

General Conference

GC(48)/INF/3
15 July 2004

General Distribution
Original: English

Forty-eighth regular session

Item 13 of the provisional agenda
(GC(48)/1)

Measures to Strengthen International Co-operation in Nuclear, Radiation and Transport Safety and Waste Management

Nuclear Safety Review for the Year 2003

Report by the Director General

- The *Nuclear Safety Review* reports on worldwide efforts to strengthen nuclear, radiation and transport safety and the safety of radioactive waste management. In line with recent suggestions made by the Board of Governors, the Review is more analytical and less descriptive than previously.
- A *Draft Nuclear Safety Review for the Year 2003* was submitted to the March 2004 session of the Board of Governors in document GOV/2004/3. The final version of the *Nuclear Safety Review for the Year 2003* was prepared in the light of the discussion in the Board.

Nuclear Safety Review for the Year 2003

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Nuclear Safety Review for the Year 2003

Analytical Overview

A. Introduction

1. The Nuclear Safety Review for the Year 2003 presents an overview of the current issues and trends in nuclear, radiation, transport and radioactive waste safety during 2003. As in 2002 the overview is supported by more detailed Notes by the Secretariat: *Safety Related Events and Issues Worldwide during 2003* (document 2004/Note 6), *The Agency's Safety Standards: Activities during 2003* (document 2004/Note 7) and *Providing for the Application of the Safety Standards* (document 2004/Note 8).

2. In January 2003, the Agency implemented an organization change and developed an integrated approach to reflect a broader assignment of nuclear safety and nuclear security and to better exploit synergy between them. The Office of Physical Protection and Material Security renamed to Office of Nuclear Security was transferred from the Department of Safeguards to the Department of Nuclear Safety, which became the Department of Nuclear Safety and Security to reflect the change. This Review provides information primarily on nuclear safety, and nuclear security will be addressed in a separate report.

B. International safety standards and their application

3. Establishing nuclear safety standards and providing for their application are statutory functions of the Agency, essential for a global safety regime that provides for protection of people and the environment. Notable achievements have been made in 2003 using the Agency standards to enhance nuclear safety in Member States. Central to the worldwide outreach and application of the Agency safety standards is, however, the need to ensure an effective process to take into account the practical experience feedback of the application of Agency safety standards in Member States.

4. In November 2001, the Commission on Safety Standards proposed to the Director General a strategy for the safety standards programme aimed at enhancing the standards and their global application. The strategy was prepared in consultation with the various safety committees and submitted to the Board of Governors in September 2003 and to the 2003 session of the General Conference. The relevant documents are:

5. *An overview of the IAEA safety standards*: A brochure explaining the philosophy, structure, scope and means of application of the corpus of safety standards.
6. *Overall structure of the IAEA safety standards*: A document showing that all necessary activities and issues are appropriately covered in the standards and that there is an appropriate combination of 'thematic' and 'facility specific' standards.
7. An action plan for the development and application of safety standards is being submitted to the Board of Governors in March 2004.¹ The action plan pays special attention to collecting experience feedback on the use of safety standards and to the review of Agency safety related publications developed outside the Agency's safety standards programme.
8. The overview and the overall structure of the safety standards were presented at the Scientific Forum held during the 2003 session of the General Conference. There was general agreement that the Agency safety standards reflect a high level of safety and should serve as the global reference for the protection of people and the environment. Many regulatory bodies of Member States are using the Agency standards as reference for national regulations. In other Member States, regulators are called upon to ensure that their regulations are in agreement with the Agency standards and the levels of safety expressed in them.
9. The Agency continued to place considerable emphasis on pursuing the worldwide application of the IAEA Safety Standards. The Agency's safety standards are being used by some countries as a reference in the preparation of national reports and for the peer review under the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.
10. International and national standards organizations develop industrial standards that complement the Agency safety standards by specifying detailed requirements for design and operation of components and for procedures. Arrangements exist between the IAEA and standards organizations such as the International Organization for Standardization (ISO), and the International Electrotechnical Commission (IEC) to use a common structure and share glossaries of terms.
11. Professional societies, as for example, those in the medical area, are also involved in the development and review of Agency safety standards.
12. Among the safety standards published in 2003, were two safety requirements entitled *Site Evaluation for Nuclear Installations* (Safety Standards Series No. NS-R-3) and *Remediation of Areas Contaminated by Past Activities and Accidents* (Safety Standards Series No. WS-R-3). The safety requirements on site evaluation for nuclear installations is an update of an earlier publication on site selection. The focus of the new publication is primarily on the evaluation of existing sites rather than on the selection of new ones. Requirements for site evaluation are intended to ensure adequate protection of site personnel, the public and the environment from the effects of ionizing radiation arising from nuclear installations. It provides specific requirements for the evaluation of external natural events (such as earthquakes, flooding, extreme meteorological conditions and geotechnical hazards) and human induced events (such as aircraft crashes and chemical explosions). The publication also covers the potential effects of the installation on the region (such as uses of land and water, population distribution in the region and dispersion of radioactive material in the atmosphere, surface water and through ground water). The safety requirements on remediation of areas contaminated by past activities and accidents establishes, for the first time, requirements in relation to protective actions and remedial measures intended to reduce actual prolonged exposure, to avert

