managing and assuring the safety and security of spent fuel and other radioisotopes are significant and will require the concerted efforts of the entire international community.

F. Fuel cycle facility safety

F.1. Trends and issues

The globalization being experienced within the nuclear industry is also affecting fuel cycle activities. Fuel cycle facilities cover a wide range of activities, including conversion and enrichment, fuel — including mixed oxide — fabrication, interim spent fuel storage, reprocessing, and waste treatment. There are more than 300 fuel cycle facilities either being designed, under construction or in operation worldwide.

Many of these facilities are operated by the private sector, with operators often in competition with one another, making much of the process and technology information commercially sensitive. These facilities also face unique safety challenges such as criticality control, chemical hazards and susceptibility to fires and explosions. Many of these facilities rely heavily on operator intervention and administrative controls to assure safety. Over the past decade, a number of serious incidents have brought these facilities to the limelight and have emphasized the need to more aggressively address all aspects of safety.

F.2. International activities

Since many of the safety concepts and methodologies developed and implemented for NPP safety are applicable to fuel cycle facilities, NPP safety enhancement experience is providing valuable input for enhancing fuel cycle facility safety. Many Member States are also enhancing their self-assessment capabilities and the Agency is currently developing the necessary fuel cycle facility safety standards.

The Agency is assisting Member States in enhancing the operational safety of their specific fuel cycle facilities and disseminating information on good practices to promote the continuous development of operational safety. The Agency has developed a safety peer review for fuel cycle facilities and will soon be offering this service to Member States. The Agency is also fostering the international exchange of information on fuel cycle facility safety issues. In cooperation with the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA), the Agency

is developing a Fuel Incident Notification and Analysis System (FINAS) for sharing information on significant events, analyses and lessons learned. Harmonization between FINAS and the Incident Reporting System for NPPs would simplify both administration and maintenance and enhance usability. The implementation of multinational approaches and regional cooperation in fuel cycle facilities could also have a variety of safety advantages.

G. Radiation protection

G.1. Biological effects attributable to radiation

In 2004, there was a consolidation of the current international consensus on the biological effects attributable to the exposure to ionizing radiation. Overall, the scientific picture is coherent, although it has become increasingly complex. The UNSCEAR position on the health effects attributable to exposure to ionizing radiation has not changed substantially over the years. Ionization is the start of a process that leads to alteration of the atoms and molecules of biological systems. Such damage can cause the cell's DNA to mutate. A mutated cell that is viable for reproduction could, after a long latency, evolve into a cancer. If the mutation occurs in a germ cell, such as ova and spermatozoa or their stem (mother) cells, it can be transmitted to descendants as a heritable effect. For the general population, the estimated lifetime risk of dying from cancer is about 9% for men and 13% for women after an acute dose of 1000 millisievert (mSv). UNSCEAR has reduced this risk by a factor of two for low radiation levels, resulting in the approximate risk factor of 0.005% per mSv. For heritable effects UNSCEAR has estimated the risk to be one order of magnitude lower still or circa 0.0005% per mSv.

UNSCEAR continues to study the complicated mechanisms of interaction of radiation with biological materials. It is also analysing the possibility that other health effects could be attributable to radiation exposure, notably a higher risk of cardiovascular diseases. However, until UNSCEAR completes these studies, its current estimates are robust enough to continue to provide the basis for radiation protection standards.

G.2. Approaches to radiation safety

G.2.1. International Commission on Radiological Protection (ICRP) recommendations

In 1990, the ICRP recommended its current System of Radiological Protection, which is based on the concepts of *practices* and *intervention*. Practices are human activities undertaken by choice that increase the overall exposure to radiation, while intervention is an action against radiation exposures that already exist, for the purpose of reducing the exposures. Both practices and interventions are justified when they cause more good than harm.

Several years ago, ICRP initiated a review of its recommendations. A major objective was to simplify the approach of practices and interventions so that both could be incorporated into a unified approach. ICRP issued a draft version of possible new Recommendations[6] for comment in 2004. ICRP is also developing fundamental documents to support the Recommendations.

[6] http://www.icrp.org/icrp_rec_june.asp

G.2.2. Regulating radiation safety

Radioactive materials of natural origin exist everywhere on the Earth's surface and in buildings, food and air. As a consequence of human activities over the past five or more decades — the testing of nuclear weapons in the atmosphere, discharges from the nuclear industry and accidents, particularly the Chernobyl accident in 1986 — radionuclides of artificial origin are now also widespread in the environment. However, until 2004 there were no comprehensive standards that determine whether any particular material containing radionuclides should be regulated or controlled. A particular problem is whether products originating from territories that were contaminated as a consequence of the Chernobyl accident can be traded internationally.

Related problems include radioactive materials and radiation-emitting devices that are in wide use in industry, medicine and research and in consumer products such as smoke detectors. It is neither necessary nor practical to regulate all activities involving exposure to radiation. Many activities result in very small exposures to radiation that correspond to negligible risk and should be exempted from the regulatory requirements that would otherwise apply. The IAEA Safety Standards and regional requirements such as the European Directive on radiological protection had established some internationally accepted exemption levels, but these were not applicable to all the above situations.

It is also desirable to clear materials from regulatory control once any residual contamination is insignificant from a health point of view. The European Commission had established clearance levels for some types of materials, but further work was required to define globally acceptable levels.

In 2004, after many years of difficult deliberation, international consensus was reached with the publication of an IAEA Safety Guide: *Application of the Concepts of Exclusion, Exemption and Clearance*. This Guide establishes levels of radionuclide activity concentration in materials below which regulatory controls need not apply. When national regulatory authorities adopt these values, it will provide clarity on which activities need to be regulated. It should also facilitate international trade in commodities containing small amounts of radioactive materials.

This Safety Guide does not cover water and foodstuffs. The World Health Organization (WHO) published specific guidance levels[7] for radionuclides in drinking water in September 2004. The FAO/WHO Codex Alimentarius Commission (CAC) is in the process of revising the *Guideline Levels for Radionuclides in Foods Following Accidental Nuclear Contamination for Use in International Trade (1989)* to include other radionuclides and to cover guideline levels for long term use. It is expected that the CAC will formally adopt the new levels for food during 2005.

G.3. Occupational radiation protection

G.3.1. Trends and issues

The Agency and the International Labour Organization (ILO) collaborated closely to further consolidate the international occupational radiation protection regime in 2004. Risk to workers from radiation risks are comparable to those from exposures to other workplace hazardous substances but are strictly controlled by the *International BSS* that establish globally recognized dose limits. Key occupational radiation protection performance indicators, such as annual dose, annual collective dose, the number of workers receiving high doses, and the numbers of overexposures continued to improve

[7] http://www.who.int/water_sanitation_health/dwq/en/gdwq3_9.pdf

in 2004, based on information from UNSCEAR, the Information System on Occupational Exposure[8] and various regional and national studies.

However, most of these data relate to nuclear fuel cycle workers. The picture is less clear for other occupational exposures. Although worker exposure in conventional radiology is generally well controlled, there are new medical practices such as interventional radiology where workers can receive high exposures. Continued efforts are required to inform medical professionals and involve health physicists to control and reduce these exposures. Worker exposure to naturally occurring radioactive material also requires attention to develop a common understanding between regulatory authorities, operators and workers. Industrial radiography can also involve substantial routine exposures and has the potential for serious overexposures. Radiographers often work unsupervised and in difficult environments, and safety relies heavily on procedures and human performance.

G.3.2. International activities

The *Action Plan for Occupational Radiation Protection*, cosponsored by the Agency and ILO, is enhancing occupational radiation protection. The emphasis is on promoting more widespread adoption and implementation of the *International BSS* and other international safety standards. The Agency is also developing and disseminating additional supporting material.

The ALARA Networks[9] were another important international achievement in 2004. Moreover, the Agency's Model Projects on Upgrading Radiation Protection Infrastructure have achieved encouraging progress. More than three quarters of the participants have established a system for individual monitoring covering at least high exposure risk workers, more than half have access to radiation monitoring instrument calibration, a third has workplace monitoring in place and working, and nearly 70% have a central dose record system.

G.4. Radiation protection of patients

G.4.1. Trends and issues

The exposure of patients during the medical application of radiation remains by far the largest man-made source of population exposure and the medical use of radiation is increasing in every country in the world. There has been an expanding use of new diagnostic and therapeutic techniques using radiation that entail new radiation risks. And although there are many benefits of expanding the use of radiation in medicine, the potential for harm cannot be ignored. Patients have, in the past, received serious accidental exposures and there is still scope for reducing doses to patients.

X-rays have been used in medicine for 100 years with considerable benefit. Wide variations in dose for many procedures resulted in increasing attention to ensure patients receive no more dose than necessary. Surveys of patient doses and image quality, which should result in establishing national and local guidance levels, are a means of reducing doses while maintaining diagnostic confidence. The few countries completing surveys have seen decreases in variations and in most cases, corresponding decreases in doses.

The use of high-dose procedures such as computed tomography (CT) has been steadily increasing as new technology allows faster image acquisition and improved image quality. This is associated with a

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[8] The Information System on Occupational Exposure, operated jointly by the Agency and the OECD/NEA, disseminates information, examples of good practice, and lessons learned within the nuclear industry.

[9] These networks were discussed in Section C.5.

substantial increase in dose to the population as a whole. In addition, in some countries there is a trend for promoting CT as a preventive practice for early detection of diseases.

Digital techniques are replacing those using conventional films and, because of higher sensitivity, have the potential to reduce patient dose. However, in the short-term, doses are likely to increase since image quality increases with increasing patient dose, even though this improved quality is not always necessary for diagnosis. Also, since it is simple to obtain and delete digital images, there may be a tendency to obtain more images than necessary.

New, very complex radiotherapy techniques have been developed, such as radiosurgery — including gammaknife, beam intensity modulation in external beam therapy, and even heavy ion therapy — which pose new patient safety challenges.

The situation regarding the release of patients undergoing therapy with unsealed radiopharmaceuticals is also quite varied, with large differences in practice among countries. These patients may cause family members, friends and caregivers to receive radiation doses unintentionally.

Overarching this constant evolution is that tens of thousands of medical professionals are performing these techniques on thousands of millions of patients. There is a need for vigilance, high standards of protection, maintaining an awareness of developments and providing safety information and training to the professionals who use radiation.

Many Member States are already addressing these trends and issues and now have national requirements in place.

G.4.2. International activities

The ICRP has long studied patient radiation protection and has issued much guidance on the subject. It also has committees and working parties currently examining various aspects associated with the medical use of radiation. During 2004 the ICRP published a report[10] on managing patient dose in digital radiology. Reports on prevention of high dose rate brachytherapy accidents and release of patients after therapy with unsealed sources are in production. The European Commission has a Directive on protection in medical exposure, and the *International BSS* has a substantial section on the subject.

In 2002, the Agency, following the 2001 Malaga Conference, launched the *International Action Plan on the Radiological Protection of Patients*. At its 2004 meeting, the Steering Panel[11] decided that an Internet platform would be the most efficient way to disseminate patient radiation protection information to those prescribing and using radiation in medical applications. The Agency, in collaboration with the relevant international organizations and professional bodies, has developed a prototype website that will include data on radiation doses to patients from Member States and training material for health professionals. The Agency is also organizing train-the-trainer workshops and preparing training packages on radiation protection in radiology, nuclear medicine and radiotherapy. In May 2004, a workshop on radiation protection was held in Vienna with senior cardiologists from 25 countries participating. Cardiologists are among the greatest users of radiation in

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[10] ICRP Publication 93: Managing Patient Dose in Digital Radiology

[11] The Steering Panel oversees the *Action Plan* and is composed of experts in radiation protection in the medical applications of radiation, and representatives of WHO, the Pan-American Health Organization (PAHO), the European Commission and the relevant international professional bodies

medicine. The Agency is also preparing a training package on prevention of accidental exposure in radiotherapy.

The Agency has approved a number of regional technical cooperation projects covering radiation protection in medical exposure and these will address the issue of image quality and patient exposure, including guidance levels, starting in 2005–2006.

G.5. Protecting the public and the environment

G.5.1. Trends and issues

Increasing public concerns, as summarized in the United Nations Environment Programme Global Environment Outlook,[12] about the state of the environment and the sustainability of economic development were evident in 2004. These concerns reflect expectations to continually control radioactive discharges from nuclear installations. There are clear international standards for controlling releases to protect the public and according to UNSCEAR estimates, doses to humans from these releases are negligible. However, public attention is now being focused on protecting non-human biota. Although radiation effects on biota have been studied, the existing international guidance on radioactive discharge control and intervention does not contain explicit recommendations on biota protection.

Despite extensive efforts to create international standards on environmental radiation monitoring, the International Conference on the Protection of the Environment from the Effects of Ionizing Radiation in October 2003 in Stockholm[13] confirmed there is still a perception that there is a lack of international guidance on monitoring strategies for various nuclear and non-nuclear facilities. There is also international demand to create and maintain a worldwide database of radioactive discharges to the environment that will provide opportunities to assess associated doses in the local, regional and global context. The Agency-based DIRATA database could meet this demand in the future. In the area of environmental modelling, increased requirements for assessment quality have created a need for internationally based model refinement programmes.

G.5.2. International activities

The findings of the Stockholm Conference established the framework for protecting non-human biota. Many consultations took place during 2004 for drafting an *International Action Plan on the Radiation Protection of the Environment*. Relevant international organizations will collaborate to enhance current radiation protection approaches by taking explicit account of non-human biota.

Some countries[14] have already included the radiological protection of biota in their radioactive waste management policy. There are other important current national and regional developments concerning the control of radioactive discharges into the environment. In Europe there is societal pressure through the OSPAR Convention[15] to reduce discharges so that environmental concentrations of artificial radionuclides become close to zero. Although international guidance recommends a constrained

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[12] http://www.unep.org/geo/yearbook/pdf.htm

[13] http://www-ns.iaea.org/downloads/rw/meetings/stockholm_conf.pdf

[14] For example, in 2004 Canada prepared draft general regulatory guidance on environmental protection policies for nuclear facilities and uranium mines

[15] The OSPAR Convention entered into force in 1998 and is the current instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic. Work under the convention is managed by the OSPAR Commission.

optimisation approach to establish radioactive discharge limits, countries can use other methodologies, such as the best available technologies approach. Further consideration and harmonisation of relevant international guidance is needed.

The IAEA Safety Guide *Application of the Concepts of Exclusion, Exemption, and Clearance*, WHO drinking water guidance levels and the FAO/WHO CAC guidance levels for foodstuffs discussed in section G.2.2 are also relevant to the protection of the public and the environment.

The Agency has set up the Environmental Modelling for Radiation Safety (EMRAS) project where all types of models of radioactivity transfers from a nuclear source to a member of the public or biota can be evaluated and optimized.

