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Measures to Strengthen International Cooperation in Nuclear, Radiation and Transport Safety and Waste Management

Nuclear Safety Review for the Year 2004

Report by the Director General

Summary

- The *Nuclear Safety Review for the Year 2004* reports on worldwide efforts to strengthen nuclear, radiation and transport safety and the safety of radioactive waste management.
- 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 in the Board.

Nuclear Safety Review for the Year 2004

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.

A. Introduction

1. 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 information available as Annexes to the booklet version of the *Nuclear Safety Review for the Year 2004*. This report discusses security as it relates to safety. A separate annual report will cover nuclear security.

2. 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

3. 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.

4. 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.

5. 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.

6. 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.

7. 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

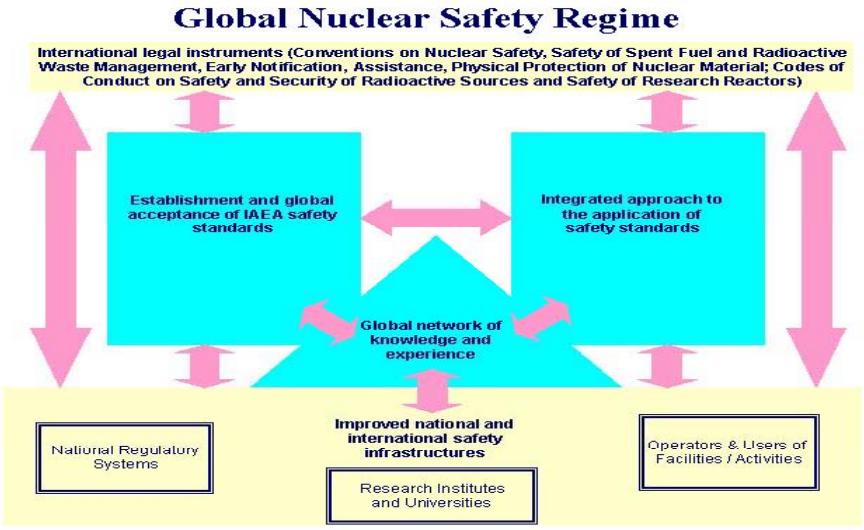
8. Sustainable education and training programmes, with quality training material and knowledgeable instructors, are key to using nuclear energy safely. Through networking, training centres can share experience and training material. The Intercentre Network for radiation and waste safety and the Asian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

9. 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.

10. 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



11. 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

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

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

14. 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; 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.

15. 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.

16. 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

17. 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.*

18. 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

[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)

this feedback to ensure the Standards continue to reflect international experience and good safety practice.

19. 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.*

20. 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

21. 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.

22. 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.

23. 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

24. 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.”

25. 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.

26. 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.

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

27. 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 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.

28. 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

29. 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.

30. 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.

31. 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.

32. 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.

33. 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.

34. 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.

35. 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

36. 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.

37. 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.

38. 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.

39. 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.

40. 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.

41. 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

42. 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.

43. 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.

44. 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.

45. 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.

46. 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

47. 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.

48. 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.

49. 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.

50. 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

51. 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.

52. 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.

53. 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.

54. 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

55. 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.

56. 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.

57. 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

58. 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.

59. 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

60. 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.

61. 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

62. 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.

63. 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

64. 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.

65. 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.

G.2.2. Regulating radiation safety

66. 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

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

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.

67. 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.

68. 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.

69. 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.

70. 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

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

72. 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

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

[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.

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

73. 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.

74. 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

75. 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.

76. 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.

77. 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 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.

78. 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.

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

79. 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.

80. 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.

81. 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.

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

G.4.2. International activities

83. 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.

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

85. 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.

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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

G.5. Protecting the public and the environment

G.5.1. Trends and issues

86. 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.

87. 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

88. 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.

89. 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 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.

90. 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.

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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.

91. 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

92. 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.

93. 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

94. 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.

95. 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.

96. 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.

97. 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.

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

98. 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.

99. 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

100. 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.

101. 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

102. 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.

103. 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*.

104. 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.

105. 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.

106. 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

107. 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.

108. 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.

109. 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.

110. 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 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.

111. 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

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

provisions necessary for longer-term storage. As more nuclear facilities are decommissioned, the need for appropriate disposal facilities will increase.

K. Decommissioning

112. 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.

113. 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.

114. 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.

L. Restoring contaminated sites

115. 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.

116. 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.

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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

117. 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.

118. 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

119. 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.

120. 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.

121. 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.

122. 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

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

the development of the *International Action Plan for Strengthening the International Preparedness and Response System for Nuclear and Radiological Emergencies*.

123. 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.

124. 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].

125. 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.

126. 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.

127. 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.

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[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