¹ This Action Plan has been submitted for the Board's consideration in document GOV/2004/6

potential prolonged exposure or to reduce the likelihood of occurrence of such exposures due to contamination. It includes remedial measures such as removal or reduction of the source of exposure as well as other long-term protective actions such as restrictions on the consumption of foodstuff, grazing by livestock and the use of fodder, and restrictions on access or on land use. In addition, nine Safety Guides were published in 2003: seven on various aspects of nuclear power plants; and two on management of radioactive waste.

C. Safety of nuclear installations

13. The safety of nuclear installations has shown substantial improvement over the past decades which continued in 2003. Traditional measures of safety (e.g. reactor protection and safety system actuations; safety related equipment and component availability; unplanned plant shutdowns) show that nuclear installations have become less susceptible to events that challenge their safety and are better prepared to mitigate the consequences of such events, should they occur. While the rate of improvement is levelling off as some performance indicators approach their realistic maximum values, significant efforts continue to be invested in securing the marginal improvements that are still attainable. Notwithstanding these apparent successes, there are numerous opportunities to improve safety margins and provide a greater assurance that the nuclear option is being pursued in a safe and responsible manner.

C.1. Design safety

14. Design considerations associated with nuclear installations continue to receive attention. Worldwide, design changes and plant modifications continue to be made to improve the safety and efficiency of in-service nuclear installations. Equally as important, significant changes are being incorporated into the new designs that are being proposed and built throughout the world.

15. Despite the improvements that have been made, there are several areas in which continued attention is needed. These include: the concerns 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.

16. Safety at nuclear power installations whose inherent design assumptions have, in the past, raised questions, continues to be an area that attracts international attention. The Agency and the World Association of Nuclear Operators (WANO) continue to conduct experts' missions, design reviews and peer reviews of safety (including design considerations) at nuclear power plants. An Agency review at Metsamor Nuclear Power Plant (Armenia) confirmed that significant safety upgrades had been implemented within the power plant. In 2002, a similar review confirmed the safety improvements that had been made at Kozloduy, Units 3 and 4 (Bulgaria); in addition, the European Commission (EC) conducted its own review of the Kozloduy plants as part of its assessment of the readiness of Bulgaria for accession to the European Union. Consideration and review of design concerns for such installations must, of necessity, continue to be handled individually, on a case-by-case basis.

17. For most of the existing nuclear power plants in the world, however, the foremost design safety issues relate to ageing and long-term operations. Ageing management is a concept that begins with the initial design of a nuclear facility, is incorporated into operational practices, such as in-service testing programmes, and manifests itself in subsequent modification and design improvement efforts. Many Member States that have operating nuclear power plants have begun to consider plant operations beyond the 'original design lifetimes'. This has resulted in the recognition that this consideration is not

limited to any unique nuclear steam supply system design. As a result of the more global implications of this challenge, numerous Member States are working with the Agency to refocus efforts in this area. The previous concentration on high-power channel-type reactors (RBMK) and water-cooled, water moderated power reactors (WWER) has been expanded to encompass all pressurized water reactor designs, and includes considering how best to address the inherent need of resolving significant design issues as part of the life extension process. This will allow the lessons that can be learned in this area to be more effectively shared throughout the nuclear community.

18. There also continues to be a demand for the re-evaluation of the impacts of external events, especially at seismic sites. These re-evaluations have been triggered either by modifications in safety requirements, or by new evidence in the site hazard assessments arising, for example, during periodic safety reviews or license extension proceedings. Examples of this demand were demonstrated by the safety reviews at the nuclear power plants in Armenia and the Islamic Republic of Iran, which have identified the need for significant seismic review in the near future.