H. Radioactive source safety and security

H.1. Trends and issues

The calls for strong controls over dangerous radioactive sources and synergy between safety and security efforts continued in 2004. During the 1990s, there was a growing awareness that accidents involving radioactive sources were occurring, often with serious consequences. This led to pressure to strengthen the controls over these sources throughout the world. And since the terrorist attacks of 2001, concerns over the safety and security of radioactive sources have increased due to the potential for malicious use.

In general, the measures required to prevent malicious use are the same as those required to prevent accidents. Today, countries understand they must establish and maintain an effective and sustainable national regulatory infrastructure for controlling radioactive sources "from cradle to grave."

H.2. International activities

The synergy between safety and security was discussed in some depth at the Senior Regulators Meeting in September 2004 and by the Commission on Safety Standards in November 2004. A particular concern expressed was that in some instances, this synergy had not been properly exploited at either the national or international level.

The Agency continues to implement the *International Action Plan on the Safety and Security of Radioactive Sources* approved in 2003. Other international initiatives — such as the IAEA/RF-MINATOM/USDOE Initiative on Securing and Managing Radioactive Sources in the Newly Independent States and the United States Global Threat Reduction Initiative — are designed to strengthen the control over orphan sources. These initiatives are upgrading the physical protection of sources in use, and dismantling and securing unused sources, either in proper storage facilities or appropriate waste repositories.

Following the Board of Governor's approval of the Code of Conduct on the Safety and Security of Radioactive Sources in September 2003 and its publication in January 2004, 69 countries had made a political commitment to work towards following its guidance by the end of 2004. Even so, there is a need to establish a comprehensive set of international standards on the control of radioactive sources, covering the entire life cycle.

An open-ended group of technical and legal experts developed guidance regarding the import and export of radioactive sources. The Board of Governors approved this guidance in September 2004 and the General Conference[16] noted that more than 30 countries had already stated their intention to work towards effective import and export controls by the end of December 2005.

The industry is also taking steps to improve source safety and security. In 2004, a number of major source manufacturers expressed their intention to form an international association, which would give priority to meeting high standards of safety and security through improved design and manufacture.

Historically, safety improvements related to source safety have been the result of lessons learned from accidents or on perceived weaknesses in the systems, processes and procedures used. The Agency has just completed research on using Probabilistic Safety Assessment to proactively identify vulnerabilities of procedures and systems in large radiation sources such as industrial irradiators and radiotherapy facilities.

I. Safety of transport of radioactive material

I.1. Trends and issues

Radioactive materials are widely used in medicine, education, research and industry and this requires the safe and secure transport from manufacturer to user. This is not always straightforward, since different consigning and carrying organizations, as well as seaport, airport and other intermodal personnel, must handle the radioactive material. Many of these radioactive materials have short usable lifetimes, so they must complete the journey as quickly as possible.

The excellent safety record for the transport of radioactive material results from Member States committing resources to this important task. Even with this record, there are continual challenges to limit the volume of radioactive material transport activities. The lessons from these challenges are being identified, analysed and shared so that the transport of radioactive material essential for medical and industrial applications will continue.

I.2. International activities

In March 2004, the Board of Governors approved the *Action Plan for the Safety of Transport of Radioactive Material*. This plan provides direction on the Agency's transport safety activities for the next five years. Action areas include reviewing and revising the *Regulations*, refining the review process, compliance and quality assurance, denial of shipments, emergency response, liability and communication.

In November 2004, the Board of Governors approved the 2005 Edition of the *Regulations for the Safe Transport of Radioactive Material*. The *Regulations* must take account of the increasing sophistication of transport systems and it remains a challenge to maintain them without excessive effort. Many Member States also find it difficult to incorporate changes into their legislation in a timely manner. As of the end of 2004, 45% of the Member States had reported that they had implemented the 1996 Edition of the *Regulations*.

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[16] Resolution GC(48)/RES/10.D

The Agency is developing guidance on trigger levels and actions to be taken regarding the security of radioactive material during transport. The UN *Model Regulations on the Transport of Dangerous Goods* already include requirements relating to security.

In recent years, radionuclide shipments intended for use in medical diagnosis or treatment have been prevented from reaching their destination in several countries. This seems to be a particular problem where the only means of transport is by air or sea. Information is being collected and analysed to determine the reasons for these denials so that measures can be put in place to prevent future occurrences.

The Agency's TranSAS missions assess the implementation of the *Regulations* in Member States by reviewing the legal framework in considerable detail. The missions also identify good practices, as well as areas requiring improvement. Recent TranSAS missions have found that Member States are implementing the *Regulations*, but that improvements are needed to maintain guides and procedures up-to-date. The 2004 TranSAS mission to France identified several recommendations for improvement, but noted a considerable number of good practices, particularly in the area of maritime transport.

J. Safety of radioactive waste management and disposal

The *International Action Plan on the Safety of Radioactive Waste Management* — adopted by the Agency following the Cordoba Conference in 2000 and revised after the International Conference on Issues and Trends in Radioactive Waste Management held in December 2002 in Vienna — was further implemented in 2004. The Agency and OECD/NEA are cosponsoring international safety standards for geological disposal.

A number of countries continue to develop geological disposal facilities for spent fuel and high-level radioactive waste. Preparations for the Yucca Mountain licence application continue in the United States, although a recent court decision is affecting the process. Finland continues to develop an underground research laboratory on the site designated for its geological disposal facility while Sweden continues with its site selection process. Work also continues in France on investigations at the Bure site. In view of its rapidly expanding nuclear power programme, China is considering accelerating its schedule for developing a geological disposal facility.

Many countries operate near surface disposal facilities for low and intermediate level radioactive waste. Member States are making increasing use of the internationally harmonized safety assessment approach developed within the ISAM[17] project to review the safety of low and intermediate-level waste disposal facilities. Applying this methodology to a number of older facilities in Eastern Europe has identified problems with the disposal of long-lived and high-activity sealed sources in some facilities. Further developments are underway regarding the application of safety assessment methodology, particularly its application to the reappraisal of existing facilities.

Investigations into the safety of borehole disposal of disused sealed sources continue. Safety standards for such facilities are under review, a generic safety assessment methodology for these facilities is

[17] Improvement of Safety Assessment Methodologies for near surface disposal facilities for radioactive waste (an Agency coordinated research project from 1997-2000)

under development and South Africa is developing a concept demonstration facility. A number of countries are also developing dedicated storage facilities and improving regulatory arrangements to enhance the safe storage of these sources.

With the delays in development of permanent disposal facilities in some countries, increasing attention is being given to the safety of storage facilities. Questions remain about the long-term sustainability of safety in such arrangements, and attention is being given to the development of an internationally harmonized safety assessment methodology to evaluate the design and operational provisions necessary for longer-term storage. As more nuclear facilities are decommissioned, the need for appropriate disposal facilities will increase.

K. Decommissioning

A 2004 study[18] calls attention to the serious decommissioning challenges the nuclear industry is facing and to the consequent radiation safety issues to address. The total decommissioning liability from now until 2050 is approximately one trillion US dollars. Many countries realize they have a substantial liability and have taken steps to ensure that when required, facility decommissioning will be performed safely and efficiently. One example is the new United Kingdom Nuclear Decommissioning Authority now responsible for managing the cleanup of Britain's nuclear legacy. However, in general, the lack of appropriate funding mechanisms remains a major concern.

The Agency approved an *International Action Plan on the Decommissioning of Nuclear Facilities* in 2004 to address the safety issues identified at the International Conference on Safe Decommissioning for Nuclear Activities that took place in Berlin in October 2002.

One major issue has been the lack of internationally acceptable standards for the release of material from regulatory control following decommissioning activities. An OECD-NEA workshop[19] on decommissioning, co-sponsored by the Agency, the European Commission and hosted by Nuclear Plant Management Company and the Italian Agency for Environmental Protection and Technical Services, recognized that the IAEA Safety Guide: *Concepts of Exclusion, Exemption and Clearance* provides this guidance and encouraged all countries to adopt it. The workshop also recognized that while immediate dismantling of nuclear facilities is preferred, this is not always possible.

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[18] Status of the Decommissioning of Nuclear Facilities around the World. Vienna. International Atomic Energy Agency. 2004

[19] NEA Workshop on Safe, Efficient and Cost-effective Decommissioning, Rome, Italy, 6-10 September 2004

L. Restoring contaminated sites

In 2004, a number of countries continue to have areas with significant radioactive contamination to varying degrees. This contamination was caused by: poor long-term management of uranium mining and milling residue; nuclear weapons production and testing; inadequate practices for radioactive waste management and disposal; the intentional or accidental discharge of radioactive material; nuclear accidents; incidents at nuclear installations or hospitals, industrial and research facilities; and other inadequately controlled past practices.

There is sufficient international guidance for determining restoration methods and end states at these sites. While some countries have considerable experience in remediating contaminated areas, experience around the world is generally limited. In addition to radiological factors, these sites frequently also have other chemical and biological hazards, and socio-economic factors have a strong influence on the decision-making process. Managing the waste resulting from remediation activities can be another concern.

The Agency is leading an initiative with the OECD, EBRD, the World Bank and the affected countries in central Asia to provide a way forward to restoring uranium mine and mill sites associated with the former Soviet Union's nuclear weapons programme. The Agency is also working with the Kazakhstan government, the European Commission and NATO to identify the remaining radiological concerns at a former nuclear weapon test site in Kazakhstan. In addition, the preliminary radiological assessment of the former French test sites in In Ekker and Reggane, Algeria was completed.

Radioactive contamination can also be caused inadvertently by human activities involving processes in which naturally occurring radioactive material (NORM) can become concentrated, in areas not normally controlled by regulatory authorities, to levels beyond the concentration limits set for practices. Such activities include conventional mining and processing of ores, such as copper ore mining, phosphogypsum production or mineral sands mining. At present, there are no defined repositories for this waste and current standards do not always provide the necessary guidance.

M. Emergency preparedness and response

Most countries operating nuclear installations have adequate systems in place for dealing with emergency situations. However, the challenges of staff turnover, new technology, lack of actual emergency experience and the cost of exercising still leave room for improvement. Many countries — particularly those not operating nuclear installations — still lack a basic level of radiological emergency preparedness.

The major challenge is for countries most at risk to establish basic radiological emergency response capabilities. Other countries should review, and where appropriate, strengthen existing capabilities to meet new challenges — including the threat of a malicious act — and to integrate law enforcement response with emergency response. Plans should be in place to effectively deal with accidents involving nuclear installations and radioactive materials, no matter how unlikely these may be. Furthermore, there is a heightened awareness of the need to strengthen arrangements to respond to

emergencies that could arise from criminal or terrorist activities. Early in the course of an event, it is usually unknown whether the cause is accidental, due to negligence or deliberate. The principal aim is to mitigate the event and its radiological consequences; a secondary aim is to address non-radiological issues, in part through consistent and authoritative provision of information to the public. Coherent initial assessment and crisis and consequence management are needed, which can only be achieved through coordinated and effective preparedness involving all relevant authorities and response organizations. For a major event, international harmonization of approaches is highly desirable.

In 2004, ICRP issued a draft report[20] regarding actions to take following a radiological attack. Many potential scenarios cannot induce immediate severe radiation injuries and the report recommends that radiological protection decisions be proportional to the attack's magnitude to prevent overreaction.

The 48th General Conference recognized these issues and encouraged Member States to improve their preparedness for these events and to implement the relevant safety standards and procedures for international emergency communication and assistance. It also encouraged Member States to put in place arrangements for effective response to requests for emergency assistance. Moreover it welcomed the development of the *International Action Plan for Strengthening the International Preparedness and Response System for Nuclear and Radiological Emergencies*.

Events during 2004 showed that the media or public's level of concern regarding an event varies considerably. Some incidents are perceived by the media and public as being much more serious than they are from a safety point-of-view — in one case leading to members of the public reportedly self-administering iodine tablets. The 48th General Conference encouraged Member States to adopt a lower threshold for notification of events to improve information exchange. It also requested the Secretariat to consider streamlining its mechanisms for reporting and sharing information about incidents and emergencies.

The Agency provides a number of services to assist Member States with emergency preparedness and response and since 1986, it has operated an Emergency Response Centre as its focal point for response during a nuclear accident or radiological emergency. The Agency is also a participant in the Joint Radiation Emergency Management Plan of the International Organizations — the 2004 edition of the plan includes Interpol, Europol and UNEP as cosponsors[21].

A number of activities on emergency preparedness and response also took place in 2004 to enhance communication and cooperation among the contracting parties to the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

One event rated as level three and 11 events rated as level two on the International Nuclear Event Scale (INES) were reported to the Agency in 2004. The level three event was related to a potential overexposure at an irradiation facility. Equipment problems at NPPs accounted for two of the level two events, while incidents involving radioactive sources accounted for nine level two events. The Agency has made guidance available for pilot use for applying INES to radioactive source or transport of radioactive material events.

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[20] http://www.icrp.org/draft_protect.asp

[21] Other participants are: European Commission; FAO; OECD/NEA; PAHO; United Nations Office for the Coordination of Humanitarian Affairs; United Nations Office for Outer Space Affairs; WHO; and World Meteorological Organization, in cooperation with the International Civil Aviation Organization

There was one case in 2004 where the Agency provided assistance in response to a request made under the Assistance Convention. Urgent provision of specialized medicine was provided for the treatment of a victim of an incident at Lia, Georgia.

Annex I

Safety related events and issues worldwide during 2004

Introduction

This annex identifies those safety related events or issues during 2004 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 2004.

International legal instruments

Convention on Nuclear Safety

The 3rd Review Meeting of the Contracting Parties is scheduled for April 2005 in Vienna. In preparation for this meeting, Contracting Parties submitted their National Reports in the summer and fall of 2004 and held an Organizational Meeting in Vienna on 28–30 September, 2004 where they determined the composition of the six country groups for the peer review. The Organizational Meeting also determined the officers for the Review Meeting and considered a number of other issues intended to improve the review process. The Review Meeting officers will meet in March 2005 to finalize arrangements for the Review Meeting. At the end of 2004, there were 55 Parties to the Convention.

Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency

The Convention on Early Notification of a Nuclear Accident (the Early Notification Convention) and the Convention on Assistance in the Case of a Nuclear Accident (the Assistance Convention) entered into force on 27 October 1986 and 26 February 1987, respectively, as a direct result of international initiatives following the Chernobyl accident. These two Conventions are the primary legal instruments that establish an international framework to facilitate the exchange of information and the prompt provision of assistance in the event of a nuclear accident or radiological emergency, with the aim of minimizing the consequences. At the end of 2004, there were 93 Parties to the Early Notification Convention and 90 Parties to the assistance Convention.