19. A particular challenge in effectively addressing seismic issues is the fact that internationally accepted standards for such re-evaluations are, generally, lacking; consequently, upgrading measures are not uniformly implemented. In most Member States, the consideration of seismic issues has been concentrated on existing nuclear installations, the evaluation of which are very complicated. Seismic hazard assessments for nuclear sites have indicated a need for benchmarking and establishing homogenous national practices. In response, an International Symposium on Seismic Evaluation of Existing Nuclear Facilities was held in Vienna. It confirmed the need to develop an international safety standard addressing this issue, and it identified the following specific items of concern: seismic considerations for safety assessments, such as the significance of high-acceleration records and the treatment of uncertainties; there remain unresolved issues in the assessment of structures and components; preparedness in case of a seismic event needs to be encouraged; and, nuclear installations other than nuclear power plants deserve attention.

20. Finally, the significant efforts that continue to be expended, internationally, on future near term designs and future long-term designs must be mentioned. The pebble bed modular reactor (a high temperature gas cooled design) demonstration project continues to be a major initiative. The environmental impact assessment for the demonstration project was completed this year and licensing activities in South Africa continue. The safety issues associated with its construction and operation will be significant topics for future consideration. The development of inherently safe reactor designs for long-term utilization continues under the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO). In the near term, a major joint research program has been initiated by several countries for developing new concepts of nuclear reactors in the frame of the Generation IV International Forum project. This research programme, envisioned as a vehicle to develop innovative reactors that can be deployed in the next few decades, has a significant safety focus. Inherent to the design of new reactors is the premise of their safety, and this is the foundation upon which this programme is built.

C.2. Operational safety

21. Overall, the nuclear industry's commitment to improving the safety of its nuclear installations continues to be confirmed by the Agency's operational safety reviews. Follow-up missions find that, on average, the percent of issues which are satisfactorily addressed has been increasing steadily for several years. The wide availability of findings through the open distribution of the Agency's Operational Safety Review Team (OSART) mission results continues to contribute to a heightened awareness of both good practices and potential pitfalls.

22. Even with the improvements noted in daily operational activities, the nuclear industry continues to be challenged by significant internal and external pressures. These pressures, in turn, have been found to be important and consistent factors in operational events. These challenges have manifested themselves in operating organizations, regulatory authorities and nuclear contracting firms. The lessons from these challenges must be identified, analysed and shared if continued improvements are to be expected.

C.3. Operational experience feedback

23. In general, the industry continues to improve the safety and reliability of nuclear power generation. The number of significant events remains low and additional emphasis has been given to further analyse operating events for human performance enhancements. This is shown by the incorporation of the operational experience review module into the Agency's OSART mission and the launching of the Peer Review of Operational Safety Performance Experience (PROSPER), a safety review programme uniquely focused on this topic.

24. Of great relevance for NPP regulators and operators are also the lessons learned from the incident which occurred in April 2003 at the Paks NPP in Hungary.

25. On a broader scale, several common issues were identified during the past year, when factors such as privatization, market deregulation, and downsizing in the nuclear industry challenged installation safety. Insights from events that occurred in 2003 can be summarized as follows: minor modifications to equipment or procedures, if not properly reviewed before implementation, may cause serious safety consequences; despite abundant operating experience information, events with similar root causes continue to reoccur; incorrect performance testing, maintenance and modification procedures continue to be relevant to events; human factors, organizational and communication deficiencies, unexpected structural defects and loss of corporate knowledge contribute to causes of events. Finally, the absolute delegation of responsibility to a contractor, with an ensuing failure to sufficiently assess contractor competence and an inadequate oversight of contractor activities were additional factors noted during 2003.

26. The most significant insights from significant design implications of operational events that have occurred during the past year centred around the challenges experienced in the materials integrity area. The discovery of circumferential cracks in pressurized water reactor vessel bottom head penetrations and pressurizer heater sleeves has led to a detailed review of the susceptibility assumptions for this area of the reactor and the associated materials. It is fortuitous that these cracks were discovered as part of proactive monitoring programmes as opposed to being reactionary responses to significant materials failures. These events continue to reinforce the premise that the maintenance of system integrity requires proactive attention and aggressive monitoring programmes.