At the second meeting of competent authorities identified under the Early Notification and Assistance Conventions, participants identified the need to establish some international harmonization for communication and assistance among States. This would allow for the best use of technologies and capabilities. The competent authorities agreed to work with the Secretariat to develop an action plan. In June 2004 the Board of Governors approved the *International Action Plan for Strengthening the International Preparedness and Response System for Nuclear and Radiological Emergencies*. The

National Competent Authorities' Coordinating Group[22] has prepared, in coordination with the Secretariat, the structure and work plan for implementing this action plan.

In 2004, the Agency was informed of 38 events involving or suspected to involve ionising radiation. In 19 of these cases, the Agency was notified of the event, requested to provide official information or requested for assistance pursuant to the Assistance Convention. In the other 19 cases, individuals or the media informed the Agency. In all cases, the Agency performed the appropriate actions, such as verifying the information, providing official information or assistance to the requesting party, and offering the Agency's good offices.

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention) entered into force on 18 June 2001. The first Review Meeting of the Joint Convention was held in Vienna in 2003. It signalled that the Joint Convention, the only internationally binding legal instrument in this field, is now fully operational. The Joint Convention's main objective is "to achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management". In 2004, the General Committee for the Joint Convention reviewed the experience of the 1st Review Meeting and recommended improved arrangements for adoption by the next meeting of Contracting Parties in 2006. At the end of 2004, there were 34 Parties to the Convention.

Convention on the Physical Protection of Nuclear Material

The Convention on the Physical Protection of Nuclear Material obliges inter alia States Parties to ensure, during international nuclear transport, the protection of nuclear material within their territory or on board their ships or aircraft. On 1 June 2004, the IAEA Director General received a letter proposing, on behalf of 25 States Parties to the Convention, amendments to the Convention. The Director General, as depositary for the Convention, circulated the proposed amendments to all States Parties to the Convention. Should a majority of States Parties to the Convention so request, the Director General shall invite all States Parties to the Convention to a conference to consider the proposed amendments. At the end of 2004, 51 State Parties to the Convention had requested the Director General to convene such a conference. At the end of 2004, there were 109 Parties to the Convention.

Code of Conduct on the Safety of Research Reactors

This non-binding international legal instrument is designed to achieve and maintain a high level of safety in research reactors worldwide through the enhancement of national measures and international cooperation. The Board of Governors adopted the Code of Conduct in March 2004, and the 48th General Conference endorsed it and called for its wide application. At the 2004 Senior Regulators Meeting, regulators discussed the application of the Code of Conduct. Most regulators are finding the Code of Conduct a simple, easy to use document. Since the Code of Conduct does not include any reporting requirements, senior regulators also discussed a number of alternatives for dealing with this.

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[22] This Group was established at the second meeting of representatives of the competent authorities identified under Early Notification and Assistance Conventions

Code of Conduct on the Safety and Security of Radioactive Sources

This non-binding international legal instrument applies to civilian radioactive sources that may pose a significant risk to individuals, society and the environment. The Code's objectives are to achieve and maintain a high level of safety and security of radioactive sources. By the end of 2004, 70 States had expressed their political support and intent to work toward following the Code. One section of the Code is devoted to the import and export of high activity radioactive sources. Experts have developed the Guidance on the Import and Export of Radioactive Sources which the Board of Governors approved in September 2004.

Cooperation between national regulatory bodies

There are a number of fora in which regulators can exchange information and experience with their counterparts in other countries. Some of these are regional or linguistic, some deal with particular reactor types and others are based on the size of the nuclear power programme. All of these fora meet regularly to exchange information of common interest and some are developing exchange mechanisms involving the Internet for more rapid means of communication. In addition, selected safety issues of wide interest to regulators are discussed at a meeting of senior regulators held in association with the General Conference each year.

International Nuclear Regulators Association (INRA)

INRA comprises the most senior officials of a number of well-established independent national nuclear regulatory organizations who wish to exchange perspectives on important issues on nuclear safety with the purpose of influencing and enhancing nuclear safety from a regulatory perspective. INRA met twice in 2004.

INRA members discussed the human resource requirements for a regulatory organization, including education and training requirements for staff and measures to ensure optimum allocation and use of the regulatory organization's staff.

INRA also continued its examination of safety culture, focusing on measures to improve safety culture, both in the regulatory organization and in the regulated industries. There were discussions on how to establish a safety conscious work environment and how to have organizations self-assess their safety culture. Associated with this work were discussions on strengthening communication. These discussions included internal communications within the regulatory organization and in regulated industries, and communication with external stakeholders.

The topic of consistency of nuclear safety regulation in Europe was also discussed, along with using the IAEA Safety Standards as a comparison.

INRA also discussed issues related to restarting or decommissioning reactors following long outages or layups.

G8-Nuclear Safety and Security Group

In June 2004 the G-8 issued a statement on guidelines for nuclear safety and security regulatory authorities that included: "Laws governing the use of nuclear energy and radioactive materials should include the establishment of a system that regulates their use for beneficial purposes, and ensures the

protection of public health and safety, security and the environment. G8 members are contracting parties to the Convention on Nuclear Safety, which provides an appropriate legislative and regulatory framework. IAEA safety standards provide guidance on the regulator's role and responsibilities. A strong, effective and credible regulatory system should include the following features:

- Regulatory authorities whose primary mission is the effective protection of the public health and safety, security and the environment, capable of making sound and independent technical regulatory decisions;
- Independence of these regulatory authorities from any organizations or bodies involved in promotion and use of nuclear energy and radioactive materials; and,
- Transparency of regulatory decisions with the aim to achieve public confidence."

Western European Nuclear Regulators Association (WENRA)

WENRA is comprised of the heads of nuclear regulatory bodies from 17 European Union countries and has launched working groups on reactor safety and nuclear waste safety. The mandate of these working groups is to analyse the current situation and the different safety approaches, compare individual national regulatory approaches with the IAEA Safety Standards, identify any differences, and propose a way forward to possibly eliminate the differences without impairing the final resulting level of safety.

In 2004 discussions were also initiated among WENRA members on topics such as experience with respect to possible effects on safety due to a deregulated electricity market, how to regulate the use of contractors, and how to monitor and intervene on a decline in safety performance.

The Ibero-American Forum of Nuclear Regulators

In the framework of the activities of the Forum, an Agency extrabudgetary programme is underway. The main objective is to enhance nuclear and radiological safety and to promote the exchange of knowledge among Ibero-American countries. Spain has contributed to the programme financially since 2003. The central element of the programme is the establishment of a safety network to capture, analyze and disseminate knowledge, as well as to facilitate mutual learning and the creation of new safety knowledge. During 2004, experts from Argentina, Brazil, Chile, Cuba, Mexico and Spain identified the thematic priorities and the structure of the programme, and a demonstration version of the network was developed and successfully tested. The programme includes workshops and technical meetings organized in close cooperation with the Agency's radiation safety activities. The 48th General Conference welcomed the establishment of the radiation safety network and the development of an action plan, as well as further reporting on its implementation.

Cooperation forum of state nuclear safety authorities of countries which operate WWER reactors

The annual meeting of the forum was organized by the authorities of the Czech Republic in 2004. The meeting exchanged information on significant events and regulatory practices. The meeting also heard and discussed the report of its working groups. After two meetings, the Working Group on Regulatory Use of Probabilistic Safety Assessment (PSA) has achieved significant progress in describing the national practices, and comparing methodologies and PSA results. This first part of the activities benefited from the publication and workshops organized by the IAEA on harmonization of PSA methodologies. The Working Group on Feedback of Operating Experience for Improving Safety of NPPs met for the first time in February 2004 in Bulgaria and established its workplan. A new Working Group was created on regulatory practices in licensing instrumentation and control (I&C)

modifications. After a presentation by Czech Republic on pilot I&C modifications at Dukovany Unit 3, and considering modifications planned at other NPPs, the annual meeting concluded that this was an area for fruitful exchange.

The group of senior regulators from countries which operate CANDU-type nuclear reactors

At their annual meeting in Romania in 2004, senior regulators from countries operating CANDU-type NPPs discussed: Generic Safety Issues; main safety issues and design changes for Qinshan Phase 3; resolution of safety issues for KANUPP; technical specifications for CANDU; PSA for CANDU; containment leakage rates; periodic safety review; highlights of country reports to the Convention on Nuclear Safety; and, safety culture.

The group is exploring the possibility of holding a specialist meeting in 2005 on PSA for the regulators of CANDU NPPs.

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.

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

UNSCEAR, 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 radiological research to assess the cancer risks from radiation exposure. Its extremely detailed reports — globally acknowledged as being authoritative — are a synthesis of thousands of peer-reviewed references. These reports provide the scientific basis for radiation protection schemes and basic standards formed by international and national organizations.

During 2004, UNSCEAR engaged itself more deeply in studying the complicated mechanisms of interaction of radiation and biological materials. UNSCEAR is analysing experimental evidence that DNA mutation caused by a *challenging* radiation dose can be reduced by prior exposure to a *conditioning* dose through a phenomenon termed adaptive response. UNSCEAR is also analysing the possibility that other targeted health effects could be attributable to radiation exposure, notably a higher risk of cardiovascular diseases. Some authors have described this phenomenon occurring in Chernobyl recovery workers, atomic bomb survivors and some radiotherapy patients. Other complicated non-targeted cellular phenomena are also being studied by UNSCEAR.

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 International Basic Safety Standards (BSS). The current version of the ICRP Recommendations was issued in 1990. In June 2004, following years of review and revision, the ICRP issued a draft revision[23] for public consultation. The draft revision has an increased emphasis on dose constraints to be applied to any particular source and includes consideration of protection of the environment. The draft has already been widely debated.

In 2004, the ICRP also issued a report[24] for comment regarding radiological protection actions to be taken following a radiological attack. The recommendations are applicable to a wide range of conceivable attacks, ranging from malicious uses of radioactive materials, sabotaging nuclear facilities to cause a nuclear accident, or in extreme cases, detonating improvised nuclear devices.

The ICRP is also addressing a number of specific issues of the radiation protection of patients, such as pregnancy and medical radiation, prevention of accidental exposure in radiotherapy, managing patient dose in computed tomography (CT), avoiding radiation injuries from interventional procedures, protecting children during diagnostic techniques involving radiation, radiation protection training for clinical personnel, mass screening of asymptomatic persons using ionizing radiation, and dose management in multi-detector CT.

International Commission on Radiation Units and Measurements (ICRU)

The ICRU, a sister organization of the ICRP, provides recommendations regarding relevant quantities and units, measurement procedures and data. The current ICRU programme is focused on four areas:

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

In 2004, ICRU published a report[25] on *Prescribing, Recording and Reporting Electron Beam Therapy* (Report 71). The Report extends to electron beam therapy the concepts and recommendations contained in ICRU Reports 50 and 62 for photons. As a general rule, the concepts and recommendations for reporting electron beam therapy should be similar to and consistent with those published for photons. However, the dose distributions with electron and photon beams are quite different and may require different approaches as far as beam arrangement, treatment planning and also clinical indications are concerned.

International Nuclear Safety Group (INSAG)

The INSAG was chartered by the IAEA Director General to be an independent, authoritative body that could provide insights and recommendations to Member State governments, industry, the media, the public and the Secretariat. Its efforts focus on nuclear installation safety, but include any other issues that could relate to the safety of nuclear installations. INSAG is made up of 16 internationally

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[23] http://www.icrp.org/icrp_rec_june.asp

[24] http://www.icrp.org/draft_protect.asp

[25] http://www.icru.org/n_04_3.pdf

recognized experts from around the world who serve for a four-year term. The group represents national regulatory bodies, the nuclear industry, academia and research institutions.

At its second meeting on March 24–26, 2004 INSAG defined the areas it intends to focus on during its mandate. The areas are:

- Global Safety Regime: INSAG will seek to further the development of a consistent and comprehensive approach to nuclear safety. INSAG's approach is to define an appropriate ultimate safety regime and then explore means to achieve it.
- Safety Principles: Safety principles are subject to change, in part as a result of the application of probabilistic approaches to complement deterministic analyses, the need to encompass fuel-cycle facilities as well as reactors, and the necessity to prepare for new reactor concepts and designs. INSAG will pursue the conceptual aspects of this problem.
- Operational Safety: There are opportunities for continuing improvement of operational safety at existing plants. INSAG will seek to define some of these opportunities, guided by the experience of operators around the globe.
- Stakeholder Involvement: Various stakeholders have a legitimate expectation that they will be informed of nuclear matters and their active involvement can enhance nuclear safety. INSAG will seek to encourage openness in communication and to promote relationships between the nuclear enterprise and various stakeholders that could have a positive impact on nuclear safety. INSAG will seek to develop insights as to when and how to enhance stakeholder involvement.

Additional thoughts from INSAG include developing a survey of how approaches to nuclear safety have changed over the past five decades to provide a backdrop for further change; dealing with and overcoming complacency that can arise from uneventful past operations; deteriorating nuclear infrastructure; and, issues associated with nuclear waste.

Activities of other international organizations

Institutions of the European Union

On 30 January 2003, the European Commission (the Commission) adopted two proposals for Directives dealing respectively with the safety of nuclear facilities and the management of spent fuel and radioactive waste. The legal bases of these two proposals are in Chapter 3 of the Euratom Treaty, which concerns health protection. In accordance with the procedure in Article 31 of the Euratom Treaty, the Commission requested the opinion of the European Parliament. The European Parliament adopted opinions on the proposals in its plenary session on 13 January 2004. The opinions support the approach taken by the Commission of endowing the enlarged European Union with binding legislation in the field of safety of nuclear facilities and radioactive waste management. The European Parliament adopted a number of amendments, the majority of which were acceptable to the Commission. The European Council has yet to adopt any legally binding directives, but it has decided upon an action plan for enhanced safety cooperation within the European Union.

In addition to the consultations resulting from the legislative procedure provided for in the Euratom Treaty, the Commission carried out numerous consultations, with both the national authorities and industries concerned with the proposals, individually and collectively through various fora, before the

submission of the proposals for Directives and during their examination process. Consultations were also undertaken with international organizations, such as the Agency and OECD/NEA.

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.

The annual meetings of the Committee on Nuclear Regulatory Activities (CNRA) and the Committee on the Safety of Nuclear Installations (CSNI) were held in June and December 2004 respectively.

Topics discussed at the CNRA meeting included significant events and the use of operating experience, regulatory requirements for power up-rates, and regulatory effectiveness and decision-making. The CNRA also reviewed the progress achieved by its inspection practices and public communication working groups. The CNRA also approved a publication addressing human performance and established a small task force to integrate regulatory authorities' comments on the draft ICRP recommendations.

The CSNI held specific discussions on the safety aspects of digital instrumentation and control, fuel safety margins, and cooperation with the Nuclear Science Committee. The CSNI reviewed the progress achieved by its operating experience and risk assessment working groups, and the special expert group addressing human and organizational factors. In addition, the CNSI discussed progress reports on the action plan on safety margins and on SESAR[26]/SFEAR[27] activities. Also, research projects under preparation that may become OECD/NEA joint projects were presented to the CSNI. During the meeting, the CSNI approved the publication of 11 new reports, including three technical opinion papers on risk management issues.

In June 2004, the CNRA organized its annual high level regulatory forum. A common concern to both regulatory authorities and the nuclear industry is the ongoing gradual loss of experienced and competent personnel in nuclear technology and the resulting weakening of nuclear field organizations. Heads of regulatory authorities came together with nuclear industry executives to exchange perspectives and experience that could bring useful insights on a licensee's ability to maintain control of nuclear safety aspects of technical support services and contracted work, and to identify inspections that would allow the regulatory authority to obtain assurance on the adequacy of these controls.

Both safety committees have put review groups, composed of recognized senior safety and regulation experts, in place to assess the effectiveness of the committee's work and make recommendations to address future challenges. Both groups expect to complete their work before June 2005. In addition, both committees have agreed on a joint CSNI/CNRA Strategic Plan, where special emphasis is placed on coordination and cooperation between committees. This Plan identifies the expected challenges for safety and regulation in the coming years. Both committees approved the Plan at a joint session in December 2004.

In the waste management area, the OECD/NEA continued to organize international peer reviews on important milestone reports in national waste management programmes. In 2004, the review of a

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[26] Senior Group of Experts on Safety Research

[27] Support Facilities for Existing and Advanced Reactors

Swiss report on the safety aspects of a repository project in Opalinus clay in Switzerland was delivered and preparatory work started on a French study on disposal in clay formations. The Radioactive Waste Management Committee (RWMC) also published a brochure on the *Safety Case for Geologic Repositories*, paving the way for a new comprehensive view on repository safety. The RWMC will continue, in close cooperation with the Agency, to further develop supporting documents on the Safety Case and applying the IAEA Safety Standards. The integration of geologic information and evidence into the safety case has been brought forward and the OECD/NEA project on performance of the engineered barrier system addressed issues of thermal analysis, alteration of non-metallic barriers, and evolution of solution chemistry. RWMC also started new initiatives on the role of storage in disposal and on long-term safety criteria for geologic disposal.

Regarding public confidence issues, the OECD/NEA organized a fourth workshop in the national context in Germany, and the main findings of four years of interactions with stakeholders have been documented in a report on *Learning and adapting to societal requirements*.

In the area of decommissioning, the OECD/NEA organised a conference on *Safe, Efficient, and Cost-effective Decommissioning*, hosted by the Italian Government, in cooperation with the Agency and the European Commission. The conference provided for stock-taking on progress made during the last five years, as well as for an orientation framework with respect to future OECD/NEA activities.

Through its Committee on Radiation Protection and Public Health (CRPPH) the OECD/NEA is engaged in an active dialogue with the ICRP and provided feedback regarding the development of new radiological protection recommendations. A workshop in Tokyo was organised with the ICRP to give Asian member countries an opportunity to discuss the draft ICRP recommendations.

The CRPPH began work to identify emerging issues that could pose challenges to radiological protection policies, regulation and application over the next five to ten years. This will update an earlier review from 1994 and will serve as a blueprint for CRPPH's key programme of work topics.

In the area of emergency management, preparations were completed for the INEX 3 nuclear emergency exercise, a table-top consequence management exercise focusing on how emergency response organizations address issues associated with wide-spread contamination in an agricultural environment. It is expected that countries will play this exercise individually during the latter half of 2005.

The OECD/NEA joint research projects continue to be useful tools to address specific safety concerns. Two new projects started in 2004, one investigating pressurized water reactor safety issues by means of thermal-hydraulic experiments and one exchanging scientific and technical information amongst decommissioning projects on nuclear facilities.

World Association of Nuclear Operators (WANO)

All NPP operators are members of WANO. Through WANO, NPP operators can communicate and exchange information with one another within a culture of cooperation and openness to achieve high standards of safety and reliability. WANO conducted peer reviews at 35 NPPs during 2004, altogether 248 since the programme began in 1992. WANO's long-term goal is for every NPP to host a peer review by 2005, and at least every six years thereafter.

WANO continues to emphasize technical support missions, which focus on providing assistance in selected areas, with 88 technical support missions undertaken during 2004. 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 and training course programme has developed both in scope and in numbers. During 2004, special emphasis was given to improving operational decision-making in the industry. A two-day Operational Decision-Making Seminar was developed and presented over 12 times at locations throughout the four WANO regions. In addition, each region conducted workshops and seminars on a variety of topics related to NPP operations. WANO performance indicators continue to show a trend of improvement.

The International Radiation Protection Association (IRPA)

The IRPA held its eleventh international congress in May 2004 in Madrid, Spain. The meeting attracted some 1600 radiation safety professionals from around the world. In addition to the scientific and technical sessions at the meeting, status reports were provided by all the international organizations involved in radiation safety and the draft ICRP recommendations were debated. IRPA continues to provide a conduit for comment on radiation safety standards from the radiation safety profession and the debate was part of the ongoing process of stakeholder consultation initiated by the ICRP. The Associate Societies also adopted a code of ethics at the congress for use by professionals working in the field of radiation safety.

Safety legislation and regulation

In March 2004 in accordance with the Presidential Decree, the Russian Gosatomnadzor was renamed the Federal Nuclear Regulatory Authority (Service) within the newly created Ministry of Industry and Energy. Further, in May 2004 in accordance with a Presidential Decree, the Federal Nuclear Regulatory Authority and the Federal Technological Supervisory Service were merged into the Federal Ecological, Technological and Nuclear Supervisory Service directly under the Prime Minister. Following the adoption of a new *Federal Law on the Technical Regulatory Process* in 2003, the existing legislative and regulatory framework will remain in force for a limited time and new technical regulations will be established. In 2004, the Russian authorities prepared draft general technical regulations on nuclear and radiation safety in the use of nuclear energy. These drafts were circulated among the members of the G8 Nuclear Safety and Security Group, the Agency and the OECD/NEA for peer-review.

The regulatory authorities of Pakistan and China cooperated during licensing of the first pressurized water reactor, Chashma NPP Unit-1 (C1), supplied by China in the 1990s. In 2004, Pakistan and China signed a contract for the construction of Chashma NPP Unit-2 (C2) at the same site and the regulatory authorities will again actively cooperate. Both Pakistan and China have adopted the IAEA Safety Standards as the basis for their regulatory requirements for design and operations of their NPPs. The Pakistani regulatory authority intends to make full use of these standards in its licensing process for C2. The experience and lessons learned from this project will provide the Agency with important feedback on the applicability and usefulness of its standards.

The international effort associated with the Agency's technical cooperation Model Projects on Upgrading Radiation Protection Infrastructure — with some 90 participating Member States — has played a major role in promoting conformance with international safety standards in general and the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of*

Radiation Sources (International BSS) in particular. By June 2004 more than 80% of participating countries had promulgated, or were close to promulgating, legislation conforming to the International BSS; 78% had adopted regulations covering the most hazardous practices and conforming to principal International BSS requirements; and 66% had established an independent and empowered regulatory authority.

NPP safety significant events in 2004

From 18-22 October 2004 the Agency held, in Beijing, the International Conference on Topical Issues in Nuclear Installation Safety: Continuous Improvement of Nuclear Safety in a Changing World. The conference was hosted by the China Atomic Energy Authority and the National Nuclear Safety Administration. 274 participants presented, critiqued and discussed issues related to the challenges before the world nuclear community as it moves into an environment of change and globalization. These participants represented 37 countries, five international and private organizations, and all aspects of the nuclear power community. The findings from the conference can be grouped under three main headings: the need to harmonize regulatory approaches; the concept of operational experience and the need to foster an environment conducive to becoming learning organizations; and, the concept of extended operations.

The International Nuclear Events Scale (INES) is used for facilitating rapid communication to the media and the public regarding the safety significance of events at all nuclear installations associated with the civil nuclear industry, including events involving the use of radiation sources and the transport of radioactive materials. To date, 60 countries are participating in the INES Information Service. A technical meeting of INES national officers was held in March 2004, with 71 participants. There was also one Advisory Committee meeting in March 2004 and two consultancy meetings to review and prepare additional guidance and prepare training material.

The Incident Reporting System (IRS) jointly operated by the Agency and the OECD/NEA is an essential element for providing information regarding NPP operating experience worldwide. The 2004 joint Agency-OECD/NEA meeting discussed lessons learned from 26 recent events in countries participating in the IRS. The meeting emphasized that grid reliability will continue and licensees should plan maintenance and activities to avoid vulnerable configurations. There were several incidents involving electrical systems and foreign material exclusion issues. These are long-term recurrent events. Other areas identified from the incidents discussed in the meeting were: configuration control, operating mode outside of normal operation such as at low power or during outages, human error in general, human error related to design deficiencies or design modifications, minor design changes, and events related to maintenance activities.

Three events were discussed in detail at the meeting:

- *Kakrapar, India:* (2004-03-10) This event involved an inadvertent power excursion from 73 percent to 98 percent, at which point the reactor tripped. While no safety limits were exceeded, operators did not appreciate the reactor was operating in a peak flux condition. Authorized power had been reduced to 90 percent in October 2003 due to fuel burnup and then further reduced to 75 percent in January 2004. However, the reactor trip setpoints had been left at those corresponding to the 90 percent limit. During the excursion, some fuel bundles exceeded the authorized bundle power limit, however no fuel failure occurred. Operators had also intentionally bypassed the liquid poison safety

system prior to the event. Corrective actions included physical modifications to correct the initial power supply problem and to preclude operators from inhibiting the liquid poison system. All operators were also given substantial retraining.

- *Cattenom, France:* (2004-05-16) A fire, apparently caused by a modification to a 6600 volt electrical penetration, burned for 2½ hours. The licensee had refurbished the cable in 2003, but had left it obstructed at both ends and the penetration could not dissipate heat properly. Hungary also experienced a smaller fire at Paks 2 NPP, caused by an oil-soaked rag on a main coolant pump housing.
- *Mihama 3, Japan:* (2004-08-09) Five contract workers were killed and six others were injured when a condensate water pipe in the turbine building ruptured. The licensee had not followed industry guidelines for inspecting aged secondary piping created following a similar event at Surry NPP in 1986. Furthermore, the licensee had not sufficiently applied the quality management system. This section of piping had never been inspected under the licensee's erosion/corrosion control programme. The causes of the accident are still under investigation.

Two additional events were also discussed:

- *Fessenheim, France:* (2004-01-24) There was a human error to align valves properly when the unit was in stretch-out operation. The cause of the event, failure of a relief valve, is the result of implementing a modification to correct a design fault. The potential consequences due to this event are: loss of coolant accident (LOCA) due to damage of sealing rings of the primary circuit pumps; loss of high pressure injection pumps (common mode failure of hydrostatic bearings damage); and unavailability of reactor scram in case of a stuck control rod. The incident demonstrates that human error has serious consequences and in this case could have induced a LOCA. This underlines the necessity of strictly applying procedures in all situations.
- *Loviisa 1, Finland:* (2004-07-29) An electrician was electrocuted and died and two co-workers were slightly injured during maintenance work in 6 kV switchgear in the electrical building during the annual outage. The accident did not jeopardize the function of nuclear or radiation safety related systems. The causes of the event were: failure in the work order system resulting in wrong management assumptions; lack of communication; and, lack of an independent voltage check.

The incidents at Kakrapar and Fessenheim highlight the need for continued vigilance in procedural compliance and training of operators in integrated plant operations. The Mihama 3 and Loviisa 1 events emphasize the need to properly manage non-nuclear related hazards to protect workers and assure public confidence.

Preserving the knowledge base remains an issue of concern as staff members retire, taking their experience with them. Documenting this experience and ensuring sufficient overlap between incoming and outgoing personnel are some of the methods to preserve this knowledge.

Environmental issues from events occurring in the Republic of Korea and the USA suggest the need for added vigilance in monitoring all possible plant effluents.

Other safety significant events in 2004

In 2004 two new research reactors were commissioned (MNSR in Nigeria and FRM II in Germany) and the operating organization of the Australian Replacement Reactor submitted a licence application for operation to the Australian regulatory body, with commissioning planned to start in the second half of 2005.

Some of the radioactive source events reported to the Agency during 2004 included:

- *Aibonito, Puerto Rico:* (2004-04-21) In the course of trying to repair a source rack upper-limit switch (up-switch) at a panoramic wet-source pool irradiator used for sterilizing medical supplies, two workers received radiation doses of 44 and 28 millisieverts (mSv) respectively, close to the USNRC annual regulatory limit of 50 mSv. The USNRC investigation determined a number of root causes to this event, including: failure to perform surveys that were adequate to ensure that sources were in a safe storage condition before defeating safety interlocks and entering the irradiator; failure to identify underlying causes of persistent maintenance problems with the limit switch; and, failure of licensee personnel to have a complete understanding of the operation and use of the irradiation room radiation monitor. (INES Rating: 3)
- *Pecos County, Texas, USA:* (2004-07-09) A well logging crew was using a rig without a floor at a well site. After moving to a new site, the crew realized that a cesium-137 (Cs-137) collimated sealed source was missing from the well logging tool. The source was found in mud near the previous rig location, after having been missing for between 24 and 36 hours. The investigation concluded that a member of the drilling crew might have picked up the source by hand. The investigation determined that the logging crew had not performed radiation surveys or followed written operating procedures. (INES Rating: 2)
- *Argentina:* (2004-09-27) A radioactive source was detected by monitoring equipment installed to survey scrap iron entering a scrap metal dealer. The Nuclear Regulatory Authority (ARN) responded and took control of an orphaned Cs-137 source commonly used in ships. A subsequent investigation found three other sources —two without labels and the third with a deteriorated label — at a farm. ARN removed the sources to a suitable storage location. (INES Rating: 2)
- *Porvoo, Finland:* (2004-10-20) Two radiographers received elevated doses after a source failed to retract to its locked position after exposure. The radiographers had personal alarming rate meters, but because of the noisy environment, did not hear the alarm until they had moved the device to the next workplace. Preliminary investigation of the device showed malfunction of the locking mechanism, allowing the device to lock while the source is not totally shielded. (INES Rating: 1)

United Nations Chernobyl Forum

The United Nations Chernobyl Forum consists of relevant international organizations[28] from within the UN family and representatives of the three countries[29] primarily affected by the Chernobyl accident. The Forum was established with a view to contributing to the implementation of the new UN strategy, *Human Consequences of the Chernobyl Accident — A Strategy for Recovery*, launched in 2002.