27. Finally, the effective feedback of operational experience requires active and functional information sharing systems. The Incident Reporting System (IRS) is jointly operated by the Agency and the Organisation for Economic Cooperation and Development's Nuclear Energy Agency (OECD/NEA). Both Agencies expressed an increasing concern that, worldwide, experience related to nuclear power plant operations was not being adequately shared through the IRS. The Agency and the OECD/NEA are particularly concerned by the lack of reporting coverage of significant events and by the substantial decrease in the overall reporting rate. Moreover, recent events, and the recurrence of commonly known problems, show that an increased vigilance is required to ensure that lessons learned in the past are retained in the knowledge of nuclear organizations. It is, therefore, particularly important that the necessary measures be implemented to assure that complete, timely and high quality event reports are submitted to all experiencing-sharing systems.

C.4. Safety management and safety culture

28. During the previous safety review, it was noted that a small but persistent number of events that had not seriously jeopardized overall safety suggested that there were safety culture deficiencies in countries with long established nuclear power programmes. During the past year, this premise was tested at several workshops.

29. The Agency and the OECD/NEA jointly sponsored a workshop in June 2003 entitled Nuclear Safety Management and Safety Culture: Lessons learned from Recent Events. It was recognized that there are differences among Member States in their regulatory approaches to safety culture. Clearly, there is much work to be done to fully understand the appropriate role of the regulator in regulating safety culture and the management of safety; additionally, there is a need for clear criteria for regulatory intervention. The Agency also presented the conclusions and recommendations from this workshop at the Senior Regulators' Meeting during the 47th session of the General Conference. There was consensus that the workshop's objective — to share lessons learned from operational events — should be pursued further and that the Agency, in collaboration with the OECD/NEA, should play a leading role in that endeavour.

30. This workshop emphasized the need to integrate the concepts associated with a vibrant safety culture into the entire spectrum of the Agency's nuclear installation safety services. It is essential to realize that not all problems are embedded in cultural differences; equipment malfunctions, technical misjudgements, and human errors do occur. Learning from such mistakes, working to minimize their recurrence, and ensuring that safety considerations are pre-eminent throughout the workforce are the safety culture challenges of the future.

C.5. Risk informed decision-making

31. The integration of risk into the normal decision-making processes inherent to the nuclear industry has been evolving for a long period of time. It is a concept that has been embraced by both the operators of nuclear power plants and the national regulatory bodies. International organizations, such as the Agency and the OECD/NEA, have, likewise, seen the benefits of including risk insights into the complex decisions that are part of the operation and regulatory oversight of nuclear installations.

32. The inclusion of risk insights, however, brings with it the potential of losing some of the benefits of deterministic regulations and criterion-based decision-making. When 'risk-informed' decision-making becomes 'risk-based', the safety margins associated with the concept of 'defence in depth' can be compromised. Even more importantly, it is essential to ensure that regulatory predictability and public transparency are retained when regulatory infrastructures that are based upon deterministic criteria have to integrate risk into the decisions that are promulgated to facility operators.

C.6. Safety of research reactors

33. During this year, there were no events that significantly challenged operational safety of research reactors. Challenges remain to long-term successful operations, especially those regarding the establishment of effective utilization programs, the maintenance of safety-related systems and the continuance of staff competence; however, these are being dealt with. In addition, developmental efforts for new research reactors (e.g. Australian Replacement Research Reactor) are focusing on providing safe and effective platforms for research and testing applications in the future.

34. One part of the international research reactor safety enhancement plan is preparation of a *Code of Conduct on the Safety of Research Reactors*.² The objective of the Code is to achieve a high level of safety in research reactors worldwide through enhancement of national measures and international cooperation. The Code provides guidance to States for developing and harmonizing policies, laws and regulations; additionally, it provides recommendations for ‘best practices’ in management of research reactor safety. The technical provisions in the Code are based on international consensus documents, primarily IAEA Safety Fundamentals and Requirements.

35. In November 2003, research reactor designers, operators, managers, users and regulators shared experiences, exchanged opinions and discussed options and priorities related to research reactors at the International Conference on Research Reactor Utilization, Safety, Decommissioning, Fuel and Waste Management held in Santiago, Chile. This Conference, resulted in several significant recommendations for the research reactor community: all countries with at least one research reactor should adopt the Code of Conduct; the physical security of research reactors and their associated fuel cycle facilities should be strengthened; regional and international networks for knowledge preservation and experience sharing should be pursued; to facilitate smaller research reactors in performing periodic safety reviews, a guideline for use in International Safety Assessment of Research Reactors (INSARR) missions should be developed; regional strategic plans for the utilization and the promotion of regional ‘centres of excellence’ should be prepared.