The Forum's goal is to issue authoritative statements and recommendations that will contribute to overcoming the widespread disagreements over the long-term impact of the Chernobyl accident. International experts are preparing reports to assist the affected countries optimise activities related to remediation of contaminated land and health care to people affected by the accident. The Forum will then discuss and approve these reports.

Since the Forum's launch, the Agency has organized three political level Forum meetings and five meetings of the Expert Group *Environment*. This expert group is considering radionuclide release and deposition, environmental contamination, environmental remediation, human exposure levels and radiation effects on biota. During the same time period, WHO organized three meetings of the Expert Group *Health*. This expert group is considering acute health effects and radiation induced mortality, thyroid cancer in the general public, leukaemia and solid cancers, non-cancer health effects (reproductive health, cataracts, etc), human exposure levels, and special health care programmes. The Forum's comprehensive consensus technical report was completed in 2004 and submitted for comments to Forum participants. This technical report will be discussed at the 4th political level Forum meeting in April 2005. Reports for the public, summarizing the technical report, will be prepared in 2005.

The Forum has also started preparations for an international conference in Vienna titled *Chernobyl: Looking back to go forward*, to be held on 6–7 September 2005.

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[28] FAO, UN-OCHA, UNDP, UNEP, UNSCEAR, WHO, World Bank

[29] Belarus, the Russian Federation, Ukraine

Annex II

The Agency's Safety Standards: Activities during 2004

Introduction

Article III.A.6 of the IAEA Statute authorizes the Agency to "establish… standards of safety… and to provide for the application of these standards" to its own operations, to assisted operations, to operations under bilateral or multilateral arrangements (at the request of the parties), and to any of a State's activities (at the request of that State). The preparation and review process for IAEA Safety Standards is described in the Attachment to GOV/INF/2001/1.

An Action Plan for the development and application of IAEA Safety Standards was submitted to the Board of Governors in March 2004 (GOV/INF/2004/10-GC(48)/INF/7). The Action Plan pays special attention to providing for the application of standards and collecting feedback on their use and to putting in place a rigorous process to review other Agency safety related publications developed outside the IAEA Safety Standards programme.

The categories of IAEA Safety Standards in the Safety Standards Series are Safety Fundamentals, Safety Requirements and Safety Guides. Safety Fundamentals present basic objectives, concepts and principles; Safety Requirements establish the requirements that must be met to ensure safety (*shall* statements); and Safety Guides provide recommendations and guidance on how to comply with the safety requirements (*should* statements). Safety Fundamentals and Safety Requirements require the approval of the Board of Governors. Safety Guides are issued under the authority of the Director General.

The IAEA Safety Standards cover five safety areas:

- nuclear safety: safety of nuclear installations;
- radiation safety: radiation protection and safety of radiation sources;
- transport safety: safety of transport of radioactive materials;
- waste safety: safety of radioactive waste management; and
- general safety: of relevance in two or more of the above four areas.

The topics in the general safety area include legal and governmental infrastructure for safety, emergency preparedness and response, assessment and verification, and management systems.

All IAEA Safety Standards are prepared and reviewed in accordance with a uniform process, involving a set of four Committees — the Nuclear Safety Standards Committee (NUSSC), the Radiation Safety Standards Committee (RASSC), the Transport Safety Standards Committee (TRANSSC) and the Waste Safety Standards Committee (WASSC) — with harmonized terms of reference to assist the Secretariat in preparing and reviewing all standards, and a Commission on Safety Standards (CSS) to assist the Secretariat in coordinating the activities of the Committees.

Thirteen IAEA Safety Standards were published in 2004:

- Nuclear safety: six safety guides;
- Radiation safety: two safety guides;

- Transport safety: transport regulations;
- Waste safety: one safety guide; and,
- General safety: two safety guides.

Since the establishment of the CSS and the Committees in 1995, a total of 67 IAEA Safety Standards have been endorsed by the CSS for publication; of those, 63 (10 Safety Requirements and 53 safety guides) have been published; and 38 further standards (one safety fundamentals, eight requirements and 29 safety guides) are being drafted or revised. A list of IAEA Safety Standards, indicating their current status, is attached as Annex I, and up-to-date status reports can be found on the Agency's WorldAtom Web site, at http://www-ns.iaea.org/downloads/standards/status.pdf. The full text of published IAEA Safety Standards is also available on the Web site, at http://www-ns.iaea.org/standards/.

The Agency is working on a draft DS 298 Unified Safety Fundamentals document to replace the Safety Series No. 110, No. 111-F and No. 120. In 2004, the four Safety Standards Committees reviewed the draft and, with some modifications, approved its submission to Member States for comments. The revised draft will be submitted to the Member States in early 2005. After consideration of comments by the Member States the draft will be submitted to the CSS for review and the Board of Governors for approval.

The members of the four Committees are appointed for three-year terms. The third such term expired at the end of 2004; the Committees are currently in the process of being reconstituted for the 2005–2007 period. The reconstituted Committees will have modified terms of reference giving more emphasis to the use of standards and sharing of the experience from their use. The current term of the CSS is for the four-year period of 2004–2007.

In June 2004 the Board approved the publication of the *Transport Regulations Edition 1996 as amended 2003*, and they were published later in 2004. In November 2004 the Board approved the publication of the *Transport Regulations Edition 2005*.

Commission on Safety Standards (CSS)

The CSS chaired by Mr. Laurence Williams, Her Majesty's Chief Inspector of Nuclear Installations and Head of the Nuclear Safety Directorate of the Health and Safety Executive, United Kingdom met twice during 2004, in June and November.

With the Board's approval of the Action Plan in March 2004, more attention is now given to the use of safety standards in Member States and feedback of experience from their use.

At its June 2004 meeting, the CSS endorsed the 2005 edition of Transport Regulations, which was approved at the November session of the Board of Governors. The CSS also approved the publication of a safety guide onRS-G-1.7: *Application of the Concepts of Exclusion, Exemption and Clearance*. The safety guide was developed in response to General Conference resolution GC(44)/RES/15. Its development proved to be challenging but the results are rewarding and exceptionally helpful for regulators worldwide; for the first time radiation levels in commodities are addressed based on scientific knowledge. At its November 2004 meeting, the CSS approved the publication of three further safety guides.

Nuclear Safety Standards Committee (NUSSC)

NUSSC, chaired by Mr. Lasse Reiman of the Radiation and Nuclear Safety Authority (STUK) of Finland, met twice during 2004.

At its meetings in April and October 2004, NUSSC endorsed three draft IAEA Safety Standards for submission to the CSS (in some cases subject to specified comments being incorporated). These draft IAEA Safety Standards included the *Safety Requirements, Management Systems for the Safety of Facilities and Activities involving the use of Ionizing Radiation*.

NUSCC also endorsed the proposals for the new overall safety standards structure and commented on the draft DS 298 *Unified Safety Fundamentals*. This Fundamental will replace the Agency's Safety Series No. 110, No. 111-F and No. 120.

The updating of the IAEA Safety Standards in the areas of nuclear power plant design and operation is complete. However, the new overall safety standards structure has identified the need for a number of new Safety Guides. The proposals for seven of these new Safety Guides were endorsed by NUSSC in 2004. In the near term, the focus of attention for NUSSC will be on the completion of the Safety Guides for research reactors and to continue with the development of the Requirements and Guides for fuel cycle facilities and of the Safety Requirements and Guides for management systems. These Requirements and Guides will eventually replace the IAEA Safety Standards on quality assurance that were published in 1996.

NUSCC also endorsed the Three-Years Report of the third term of the Committee.

Radiation Safety Standards Committee (RASSC)

RASSC, chaired by Mr. Ian Robinson of HM Nuclear Installations Inspectorate, United Kingdom, met twice in 2004, in March and October. Each meeting included a joint session with WASSC to discuss issues of common interest.

One of the major achievements of RASSC and WASSC during 2004 was the approval and publication of the Safety Guide *Application of the Concepts of Exclusion, Exemption and Clearances* (RS-G-1.7), as discussed in the section on WASSC.

At the March meeting, RASSC approved a Safety Guide on *Strategies for Environmental and Source Monitoring for Public Protection Purposes* and a Safety Guide on *Radiation Protection Aspects of Design for Nuclear Power Plants* for submission to the CSS.

At the October meeting, RASSC approved a Safety Guide on *Categorization of Radioactive Sources* for submission to the CSS. RASSC reviewed the draft DS 298 *Unified Safety Fundamentals*, and approved its circulation to Member States for comment. RASSC also approved Safety Requirements on management systems, and two Safety Guides on implementation of remediation process for past practices and accidents, and the removal of sites and buildings from regulatory control for circulation to Member States for comment, for which other Committees were the lead Committees.

RASSC also reviewed reports from the Secretariat on the implementation of the Action Plan. RASSC received a report 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), and was informed that a Document Preparation Profile for the review and revision of the BSS will be presented to RASSC at its meeting in April 2005.

RASSC endorsed the Three-Years Report of the third term of the Committee.

Transport Safety Standards Committee (TRANSSC)

TRANSSC, which was chaired by Mr. Clive Young of the Department for Transport, United Kingdom, met once in March 2004 in a joint meeting with RASSC and WASSC.

The major achievements of TRANSSC were the publication of the Transport Regulations, 1996 Edition (as amended 2003) and the approval by the Board of Governors for publication of the 2005 Edition. These documents have been incorporated into the other documents on safety of transport of dangerous goods published by the United Nations, the International Civil Aviation Organization and the International Maritime Organization. It is expected that Member States will adopt the requirements of the Transport Regulations within two to four years.

In addition to the Transport Regulations, TRANSSC has recommended the continued development of guidance documents on radiation protection, management systems in transport operation, and management systems for the regulation of transport. TRANSSC expects to review the first documents in 2005. These documents will improve protection of workers and the public during transport.

TRANSSC will consider the Three-Years Report of the third term of the committee at its March 2005 meeting.

Waste Safety Standards Committee (WASSC)

WASSC, chaired by Mr. Luc Baekelandt of the Federal Agency for Nuclear Control, Belgium, met in March and October in 2004. Each meeting included a joint session with RASSC and the meeting in October included a joint meeting with the International Radioactive Waste Technical Committee to discuss issues of common interest.

One of the major achievements by RASSC and WASSC during 2004 was the publication of a new Safety Guide *Application of the Concepts of Exclusion, Exemption and Clearances* (RS-G-1.7). This Safety Guide was developed following General Conference resolution GC(44)/RES/15 in 2000, requesting the Secretariat to develop criteria for radionuclides in commodities. The Safety Guide specifies levels of activity concentration that can be used in the practical application of the concepts of exclusion, exemption and clearance established in the BSS. The document also provides guidance for the application of the values to commodities in trade, and for a graded approach in their application.

Another major achievement by WASSC in 2004 was the approval for submission to the CSS of the Safety Requirements *Geological Disposal of Radioactive Waste*. This Safety Requirements was developed with the co-sponsorship of the OECD/NEA.

In 2004, WASSC reviewed and approved for circulation to Member States the Safety Requirements standards on decommissioning and the Safety Guide on rehabilitation of contaminated areas. The publication of these documents will complete the set of standards in these areas.

WASSC also reviewed and approved for circulation to Member States the Safety Guide on *Borehole Facilities and Management Systems*.

Based on the new safety standard structure and the Action Plan, WASSC has begun reviewing new safety standards, including the new thematic Safety Requirements on radioactive waste management and the new facility-specific Safety Requirements on disposal of radioactive waste. WASSC is also preparing to review documents that were published more than five years ago.

WASSC reviewed draft DS 298 *Unified Safety Fundamentals*. WASSC commented that the important principles contained in *Principles of Radioactive Waste Management* (111-F) should not be lost in the new Safety Fundamentals. WASSC approved the draft for circulation to Member States for comment.

WASSC endorsed the Three Years Report of the third term of the committee.

Appendix 1: The Current IAEA Safety Standards

Safety Fundamentals

110	The Safety of Nuclear Installations (1993)
111-F	The Principles of Radioactive Waste Management (1993)
120	Radiation Protection and the Safety of Radiation Sources (1996) **Co-sponsorship:** FAO, ILO, OECD/NEA, PAHO, WHO.

The Safety Fundamentals are being revised combining the three documents into one.

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)
50-SG-O6	Preparedness of the Operating Organization (Licensee) for Emergencies at NPPs (1982)
98	On-Site Habitability in the Event of an Accident at a Nuclear Facility (1989)
109	Intervention Criteria in a Nuclear or Radiation Emergency (1994)

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

Management Systems

Safety Series

No.50-C/SG-Q	Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations (1996) under revision.

Safety Guides (1996)

Q1	Establishing and Implementing a Quality Assurance Programme
Q2	Non-conformance Control and Corrective Actions
Q3	Document Control and Records
Q4	Inspection and Testing for Acceptance
Q5	Assessment of the Implementation of the Quality Assurance Programme

Q6	Quality Assurance in the Procurement of Items and Services
Q7	Quality Assurance in Manufacturing
Q8	Quality Assurance in Research and Development
Q9	Quality Assurance in Siting
Q10	Quality Assurance in Design
Q11	Quality Assurance in Construction
Q12	Quality Assurance in Commissioning
Q13	Quality Assurance in Operation
Q14	Quality Assurance in Decommissioning. under revision.

Six new 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, in print)

A new Safety Requirement on safety assessment and verification is 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 (2002)
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 (2003)
NS-G-3.6	Geotechnical Aspects of NPP Site Evaluation and Foundations (2004)

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
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 radiation protection (2005, in publication)
RS-G-1.9	Categorization of Radioactive Sources (2005, in publication)

Two new Safety Guides, on safety of radiation sources and on naturally occurring radioactivity, 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)
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 (2004)

Two new Safety Guides on: safety assessment for nuclear and radiation facilities; and on storage of radioactive waste are being developed.

Decommissioning

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)

A new Safety Requirements on decommissioning of nuclear facilities is being developed.

Rehabilitation

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

A Safety Guide on implementation of remediation process is being developed.

Transport Safety

TS-R-1	Regulations for the Safe Transport of Radioactive Material 1996 Edition (as amended 2003), (2004)
TS-G-1.1	Advisory Material for the Regulations for the Safe Transport of Radioactive Material (2002)
TS-G-1.2	Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material (2002)

One Safety Guide on management systems for the safe transport of radioactive material is being developed.