C.7. Security of nuclear installations

36. Member States have given increased attention to the security of nuclear installations in relation to sabotage. Some considerations involve assessment of the robustness of the installations against extreme malicious events. In parallel to the efforts being expended to address extreme events, a great effort is also being made to apply the principles of defence in depth (in a graded approach) to protect nuclear facilities against malicious acts. The more comprehensive and coherent techniques to protect nuclear installations against sabotage would include: protecting the nuclear control processes; ensuring the maintenance of measures to regain control; and providing provisions to mitigate the consequences of a loss of control. This requires extensive cooperation between safety and security experts.

37. Another development that evolved from the co-ordinative efforts of the safety and security specialists was in the area of International Physical Protection Advisory Service (IPPAS) missions. Whenever these Agency missions involved the sabotage of nuclear facilities, nuclear safety specialists were included in the teams. The inclusion of safety experts in the IPPAS team has been welcomed by concerned Member States and has led to a better understanding and acceptance of recommendations to improve the protection against sabotage. More improvements are needed and planned to further this co-ordinated approach next year. A great majority of the tasks surrounding the development of documents, methodology development and the delivery of services will include such co-ordinated efforts.

² This Code has been submitted for the Board’s consideration in document GOV/2004/4.

D. Safety of transport of radioactive material

38. The safety of transport of radioactive material in all forms, domestically within States and internationally between States, and by all modes of transport — road, rail, water and air — is vital to the peaceful uses of these materials. The Agency, as part of its statutory mandate and at the request of the United Nations Economic and Social Council, has worked for decades with its Member States and applicable international organizations to foster the development and application of sound safety standards for the transport of radioactive material.

39. The excellent safety record for transport results, in no small part, from the efforts that have gone into developing and maintaining the *Regulations for the Safe Transport of Radioactive Material*. The 2003 amended edition of the Agency's Transport Regulations has been prepared for adoption into the International Maritime Organization (IMO) and International Civil Aviation Organization (ICAO) regulatory documents. To assist in determining the extent to which the Agency's Transport Regulations are adopted at the State level, the Agency undertakes an annual survey of Member States' infrastructures for transport regulation. To date, 44 Member States have provided that information, which is available on the Agency's website. The appraisal of a State's transport operations is another of the necessary tools for assisting States in discharging effectively their regulatory responsibilities. During 2003, two Transport Safety Appraisal Service (TranSAS) missions were completed in Panama and Turkey. These reviews identified good practices as well as areas for improvement.

40. A significant International Conference on the Safety of Transport of Radioactive Material, hosted by the Austrian Government, was held in Vienna, 7–11 July 2003. It was co-sponsored by ICAO, IMO and the Universal Postal Union and held in cooperation with the International Air Transport Association and the ISO. The Conference addressed many topics that contribute to maintaining the good record for transport safety including radiation protection, compliance and quality assurance, emergency preparedness and response, packaging for radioactive materials and regulatory issues. There were also discussions on liability and communication with the public and between governments. The summary and findings were submitted to the 47th session of the General Conference, and in response, the General Conference requested the Agency to draft an international action plan³ for approval by the Board.

E. Safety and security of radioactive sources

41. International concern related to the safety and security of radioactive sources remains high, particularly with respect to orphan source accidents and the malevolent use of radioactive sources. The 2003 session of the General Conference adopted a resolution welcoming the revised *Code of Conduct on the Safety and Security of Radioactive Sources* and urging Member States to write to the Director General stating that they were moving towards following the guidance contained therein.

³ This Action Plan has been submitted for the Board's consideration in document GOV/2004/2.

42. A major International Conference on Security of Radioactive Sources involving 751 participants from 123 countries and 12 organizations was held in March 2003. This was organized by the Agency, hosted by the Austrian Government, co-sponsored by the Governments of the Russian Federation and the United States of America, in cooperation with the European Commission, the European Police Office (Europol), the International Criminal Police Organization (Interpol) and the World Customs Organization. The findings from this conference were incorporated into the Agency's new International Action Plan for Safety and Security of Radioactive Sources⁴ which was endorsed by the 2003 session of the General Conference.

43. The Tripartite Initiative, between the Agency, the Russian Federation (Ministry for Atomic Energy of the Russian Federation) and the USA (Department of Energy), on securing and managing radioactive sources has been proceeding rapidly with altogether 14 missions to determine what actions are necessary to secure sources having been completed as of the end of October 2003. These missions have identified significant numbers of sources that are regarded as vulnerable. Some of these have been secured, but much further work still needs to be done.

44. Interim guidance on the security of radioactive sources was published in June 2003 and a revised *Categorization of radioactive sources* in July which is finding use in a range of applications. Work has also continued on the development of guidance, national strategies for improving control over radioactive sources, including orphan sources. There has been progress in the development of a new, inherently understandable warning label for dangerous sources and discussions have been held with source manufacturers regarding their contribution towards increasing the safety and security of radioactive sources.

45. Direct assistance to render sources safe had been provided to Cote D'Ivoire, Ethiopia, Haiti, Mozambique, Sudan and Thailand. Over 20 000 curies of radioactivity in the form of sealed radioactive sources have been recovered and rendered safe by either conditioning for long-term storage or return to supplier. A conceptual design for a mobile infrastructure to condition disused high activity sources in a systematic fashion had been finalized in 2003. Agreements have been put in place with a number of Member States to test this design. It is expected that the mobile infrastructure will be operable by 2005.

46. Progress has been made on the borehole disposal concept of disused sealed radioactive sources under a regional technical cooperation (TC) project for Africa. Currently, the Agency is organizing an international peer review of the concept developed by the South Africa Nuclear Energy Corporation (NECSA). Following this peer review, a field demonstration of the concept by NECSA has been planned in 2004.

F. Radiation protection

F.1. Occupational radiation protection

47. The International Conference on Occupational Radiation Protection: Protecting Workers Against Exposure to Ionizing Radiation, which was held in August 2002 at the International Labour Organization (ILO) in Geneva, Switzerland, was the first international conference to cover the whole

⁴ See document GOV/2003/47-GC(47)/7

area of occupational radiation protection. Based on the findings and recommendations of the Conference an *International Action Plan for Occupational Radiation Protection*⁵ was developed in cooperation with ILO. A steering committee is being established to monitor and advise on the implementation of the Action Plan.

48. The findings and recommendations of the Conference highlighted successes, as well as issues needing further attention. A lot of effort is being put into establishing more practically oriented guidance and supporting activities tailored to particular naturally occurring radioactive material (NORM) industry sectors. The Information System on Occupational Exposure (ISOE), operated jointly by the OECD/NEA and the Agency and covering about 93% of the world's commercial nuclear power plants, provides an effective means of information exchange on occupational exposure and has contributed to the downward individual and collective dose trends in this industry. For the ISOE system, for any international dose comparison and for the control of compliance with dose limitation requirements, it is crucial that internationally agreed quantities and assessment methods are harmonized. For this purpose the Agency is continuously organizing intercomparison exercises for harmonization of radiological quantities and monitoring methods for assessing occupational exposure.

F.2. Radiation protection of patients

49. Ionizing radiation is used extensively in medicine; worldwide, about 2000 million diagnostic X-ray examinations and 32 million nuclear medicine procedures are carried out annually, and of about 10 million cancer patients 40–50% receive radiotherapy. Moreover, the use of ionizing radiation in medicine is increasing, as the benefits for patients far exceed the risks. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), has stated that medical applications of ionizing radiation represented by far the largest man-made source of ionizing radiation exposure. Therefore, radiation protection in this area deserves increased attention.

50. In September 2002, the General Conference endorsed the decision of the Board of Governors to approve an International Action Plan for the Radiological Protection of Patients⁶ and requested the Secretariat to implement it, subject to the availability of resources. Work on over half of the actions in the Action Plan has been implemented. A group of senior experts in various fields - the Steering Panel on the International Action Plan for the Radiological Protection of Patients - has been established for the purpose of keeping the various activities under review, maximizing synergy and minimizing duplication.

51. Three practice-specific guidance documents on the application of the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* in radiology, nuclear medicine and radiotherapy have been finalized. These documents have been developed with input from professional bodies, international organizations and national authorities responsible for the radiological protection and medical care of patients.

52. Standard syllabuses and packages for training in the application of safety standards in medicine have been developed and tested. The feedback from a number of training courses and two 'train-the-trainers' workshops, and from the World Health Organization (WHO), the Pan American Health Organization (PAHO) and the relevant international professional bodies has been taken into account and the material will be made available in the Agency's six official languages.

⁵See document GOV/2003/47-GC(47)/7 Annex 2.

⁶ See document GOV/2002/36-GC(46)/12.

53. Guidance levels for diagnostic examinations have proven to be a useful tool for optimizing the protection of patients. The role of international organizations is to encourage countries to develop their own guidance levels, but to provide them with a methodological approach. A draft methodology for establishing guidance levels for diagnostic radiology through simple surveys taking into account image quality has been developed to serve as the basis for technical assistance in this area. The methodology will first be used in an ARCAL project involving ten Member States.