Facility Specific Safety Standards

Design of Nuclear Power Plants

NS-R-1	Safety of Nuclear Power Plants: 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 Nuclear Power Plants (2001)
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 Nuclear Power Plants (2003)
NS-G-1.5	External Events Excluding Earthquakes in the Design of Nuclear Power Plants (2003)
NS-G-1.6	Seismic Design and Qualification for Nuclear Power Plants (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 Nuclear Power Plants (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 Nuclear Power Plants (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 Nuclear Power Plants (2004, in Print)
NS-G-1.12	Radiation Protection Aspects of Design for Nuclear Power Plants (2005, in publication)
79	Design of Radioactive Waste Management Systems at Nuclear Power Plants (1986)

Operation of Nuclear Power Plants

NS-R-2	Safety of Nuclear Power Plants: Operation (2000)
NS-G-2.1	Fire Safety in Operation of Nuclear Power Plants (2000)
NS-G-2.2	Operational limits and conditions and operating procedures for NPPs (2000)
NS-G-2.3	Modifications to Nuclear Power Plants (2001)
NS-G-2.4	The Operating Organization for Nuclear Power Plants (2001)
NS-G-2.5	Core Management and Fuel Handling for Nuclear Power Plants (2002)
NS-G-2.6	Maintenance, Surveillance and In-Service Inspection in Nuclear Power Plants (2002)
NS-G-2.7	Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants (2002)
NS-G-2.8	Recruitment, Qualification and Training of Personnel for Nuclear Power Plants (2002)
NS-G-2.9	Commissioning of Nuclear Power Plants (2003)
NS-G-2.10	Periodic Safety Review of Nuclear Power Plants (2003)
93	System of Reporting Unusual Events in Nuclear Power Plants (1989), under revision.

A new Safety Guide on conduct of operations is being developed.

Research Reactors

NS-R-4	Safety of Research Reactors (2004, in Print)
35-G1	Safety Assessment of Research Reactors and Preparation of the Safety Analysis Report (1994)
35-G2	Safety in the Utilization and Modification of Research Reactors (1994)

Six new Safety Guides on: commissioning; maintenance, periodic testing and inspection; operational limits and conditions; and on operating organization, recruitment, training and qualification; radiation protection and waste management; and core management are being developed.

Fuel Cycle Facilities

116	Design of Spent Fuel Facilities (1994)
117	Operation of Spent Fuel Facilities (1994)

One Safety Requirements on safety of fuel cycle facilities, and three Safety Guides on safety of uranium fuel fabrication, MOX fuel fabrication and Conversion facilities are being developed.

Radiation Related Facilities

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

Waste Treatment and Disposal Facilities

WS-R-1	Near Surface Disposal of Radioactive Waste (1999) under revision.
WS-G-1.1	Safety Assessment for Near Surface Disposal of Radioactive Waste (1999)
WS-G-1.2	Management of Radioactive Waste from the Mining and Milling of Ores (2002)
111-G-3.1	Siting of Near Surface Disposal Facilities (1994)
111-G-4.1	Siting of Geological Disposal Facilities (1994)
108	Design and Operation of Radioactive Waste Incineration Facilities (1992)
99	Safety Principles and Technical Criteria for the Underground Disposal of High Level Radioactive Wastes (1989), under revision.

Two Safety Requirements on Geological Disposal of waste and on waste disposal and two Safety Guides on the removal of sites from regulatory control and borehole disposal of waste are being developed.

Annex III

Providing for the Application of the Agency's Safety Standards: Activities During 2004

Introduction

Article III.A.6. of the IAEA Statute authorizes the Agency to "establish… standards of safety… and to provide for the application of these standards" to its own operations, to assisted operations, to operations under bilateral or multilateral arrangements (at the request of the parties), and to any of a State's activities (at the request of that State).

An integrated approach to the application of the IAEA Safety Standards is a key component of the Global Nuclear Safety Regime discussed in section C.1 of the Analytical Overview. This Annex presents the Agency's activities in 2004 related to the application of the IAEA Safety Standards, both with respect to its own operations and in Member States.

Providing for the application of the IAEA Safety Standards to its own operations

The Agency routinely monitors the occupational exposure of all staff and external experts who might be exposed to radiation as a result of their work for the Agency. A total of 559 Agency staff were monitored routinely (monthly) during 2004, along with 1358 other individuals monitored on an as-required basis. The latter group includes Technical Cooperation experts and participants in Agency training courses and missions. The external dosimetry laboratory processed about 13 500 dosimeters covering whole body and extremities. The whole body counter laboratory performed 307 measurements for fission products and 330 measurements for actinides in lungs. About 760 urine samples were analyzed by gamma, alpha, and beta spectrometry. Overall during 2004, personal doses were kept to the expected low values and the laboratories involved maintained satisfactory working conditions.

The quality management system, which has been established in the operational radiation protection services, has become deeply rooted in the daily workflow. Almost all improvement possibilities identified during the first audit of the system have been implemented and led to a general improvement of the system. Furthermore the system is now under constant surveillance by a dedicated quality manager, who is focusing the combined efforts of staff on acquiring accreditation to the international standard for the competence of testing laboratories (ISO/IEC17025). A second audit of the system showed further improvement possibilities of minor orders. Management addressed these as well, resulting in an increase to the workforce in critical parts of the service, which will substantially increase the quality of occupational radiation protection monitoring services. All support activities were carried out in full compliance with the Agency's Radiation Protection Rules and Procedures, and

the International Basic Safety Standards (BSS) for Protection against Ionizing Radiation and for the Safety of Radiation Sources.

The Radiation Protection Committee undertook a fundamental review of the arrangements relating to radiation safety in the Agency. The Director General accepted the Committee's proposals and implementation is underway.

Thematic action plans

Action plan for the development and application of IAEA Safety Standards

In March 2004, the Board of Governors approved the action plan for the development and application of IAEA safety standards. More details on this work are included in the Annex II.

Safety of research reactors

In Resolution GC(45)/RES/10.A, the IAEA General Conference endorsed a decision of the Board of Governors to request the Secretariat to develop and implement, in conjunction with Member States, an international research reactor safety enhancement plan. In 2004, work was completed on the Code of Conduct on the Safety of Research Reactors and work continued to develop a Safety Requirements document to supersede and update the content of two former safety standards, one on design and one on operation.

Several mechanisms are available to monitor the safety of research reactors. The most extensive safety assessment is the Integrated Safety Assessment of Research Reactors (INSARR) mission, which addresses all aspects of operational safety. Other Agency review missions, such as the International Regulatory Review Team (IRRT) provide information on the regulatory control of research reactors, as do the special purpose missions that address specific issues. In addition to the primary missions, follow-up missions are used to assess progress and verify implementation of recommendations.

The survey of research reactor safety was initiated in 2002 and, by December 2002, responses had been received for 233 reactors. These responses were analysed and a report was posted on the Agency website in February 2003. A further request in 2004 yielded 20 additional responses. Additional analysis of all responses received has been completed, and the 2003 report is being updated. Overall, questionnaires have been received from about 59% of the reactors listed as operational in the Research Reactor Database (RRDB) and 26% of those listed as shutdown. Most of the reactors that have not responded are located in two Member States, each having a large nuclear programme.

Generally, the responses to the survey from the operational reactors indicated that operational safety and regulatory supervision were being handled in a reliable and effective manner. Overall, the responses indicated that attention should be focused on the areas of quality assurance, radioactive waste management and off-site emergency planning. The responses from the reactors in a shutdown status did not communicate such a positive picture; however, the primary areas in which attention is needed mirrored those of the operating reactors, specifically, quality assurance, waste management and (holistically) emergency preparedness. Just as important as these insights, however, is the fact that two of the primary assumptions that formed the basis for conducting the survey were called into question.

First, no operational or shutdown reactors reported being without some form of independent oversight and over 90% reported supervision by a formal regulatory body. However, additional assessment to determine the quality of this oversight is needed. Second, over 80% of the reactors in a shutdown status reported that they did have plans to either restart or decommission (as opposed to the presumption that numerous reactors throughout the world had, effectively, been abandoned). The point of emphasis for the Secretariat, therefore, should be to focus on the quality of regulatory oversight within Member States and to encourage operating organizations and national authorities to make and implement their plans concerning the resumption of operations or the initiation of decommissioning activities.

Safety of radiation sources and security of radioactive material

The revised Code of Conduct on the Safety and Security of Radioactive Sources was approved by the Board of Governors in September 2003. By the end of 2004, 70 States (including some that are not Agency Member States) had made a political commitment to supporting the Code. Some States, and the European Union, have taken steps to promote the Code. The Code was published by IAEA in January 2004 (IAEA/CODEOC/2004).

In February 2004, the Secretariat convened an open-ended group of technical and legal experts to develop guidance on the import and export of radioactive sources to facilitate the implementation of the Code of Conduct. Following consensus among the experts, the Board of Governors approved this Guidance at its September 2004 meeting. Also in 2004, the Commission on Safety Standards approved a Safety Guide on the categorization of radioactive sources, which was based on TECDOC-1344: "Categorization of Radioactive Sources".

In September 2004, the Board of Governors approved an Agency policy for promoting effective and sustainable national regulatory infrastructures for the control of radiation sources. This policy, and the associated actions to implement it, are described in GOV/2004/52-GC(48)/15.

Radiological protection of patients

In September 2002, in resolution GC(46)/RES/9.A, the General Conference endorsed the decision of the Board of Governors to approve the action plan for the radiological protection of patients. A steering panel comprising a group of senior experts in various fields met in Madrid in January 2004 and made a number of recommendations.

A number of activities were also undertaken in 2004 under the action plan. Train-the-trainer events were held for Latin America and East Asia and the Pacific regions and there were two regional and six national training courses for radiographers and radiologists. There was also a radiation protection training course for interventional cardiologists from 25 countries and regional workshops on accidental exposures in radiotherapy.

An outline requirements document was produced at a meeting of a group of experts with manufacturers and representatives of the International Electrotechnical Commission regarding standardizing, displaying and recording data related to patient doses for CT, fluoroscopy and interventional techniques.

The methodology for establishing local guidance (reference) levels for diagnostic radiology has been developed and is being applied in a regional project involving 11 Latin American Member States. Pilot projects on image quality improvement and patient dose reduction have been launched in Kazakhstan, Moldova, Jordan and Kuwait. Five countries in East Asia have been provided with equipment for quality control testing.

Occupational radiation protection

The Board of Governors approved the action plan for occupational radiation protection in September 2003. The overall objective is to focus the efforts of the relevant international organizations, in particular the Agency and the ILO, to assist Member States in establishing, maintaining and, where necessary, improving programmes for the radiation protection of workers. The action plan also includes ongoing activities related to exposure to enhanced natural radiation in the workplace. The first meeting of the steering committee was held in Vienna from 4–6 February 2004 to consider the actions making up the action plan and set priorities. The steering committee agreed to meet at intervals of 12–18 months.

A Safety Report on Occupational Radiation Protection in the Mining and Processing of Raw Materials, co-sponsored by the Agency and the ILO, was published in April 2004. Also in 2004, the Agency published the French and Spanish language versions on two Safety Guides co-sponsored by the ILO — Occupational Radiation Protection and Assessment of Occupational Exposure due to External Sources of Radiation (published in English in 1999).

An interregional training course for Europe and East and West Asia regions on radiation protection and the management of radioactive waste in the oil and gas industry was held in May 2004.

Radioactive waste management

The most recent version of the action plan on the safety of radioactive waste management was approved by the Board of Governors in September 2003. The modified plan contains actions on the following topics: a common framework for radioactive waste management and disposal; assessment of the safety implications of extended storage of radioactive waste; safety standards on geological disposal; harmonized approach for removing materials and sites from regulatory control; systematic programme for application of Agency waste safety standards; transfer of knowledge to future generations; the broader social dimensions of radioactive waste management; policies for control of discharges to the environment; and, management of spent sealed sources.

Safety of transport of radioactive material

The use of radioactive material necessitates its transport in the public domain and therefore careful attention needs to be paid to the safety of the public and workers involved, as well as of the environment. Many types of radioactive material and all modes of transport are involved. Provisions compatible with the IAEA *Regulations for the Safe Transport of Radioactive Material* have been adopted into domestic requirements by many Member States. In addition, these Regulations serve as the basis for the "model regulations" of the United Nations Economic and Social Council's Subcommittee of Experts on the Transport of Dangerous Goods. In 2003, the IAEA General Conference, in resolution GC(47)RES/7.C, requested that the Agency develop an action plan. In March 2004, the Board of Governors approved the action plan on the safety of transport of radioactive material. Major elements of the action plan include: regulations and regulatory activities; guidance documents; denial of shipments; transport safety appraisals; research; training; and, emergency preparedness and response.

A number of activities have already taken place under the action plan. Regarding denial of shipments, a fact-finding forum was held in July 2004 and a consultants meeting in August 2004 to analyse the results of the forum. In September 2004, the Review Panel for the *Regulations for the Safe Transport of Radioactive Material 2007 Edition* had its first meeting. And in October 2004, a consultant's meeting was held to review a draft standard on quality assurance.

Decommissioning of nuclear facilities

In June 2004, the Board of Governors approved the action plan on decommissioning of nuclear facilities. The safe decommissioning of nuclear facilities requires a systematic approach that begins during the design stage of a facility and continues through each stage of the facility's life until the facility is removed from service, dismantled, and finally removed from regulatory control. During each of these stages, certain actions must be performed to ensure that an eventual safe termination of control can be achieved.

The action plan includes developing a Safety Requirements document on the safety of decommissioning and reviewing existing Safety Guides to ensure coherence with the Safety Requirements and to take account of experience. A number of Safety Reports will also be prepared and workshops and specialized courses on decommissioning small industrial, medical, and research facilities will be held. A new web-based forum for exchange of information on the decommissioning experience will be established.

In 2004, the Agency published *Status of the Decommissioning of Nuclear Facilities around the World* as one of the first steps of the action plan.

Strengthening the international preparedness and response system for nuclear and radiological emergencies

In June 2004, the Board of Governors approved the action plan for strengthening the international preparedness and response system for nuclear and radiological emergencies. The objectives of the plan are to minimize the consequences of any nuclear accident or radiological emergency and to harmonize countries' approaches to avoid confusion and mistrust by the public, by providing internationally agreed standards and criteria for response to such events, and by assisting in the strengthening and maintenance of national, local and on-site response capabilities. Major activities on the plan include: collecting and disseminating information on methodologies, techniques and available results of research relating to response to nuclear or radiological emergencies; completing a number of Safety Guides; reviewing and updating as necessary a number of technical response manuals; making available a consolidated summary of lessons learnt from past experience that underpin the safety standards; revising the INTERRAS computer code, user manual, workbook and training module for simple assessment of protective actions in the event of a nuclear or radiological emergency; revising the methodology and support material for certifying competent emergency response experts and lecturers for supporting the TC programme, based on results of a pilot project; and, training potential experts in the IAEA Safety Standards. This work will involve WHO, FAO, and ILO as necessary.

Providing for safety assistance

There were 190 safety-related TC projects in operation during 2004, amounting to a total budget of about $15 000 000. 69% of this amount involved topics in the fields of radiation, transport and waste safety. The remaining 31% was related to the safety of nuclear installations.