54. The development and application of guidance levels for complex procedures such as interventional procedures are less straightforward and further research is required. A pilot study, launched in 2002, has provided preliminary results in 2003, which indicates that it is feasible to establish guidance levels for coronary angiography procedures. However, establishing guidance levels for therapeutic interventional procedures is proving much more complex and may require the use of complexity indexes associated to the values of guidance levels. Similarly, research has been initiated on optimizing radiation protection in the areas of digital radiology and computer tomography.

G. Radioactive waste

55. An important step forward in the field of radioactive waste management has been the holding of the first Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. It establishes an international legal mechanism for improving the safety of radioactive waste and spent fuel management worldwide. Also in 2003, there have been a number of significant events and developments relevant to particular areas of radioactive waste management, namely, discharge control, decommissioning, and the disposal of radioactive waste.

G.1. Joint Convention

56. The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention) is the only legally binding international instrument in its field. The first Review Meeting of Contracting Parties was held in November 2003. One of the conclusions was that it is important for all countries to have in place a long term strategy for managing spent fuel and radioactive waste, recognizing that, at present, only a few have firm plans for the disposal of spent fuel and high level waste. A linked issue is the growing recognition of the need for countries to plan for integrated decommissioning and waste management, with schemes for managing all of the various types of waste resulting from the decommissioning process. Of particular relevance in this context is the absence, at present, of agreed international criteria for the clearance of materials containing very low activity levels from regulatory control.

57. The emphasis in national reports and in the discussions at the Review Meeting was on spent fuel and radioactive waste from the nuclear fuel cycle. Comparatively little attention was given to the issue of managing disused sealed radioactive sources, an issue of principal interest for some of the smaller non-nuclear power countries. This together with the subject of effluent discharge control was identified as needing more consideration at the next meeting.

58. Public consultation is seen as being increasingly important in relation to long term radioactive waste management. The old policy of 'decide, announce and defend' is no longer seen as tenable and, in several countries, the public is involved through consultation processes in decision-making with regard to repository-siting decisions, options for decommissioning and policies for effluent discharge.

59. An issue of general concern to the participants of the Review Meeting is the comparatively small number of Contracting Parties — currently it is 33 — especially when it is considered that the Joint Convention is relevant to all countries with radioactive waste. The Secretariat was mandated to publicize and bring the Joint Convention to the attention of States that have not already ratified. In the intercessional period before the next review meeting in 2006, the Secretariat will, inter alia, work with the General Committee of the first Review Meeting to improve procedures for the review process, based on lessons learned at the first Review Meeting, and introduce a new electronic process for submission of National Reports and for managing the process of questions and answers.

G.2. Radioactive discharges to the environment

60. Governmental policies on the control of discharges of radionuclides to the environment are coming under increasing scrutiny. This has arisen from the changing attitudes of the public, of experts and of governments to the environment which is now widely seen as being under threat. There have been several international initiatives over the last two decades which reflect the shifting policies in this area, notably the Rio Declaration on Environment and Development in 1992.

61. One practical example of this changing policy can be seen in the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) through which more restrictive discharge controls are being introduced on all potential pollutants.

62. Policies on the control of discharges to the environment are also expected to be influenced by new considerations related to ensuring that the environment is protected from the effects of ionizing radiation. This has been recognized as a 'gap' in the international radiation protection system and work is currently under way by the relevant international organizations to remedy the situation. An International Conference on the Protection of the Environment from the Effects of Ionizing Radiation organized by the Agency in Stockholm in October 2003 has identified the roles of the various international organizations in consolidating the present approach to controlling radioactive discharges to the environment by taking explicit account of the protection of species other than humans. At present a major role is being played by the International Commission on Radiological Protection (ICRP) in developing specific recommendations for the protection of non-human species; at a later stage it is expected that the established mechanisms for developing international safety standards will be used to convert the recommendations of the ICRP into a practical framework which can be applied by national regulatory authorities. At the same time it will be necessary for the new policy proposals to be widely disseminated to Agency Member States in order to ensure that the new standards have broad international support.

G.3. Decommissioning

63. There is an increasing awareness of the issue of decommissioning in many countries because of the increasing numbers of nuclear facilities entering this phase and because of special national policy and strategy issues raised. In the United Kingdom, for example, the Nuclear Decommissioning Authority has been created to ensure that the UK's civil nuclear legacy is managed safely. Information from an Agency global survey report in preparation indicates that there are hundreds of research reactors and nuclear power plants that have been 'shut down' and are awaiting or undergoing decommissioning.