Safety of nuclear installations

National technical cooperation projects have addressed topics related to the safety of Nuclear Power Plants (NPPs) and research reactors. The scope of these projects includes the application of IAEA Safety Standards through safety review missions (e.g. OSART, IRRT and INSARR), expert advice and training activities. Topics addressed include: seismic, siting, and design safety; fire safety; operational safety; deterministic and probabilistic accident analysis; and, accident management. In addition, assistance was provided to Member States that operate WWER NPPs in the fields of design basis reconstitution, use of analytical tools in support of operational safety, analysis of severe accidents and accident management, safety assessment of component replacement and implementation of periodic safety reviews necessary for a safe management of long term operation situations. Regional technical cooperation projects supplemented the national projects in the areas of safety assessment and strengthening of regulatory infrastructure and effectiveness.

Radiation, transport and waste safety

For several years, a substantial part of the Agency assistance in the radiation and waste safety fields has been delivered through the Model Projects on upgrading radiation protection infrastructure. This was originally a single interregional project, then five regional projects, and now comprises 11 regional projects.

The total number of Member States participating in one or both of these projects in their region has increased to more than 90 by December 2004. The implementation of these projects has relied, inter alia, on new approaches characterized by the following features: (a) a proactive role of the Secretariat in identifying countries' needs and shortcomings with respect to the BSS and related safety documents; (b) national commitments; (c) standard packages aiming at responding to a country's specific needs in an integrated and harmonized fashion; and (d) Radiation Safety Infrastructure Appraisal (RaSIA) missions focused on the assessment of the effectiveness of national regulatory infrastructures.

The progress on the implementation of the Model Projects is monitored through a methodology quantified through performance indicators covering the five milestones[30] of the projects. This methodology is based on comprehensive information provided by RaSIA missions, project monitoring, expert missions and the coordination and planning meetings with participating Member States. 48 participating countries (55%) have achieved essential parameters signifying compliance with the requirements for attaining milestones 1 and 2. Specifically, these requirements have been met by 12 countries in the Africa region (40%), 8 in East Asia and the Pacific (67%), 13 in Europe (68%), 8 in Latin America (57%), and 7 in West Asia (58%). Substantial parts of activities relating to milestones 3, 4, and 5 are still to be implemented by most of the participating countries. Furthermore, tools are still being developed for the appraisal of the progress made in the areas of medical and public exposure control, as well as in the development of national plans for response to radiological and nuclear emergencies.

In May 2004, a comprehensive evaluation of the Model Projects was carried out by an independent panel under the auspices of the Office of Internal Oversight Services (OIOS). Five recognized international experts took part in the work of the OIOS Evaluation Panel (the Panel), the main tasks of which were: to assess the performance of the Secretariat in achieving the stated objectives of the

[30] Milestone 1: "The establishment of a regulatory framework". Milestone 2: "The establishment of occupational exposure control". Milestone 3: "The establishment of medical exposure control". Milestone 4: "The establishment of public exposure control". Milestone 5: "The establishment of emergency preparedness and response capabilities".

Model Projects; to evaluate the efficiency and effectiveness of management policy in the project delivery to the participating countries; and to identify best practices and lessons learned that would help in defining an optimum future approach for Agency assistance to Member States in this area. The Panel was positive about the achievements of the Model Projects and their impact in participating countries, but it proposed some changes regarding the structure and contents of follow-up projects. The shift from "milestones" (the current term) to "thematic safety areas" — a term that reflects all essential radiation protection issues, including new developments on safety and security of radioactive sources — will enable the Secretariat to address more efficiently the needs and priorities of Member States in achieving full compliance with the BSS and the Code of Conduct on the Safety and Security of Radioactive Sources.

RaSIA missions were conducted during 2004 in the following States participating in the Model Project: Azerbaijan, Bahamas, Bahrain, Bolivia, Bulgaria, Chad, China, Congo, Costa Rica, Cuba, Estonia, Ghana, Indonesia, Iran, Jamaica, Jordan, Kazakhstan, Kenya, Kuwait, Lithuania, Mali, Pakistan, Panama, Philippines, Portugal, Romania, Syria, Uganda, Ukraine, and Uruguay.

Extrabudgetary programmes

Extrabudgetary Programme on the Safety of Nuclear Installations in the South East Asia, Pacific and Far East Countries

The objective of this Extrabudgetary Programme (EBP) is to assist China, Indonesia, Malaysia, Philippines, Thailand, and Vietnam to enhance safety of NPPs and research reactors, and to strengthen their legal and governmental safety infrastructures. France, Germany, Japan, Republic of Korea, and the USA provided cash and/or in-kind contributions for the implementation of the EBP. Australia joined the EBP in 2004. Over 180 specific activities have been undertaken since the programme was initiated in 1997.

In 2004 nine regional and 25 national activities — China (10), Indonesia (5), Malaysia (4), Philippines (3), Thailand (2), and Vietnam (1) — were carried out under the EBP. These activities focused primarily on training workshops and courses, peer review missions and expert advice on matters related to regulation and safe operation of NPPs (China) and research reactors. Guidance was also provided by the Agency for countries to perform national self-assessments to review achievements and to identify priority safety actions needed. The annual programme technical meeting was convened by the Agency in December 2004 to review progress and to approve the 2005 work plan.

A steering committee was established to supervise and promote the development of the Asian Nuclear Safety Network (ANSN). The steering committee met in early 2004 in Korea and established four topical groups to lead ANSN development in the areas of safety analysis, safety culture, education and training, and operational safety. Hubs are operating in China, Japan, Korea and Germany, and the Agency has established a hub to host the master index database. National centres under development in Indonesia, Malaysia and Vietnam are being connected to the ANSN. An information technology group, led by the Agency and with representatives of all hubs, is developing technical solutions for the network. In 2004, the ANSN entered into regular operation and the database was further populated with the training material available from the Agency and participating organizations. Quality assurance procedures were developed for the data input to establish common quality measures and to assure minimum standards on the choice and content of materials distributed through the network.

The Asia Programme Management Database containing the full reports of all EBP activities has been restructured with more user-friendly interrogation options and made available, via Internet, to registered users from the EBP participating countries.

Extrabudgetary Programme on Accident Analysis and its Associated Training Programme for RBMK-1000 NPPs

In 2004 the Integrated Training and Accident Analysis System (ITAAS) was delivered and installed at Kursk NPP. ITAAS is a comprehensive and integrated (software and hardware) system that includes deterministic analysis, training, reference, and probabilistic analysis modules. It can easily be expanded to include other analysis tools and provides plant personnel, technical support organizations and regulators with a comprehensive and complete accident, safety and potential risk analysis capability. ITAAS can be configured for other NPPs or nuclear installations and is flexible and modular to accommodate changes, modifications and additions that reflect technological and computational advances or new applications.

The ITAAS training module — covering both understanding and application of the general models and features and the plant specific data and recent modifications for Kursk 1 — was developed in DVD format and is provided in English and Russian languages.

Extrabudgetary Programme on Long Term Operation of Water Moderated Reactors

In May 2003, the Agency initiated the extrabudgetary programme on safety aspects of long-term operation (LTO) of pressurized water reactors. In 2004, the programme scope and name were changed to include all water-moderated reactors. The programme activities are guided by a Steering Committee and are implemented in four Working Groups:

- Working Group 1: general LTO framework;
- Working Group 2: mechanical components and materials;
- Working Group 3: electrical components and I&C; and,
- Working Group 4: structures and structural components.

In 2004, there was one steering committee meeting, seven working group meetings and one coordinating meeting among the working groups. The Programme QA manual was developed and a Standard Review Process finalized. The Country Information Reports are close to completion and a review process to identify common elements and differences in the approaches to LTO in participating Member States and future/open issues has started. All Member States participating in the programme provide in-kind support and most contribute financial support to the programme. Argentina, China and Japan have expressed interest in joining the programme. Further detailed information is available on http://www-ns.iaea.org/projects/salto/default.htm.

Promoting safety related education and training

Safety of nuclear installations

The Agency continues to implement the Strategy for Education and Training in Nuclear Installation Safety. The expected outcomes of the strategy are national and regional training centres established and providing training in line with IAEA safety standards and standardized training material for use by lecturers and students developed by the Agency.

A training course on methodology of training, course organization, and on the use of the various Agency training materials was conducted in the United States of America in 2004. The course was oriented to professionals from Europe and East Asia engaged in human resource development, including planning, design, and conduct of education and training events.

A two-week version of the Basic Professional Training Course on Nuclear Safety was conducted on a national level in Indonesia and in Vietnam. In both cases local experts delivered most of the lectures using IAEA standard training material.

A regional workshop was held in Japan to assist in the development and maintenance of sustainable training programmes in nuclear safety and to exchange information among trainers. The workshop served as a follow-up to a workshop in China and review missions on education and training that had been conducted in Indonesia, Malaysia, Thailand, and Vietnam.

The development of standard training packages continued in 2004 and modules on self-assessment of NPPs and on level 2 PSA have been completed.

Distance learning tools for self-study were created under two different formats: (1) hypertext modules and (2) multi-media material with video and slide presentations synchronized. A hypertext module on operational safety of NPP was completed in 2004. For the second format, a special series dedicated to the IAEA nuclear safety standards was initiated and 14 videos have been produced.

In addition to the activities developed within the focus of the long-term plan, the Agency continues to deliver regular training courses and workshops (about 45 in 2004). Among those, three types constitute the basis for the understanding of the principles of safety in nuclear installations and have been conducted regularly during the last years: (1) A training course on regulatory control of NPPs was held in Germany; (2) a training course on safety assessment of NPPs to assist in decision-making was held in Spain; and, (3) the six-week Basic Professional Training Course on Nuclear Safety, traditionally conducted in France, was not held in 2004 and its future is currently under review.

Radiation, transport and waste safety

During 2004, the Agency organized and delivered five post-graduate educational courses, more than 30 specialized thematic training events and, at the request of Member States, supported more than ten national training courses. Over 700 professionals from Member States participated in these training events. The specialized training events were organized in the areas of radiation protection in medicine, transport safety, radiation protection in industrial radiography, authorization and inspection for regulators, general aspects of waste management, safety assessment for near surface disposal facilities, decommissioning of nuclear facilities, and radioactive discharges. In 2004, 55 professionals also attended an Agency “train-the-trainer” workshop.

The Agency has been developing standardized training materials in radiation protection since 2000. By the end of 2004, 25 standardized training packages on CD-ROM had been developed and more than 25 further training modules are in process. The feedback from the training centres and training event participants regarding these packages has been very positive. Also in 2004, a standard syllabus for radiation protection officer training was developed and reviewed. The final version will be available in 2005.

An Inter Centre Network (ICN), which facilitates communication and information exchange among the Agency's regional, national and collaborating training centres, is now in operation. Validated training packages and other documents, as well as reports from member training centres, are available on the ICN website.

In 2004, an Educational and Training Appraisal, which could be used to identify training needs and assess training centres, was developed.

Rendering safety reviews and expert advice

The following provides an overview of safety reviews and missions to provide expert advice conducted in 2004. An integrated approach is used to ensure the application of the IAEA Safety Standards to all safety reviews, the assessment of feedback, and the management and effective sharing of the associated knowledge base.

Infrastructure for safety

In 2004, two full scope International Regulatory Review Team (IRRT) missions were performed (full scope follow up IRRT in Armenia and China).

At the request of the Armenian Government, a follow-up IRRT mission reviewed the progress towards improvement of effectiveness of the regulatory body in Armenia in response to the recommendation from the IRRT mission held in 2002. The mission realized that major changes have taken place since 2002 that affected and may still affect ANRA's functions and responsibilities as well as human resources development.

These missions have similar findings to missions undertaken over the past few years, which have identified four main issues:

- lack of resources of the regulatory body,
- competency and training of regulatory body staff,
- staff succession planning and
- the need for both internal and external regulatory guidance.

A positive theme has also emerged from the follow up IRRT missions: In general, regulatory bodies have made significant progress in resolving issues raised during the full scope missions.

The Agency also conducts, upon request, review missions specifically related to the infrastructure for radiation and waste safety. Missions can be conducted in combination with an IRRT or separately. The latter may be of particular interest to Member States that do not have NPPs. Similar reviews are used to assess progress in achieving the milestones set out in the Model Project on upgrading radiation safety infrastructure.

Safety of nuclear installations

Site evaluation and design safety

Design considerations associated with existing and new nuclear installations continue to receive relevant attention. Significant changes are being incorporated into the new designs that are being proposed and built throughout the world. The areas of major concern continue to be: those associated with older designs; the implications of long term operations and power up-rating at all types of installations; seismic vulnerabilities; and the need to incorporate design concepts into security upgrade strategies.

The re-evaluation of the seismic safety of existing NPPs in countries operating WWER type reactors was completed in 2004 and much upgrading has been completed. Although some work still remains, the most important upgrades and fixes have been done using deterministic approaches as developed mainly in the USA but adapted to the specific conditions prevailing in those designs. Examples of such almost completed re-evaluation processes are the ones conducted for Kozloduy NPP (Bulgaria), Paks NPP (Hungary), Mochovce and Bohunice NPPs (Slovak Republic) and Krsko NPP (Slovenia) in which the Agency has actively participated. During 2004 steps were taken at the Armenian NPP to review the status reached to date in the execution of easy fixes and to define the priority actions regarding a full and comprehensive assessment programme.

The experience gained from these processes resulted in the Safety Report Series No 28, published by the Agency in 2003. In 2004 the NUSSC has approved the upgrade of this document to the Safety Guide level in order to provide guidelines for the seismic safety assessment of existing nuclear facilities in relation to those cases affected by higher seismic demands or with no original seismic qualification.

Continuing these seismic re-evaluation efforts, the use of probabilistic methods is underway at a number of sites and plants for complementing the assessment and upgrades performed using deterministic approaches. In this regard, during 2004 studies of probabilistic seismic hazard assessment for the Cernavoda (Romania) and Armenian NPPs were reviewed as part of the Engineering Safety Review Services provided by the Agency. In future, seismic PSA will make use of these seismic hazard assessments for assessing the safety vulnerabilities. Paks and Krsko NPPs have already undergone such assessment.

In relation to new nuclear facilities, the Agency continues the technical assistance to the Islamic Republic of Iran for a safe completion and operation of Bushehr NPP. The work done so far and the atypical characteristic of this project continue to provide a challenging opportunity for the validation and improvement of the Agency's Safety Standards for the design of NPPs. Particularly, a first significant step was done in 2004 to prepare the review of the seismic qualification of selected critical components while increasing the owner's capabilities for conducting such reviews.

A workshop was organised in China in 2004 on safety demonstration and market potential for High Temperature Gas Cooled Reactors. The workshop was concluded by a safety demonstration test performed at the reactor HTR-10 of the Tsinghua University. The test selected for the safety demonstration was the Loss of Primary Coolant Flow without reactor trip. The importance of this test and its significance to safety and licensing is relevant because it showed how the use of inherent properties and passive features might contribute to achieve high level of safety. In addition it showed that the evolution of the transients caused by failures or human errors in such a type of reactor is very slow if compared with similar transients on other kind of reactors. Relying as much as possible on inherent characteristics to prevent and control abnormal situations is always a preferred approach to safety as stated in the Agency's Safety Standards for NPPs.

In the arena of HTGRs of larger size, the South African design of PBMR is moving ahead and China, after the successful construction of the HTR-10, has decided to design by 2006 and to build by 2010 a new larger HTR (400 MWth) for commercial use. The safety and licensing issues associated with the construction and operation of these reactors will be topics for future consideration. The Agency has devoted a significant effort in the development of a general technology neutral safety approach for new advanced reactors. This approach will be the future basis for establishing guidance for the design, safety assessment and licensing of all advanced reactor including innovative concepts such as those under current consideration by Gen IV and INPRO.

Operational safety

The Agency's operational safety reviews continue to seek to inform and advise NPP operators and regulators on the application of IAEA Safety Standards at specific facilities and, more generally, within the Member States. Results of the operational safety reviews are fed back into the process to improve future revisions to the safety standards.

Assistance in developing a national 'operational assessment' programme is being provided to China. The project provides opportunities to study operational assessment programming and implementation (as utilized by OSART and PROSPER) and to review various applicable operational assessment programmes in Member States. Training is also being provided for evaluators and team leaders along with expert assistance and guidance in developing and implementing the programme.

Operational Safety Review Team (OSART)

In 2004 six OSART missions, one Pre-Commissioning OSART mission and three follow-up visits were conducted. Four of these missions were to countries with developed nuclear programmes. This trend is projected for 2005 and 2006 and shows a firm commitment throughout the world to use the Agency's safety services and standards for further improvements in operational safety. Of particular note in 2004 were the invitations and preparatory meetings to the Russian Federation and the United States of America to conduct OSART missions to those countries on a three-year schedule to coincide with the Convention on Nuclear Safety. In addition, many countries have institutionalised the Agency's OSART programme by incorporating this service into their periodic safety review programme.

OSART mission results have shown overall improvements in the material condition of structures, systems and components, as well as improvements in management goals and emphasis on staff training programmes. Most OSART recommendations centre around areas of procedure and policy implementation, adherence and enforcement to industrial safety work practices, management oversight and enforcement of nuclear safety work practices, and implementation of operating experience programmes for low-level events and near misses.

Peer Review of Operational Safety Performance Experience (PROSPER)

The Agency, in consultation with the Member States, has developed the Peer Review of the Effectiveness of Operational Safety Performance and Experience Review process (PROSPER). In 2004, a workshop on PROSPER was held in China and preparatory meetings and seminars held in Pakistan and Spain.

The PROSPER technique also serves a basis for the enhanced review of operating experience conducted as part of some OSART missions.

Safety assessment

The development of Probabilistic Safety Assessment (PSA) has become a regular requirement for each NPP in most countries. Since NPP operators and regulators are making greater use of PSA results in combination with deterministic approaches for safety related decisions, there is an international consensus that peer review of a PSA, by independent and experienced PSA practitioners, would enhance the PSA quality. Consequently this peer review, similar to that done in International Probabilistic Safety Assessment Review Team (IPSART) missions, would strengthen PSA credibility in supporting safety related decision making during plant design and operation. In addition, the Agency continues to support Member States in the development and use of PSA through the conduct of workshops, training activities and technical meetings. Even though PSA techniques are mature, they continue to evolve to address emergent and more difficult aspects.

Two IPSART missions were conducted in 2004 to verify the adequacy of modelling data and important methodology issues stemming from the development of the PSAs for Tianwan NPP in China and Sizewell B NPP in the United Kingdom.

Safety of research reactors

In 2004, one Integrated Safety Assessment of Research Reactors (INSARR) mission was conducted in the Democratic Republic of the Congo. In addition, one Pre-INSARR was conducted in the Netherlands. Five follow-up INSARR were done in Bangladesh, Chile, Greece and Romania (two).

Radiation, transport and waste safety

In addition to the service providing peer reviews of radiation safety infrastructure, the Agency offers safety review and advisory services on request in relation to occupational radiation protection (ORPAS), emergency preparedness (EPREV), the safety and security of radioactive sources, transport operations (TranSAS), safety assessment of radioactive waste management and decommissioning. These services are tailored to the particular needs of the requesting State. In 2004, ORPAS missions were conducted in China and Malaysia, an EPREV mission in Indonesia and a TranSAS mission in France, while a pre-TranSAS mission was carried out in Japan. In addition, a peer review of the licence application for Australia's proposed near-surface national radioactive waste repository was carried out.

Fostering safety related information exchange

Conferences and other meetings

International conferences and other major meetings have been organized by the Agency in cooperation with other international organizations. These events are reported throughout this Annex under the relevant thematic area and in Annex I: Safety Related Events and Issues Worldwide during 2004, and include, inter alia, the International Conference on Topical Issues in Nuclear Installation Safety: Continuous Improvement of Nuclear Safety in a Changing World, held in October 2004 in Beijing, China.

Publications

Publications under the safety standards series are reported in Annex II. Therefore, this section only addresses other safety-related publications in 2004.

In recent years, orphan sources have caused multiple fatalities or serious injuries when unknowing individuals find them. This problem, along with concern that orphan or vulnerable sources might be acquired for malicious purposes, has led many countries to consider making concerted efforts to improve control over them. TECDOC-1388 "Strengthening Control Over Radioactive Sources in Authorized Use and Regaining Control Over Orphan Sources: National Strategies" provides a methodology as to how to do this.

TECDOC-1397 "Long Term Behaviour of Low and Intermediate Level Waste Packages under Repository Conditions" provides an overview of scientific and technical issues related to the behaviour and performance of a wide range of low and intermediate level waste packages in the context of overall repository performance and safety. Specific approaches for the testing and assessment of waste package components, including modeling considerations in predicting waste package performance, are presented and discussed.

The radioactive gases radon and thoron and their decay products are ubiquitous in the open atmosphere. They are found in higher concentrations in the confined atmospheres of buildings and underground workplaces where workers are exposed to these radionuclides. Safety Reports Series No. 33: "Radiation Protection against Radon in Workplaces other than Mines," co-sponsored by the ILO, is intended for use in the application of radiation protection principles in those workplaces where employers may not have an extensive background in radiation protection. It provides practical information on action levels for workplaces, on monitoring techniques and on actions aimed at reducing exposures to radon and thoron and their decay products when necessary. It is also intended to assist regulatory bodies in establishing their own national policies in controlling high radon and thoron exposures of non-mining workforces.

The oil and gas industry, a global industry operating in many Member States, makes extensive use of radiation generators and sealed and unsealed radioactive sources, some of which are potentially dangerous to human health and to the environment if not properly controlled. In addition, significant quantities of naturally occurring radioactive material (NORM) originating from the reservoir rock are encountered during production, maintenance and decommissioning. Safety Report Series No. 34 "Radiation Protection and the Management of Radioactive Waste in the Oil and Gas Industry" provides practical information, based on good working practices, on radiation protection and radioactive waste management in the oil and gas industry. The Safety Report was drafted and finalized in six consultants meetings and one Technical Committee meeting, held during the period 1997–2002. In addition, the draft formed the basis for a regional workshop held in the Syrian Arab Republic in 2000.

Safety Reports Series No. 36: "Safety Considerations in the Transition from Operation to Decommissioning of Nuclear Facilities" and Technical Reports Series No. 420 "Transition from Operation to Decommissioning of Nuclear Installations" provide information to support and extend the recommendations given in IAEA Safety Guides. They highlight technical, management and organizational issues arising during the transition period and provide guidance to minimize delays and undue costs, optimize personnel and other resources, and initiate preparatory activities for decommissioning.

Among the various efforts to improve operational safety of nuclear installations, the systematic collection, evaluation and feedback of operational experience are considered valuable and effective.

This may be achieved by establishing a system for the effective feedback of operating experience. Such a system enables all safety related events to be analyzed, root causes determined and corrective and preventive actions implemented to avoid "repeat events" or new events rooted in the same causes. TECDOC-1417: "Precursor Analyses — The Use of Deterministic and PSA Based Methods in the Event Investigation Process at Nuclear Power Plants" outline a synergistic process that makes more effective use of operating experience event information by combining the insights and knowledge gained from both traditional root cause event investigation and PSA based event analysis.

Intercomparison and validation of computer codes for thermalhydraulics safety analyses enhance the confidence in the predictions made by these codes. TECDOC-1395 "Intercomparison and Validation of Computer Codes for Thermohydraulic Safety Analysis of Heavy Water Reactors" summarizes the work done under a project to compare the results obtained from six participating countries using four different computer codes against the RD-14M Large-Loss Of Coolant Accident (LOCA) test B9401 simulating heavy water reactor LOCA behaviour conducted by Atomic Energy of Canada Ltd.

Decommissioning of nuclear facilities is a process involving activities such as radiological characterization, decontamination, dismantling of plant, equipment and facilities, and the handling of waste and other materials. Many organizational and management needs arise during the course of decommissioning projects. With growing experience in the decommissioning of some large scale nuclear installations, including the completion of projects over several years, TECDOC-1394: "Planning, Managing and Organizing the Decommissioning of Nuclear Facilities: Lessons Learned" consolidates practical experience, issues and lessons learned. The Agency also published "Status of the Decommissioning of Nuclear Facilities around the World" in 2004, which reviews and summarizes the decommissioning activities that have been performed to date, those that are currently underway and those that will need to be performed in the future.

The fast reactor has been the subject of research and development programmes in a number of countries for more than 50 years. Now, despite early sharing and innovative worldwide research and development, ongoing work is confined to China, France, India, Japan, the Republic of Korea, and the Russian Federation. TECDOC-1405: "Operational and Decommissioning Experience with Fast Reactors" documents the results of an Agency technical meeting hosted by CEA, Centre d'Etudes de Cadarache, France, held 11–15 March 2002.

Information systems

Information System on Occupational Exposure

For more than ten years, the OECD/NEA and the Agency have jointly operated the Information System on Occupational Exposure (ISOE) and currently covers about 93% of the world's NPPs. It provides a communication and experience exchange network for radiation protection managers at NPPs and has contributed to the downward individual and collective dose trends in NPPs. At the end of December 2004, there were 13 utilities and nine regulatory authorities from 11 Member States participating in the ISOE through the Agency's ISOE Technical Centre.

The European Technical Centre held the 4th ISOE European Workshop on Occupational Exposure Management at NPPs on 24–26 March 2004 in Lyon, France. The issue of itinerant workers was discussed not only in the regulators meeting, but also by radiation protection managers and in the group discussions. Many aspects on the problems connected with itinerant workers were presented. The group discussions covered many other items of relevance to the occupational radiation protection programme, for example education and training, self-assessment, and worker awareness. Outcomes from the workshop will be useful in implementing the *Action Plan for Occupational Radiation Protection* and in implementing related TC projects.

Incident Reporting System

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. Over the twenty years the IRS has proved its usefulness as a comprehensive source of information for worldwide operating experience and lessons learned from that experience.

The IRS is an essential element of the mechanism for providing feedback of international operating experience for NPPs. It ensures proper reporting and feedback of safety significant events for the international community, so that the causes and lessons learned can be disseminated widely. In this way, the IRS plays an important role in contributing to the prevention of occurrence or recurrence of incidents. The information provided through IRS is also useful for making improvements in design, operational procedures, organizational aspects and human factors in NPPs.

Activities within the IRS extend beyond the exchange of IRS reports. The Agency and the OECD/NEA have assigned working groups of experts who meet annually and discuss the safety relevance of events, thus contributing to the dissemination of lessons learned to the international community and to the safe operation of NPPs.

In 2004, the IRS meeting discussed lessons learned from 26 recent events in all countries participating in the IRS through presentations made at the meeting. The meeting emphasized that grid challenges will remain and NPP operators should plan maintenance and activities to avoid vulnerable configurations. There were several incidents involving electrical systems and foreign material exclusion issues. Those are long-term recurrent events. Other areas identified from the incidents discussed in the meeting were: configuration control; operating mode outside of normal operation such as at low power or during outages; human error in general and human error related to design deficiencies or design modifications; minor design changes; and, events related to maintenance activities.

The number of countries participating in the Incident Reporting System for Research Reactors (IRSRR) increased from 38 to 42 in 2004, covering more than 90% of the current research reactor population. The Agency and the State Scientific Centre of the Russian Federation at the Research Institute of Atomic Reactors Dimitrovgrad jointly conducted a workshop on the Incident Reporting System for Research Reactors (IRSRR) in Dimitrovgrad, Russian Federation, 6-10 September 2004. The purpose of the workshop was to exchange information on events that occurred at research reactors in the region, and to provide insight from operational experience feedback. Representatives of operating organisations and regulatory bodies from the countries in the region were invited. The workshop included lectures, country presentations, a technical visit to RIAR Centre, and a tabletop exercise for participants.

International Nuclear Event Scale (INES) and Nuclear Events Web-based System

The INES is used for facilitating rapid communication to the media and the public regarding the safety significance of events at all nuclear installations associated with the civil nuclear industry, including events involving the use of radiation sources and the transport of radioactive materials. To date, 60 countries are participating in the INES Information Service.

A technical meeting of INES national officers was held in March 2004, with 71 participants. There was also one Advisory Committee meeting in March 2004 and two consultancy meetings to review and prepare additional guidance and prepare training material. As a result of these meetings, clarification for the rating of fuel damage events and, for pilot use, additional guidance for rating radiation source and transport events were issued. The terms of reference of the INES Advisory

Committee were revised in 2004 to involve expertise covering reactors, fuel cycle, medical and radiation facilities, radiation sources and transport of radioactive material. In 2004, the Agency started development of a new modular INES training package. The modules address different audiences: technical experts responsible for rating events; managers; the media; and, the public.

Intercomparison exercises

Pursuant to IAEA General Conference resolution GC(43)/RES/13, the Secretariat organizes intercomparison exercises for monitoring purposes with a view to helping Member States to comply with dose limits and to harmonizing the use of internationally agreed quantities and assessment methods recommended in Agency standards. Regional intercomparison exercises focused on the determination of radiological quantities in photon radiation fields were finished in Latin America and East Asia and started for West Asia and Africa in 2004. Ongoing international intercomparison exercises are dealing with: the direct method of activity measurement in the whole body (to be finished in 2005); the determination of radiological quantities in neutron-gamma mixed fields (Phase II to be finished in mid-2005); and, the assessment of internal dose from incorporating monitoring data (to be finished in mid-2005).