64. International conferences organized by the Agency in Berlin, Germany in 2002 and in Santiago, Chile in 2003 have highlighted the issues associated with nuclear power plant and research reactor decommissioning. The common problems are in providing appropriate funding for implementing the decommissioning, in establishing facilities for disposing of the associated radioactive waste and in preserving knowledge of the facility if there are delays in implementing the decommissioning. The

funding issue is relevant to almost all countries. If funding arrangements had not been made in advance of the decision to decommission there is often a reluctance to provide such funds for facilities that are no longer productive. Funding is a particular problem in the context of research reactors located in developing countries where resources are often scarce. In recognition of the increasing importance of decommissioning issues in its Member States, the Agency has established a technical expert group on decommissioning. At its first meeting, the Group discussed the issues mentioned above and established subgroups on 'Strategy' and 'Funding'. The Group has the role of assisting the Agency in the development of harmonized policies and strategies for decommissioning and of providing technical guidance on the Agency's programmatic activities in this area. A draft International Action Plan on Decommissioning Activities is to be presented to the Board of Governors for approval in 2004.

G.4. Radioactive waste and spent fuel management strategy

65. An important conclusion from the Agency's International Conference on Storage of Spent Fuel from Power Reactors held in June was that spent fuel storage can be considered as a well-understood and rapidly maturing technology. Preliminary results of probabilistic safety analyses of dry storage systems by the US Nuclear Regulatory Commission have shown extremely low levels of risk.

66. A position paper of international experts, *The Long Term Storage of Radioactive Waste: Safety and Sustainability*, was published by the Agency. This document addresses the ethical, safety, security, economic, and societal aspects of the subject. It concludes that a passively safe waste management option such as geological disposal should be preferred to surface storage mainly because the necessary active controls needed for a storage facility cannot be guaranteed in perpetuity because there is no guarantee that the necessary societal infrastructure can be maintained in perpetuity. Security considerations also favour geological disposal over surface storage, and at the Stockholm International Conference on Geological Repositories: Political and Technical Progress held in December, it was clear that this had become an important part of the rationale for the planned Yucca Mountain repository in the USA.

67. In Canada and UK, new committees or organizations have been established with the task of determining the most appropriate course of action for managing the country's radioactive waste. In both countries, the issue is being approached in a completely 'open-minded' way and all possible options will be considered. Another common feature of the new approaches is that the public and the relevant stakeholders will have a prominent role in establishing the policy.

G.5. Regional repositories

68. The progress being made towards establishing geological repositories in Finland, Sweden and the USA continues to be encouraging. In smaller countries, without a large legacy of wastes, the concept of regional repositories is appealing for various reasons, not least those of an economic nature. The concept has been discussed for almost two decades but has not moved forward to implementation mainly because of the difficulty in finding host countries for such repositories. Over the years new potential host countries have been proposed with favourable geographies and geologies for radioactive waste repositories only for them to be rejected, usually because of the difficulty in obtaining acceptance of the concept by the public of the country and the authorities concerned. At the same time, countries with advanced programmes for establishing national repositories have expressed concern about such developments since they potentially undermine of their own national programmes. Nevertheless, discussions continue among groups of interested countries, and in 2003, the European Commission established a project aimed at bringing together Member States of the EU and candidate countries wishing to explore the feasibility of potential regional European disposal solutions.

69. In 2003, the Director General of the Agency proposed that consideration be given to multinational approaches to the management and disposal of spent fuel and radioactive waste, referring to advantages in cost, safety, security and non-proliferation and proposed evaluation of the merits and feasibility of such approaches.

H. Emergency preparedness and response

70. There is a continuing need to maintain emergency response arrangements and to ensure that they are comprehensive in their scope. This issue was highlighted at a conference⁷ held in Salzburg, Austria, on off-site nuclear emergency management. Many countries continue to enhance emergency centres and decision support systems. However it appears that some developments are not focused on real needs nor tested adequately under simulated emergency conditions before their formal introduction into standing emergency arrangements. In particular there is a need to establish some level of harmonization internationally for communication and assistance among States that will allow for the best use of these technologies and capabilities. This same issue was raised at the second meeting of competent authorities identified under the Early Notification and Assistance Conventions, who agreed to work with the Agency Secretariat to develop a long term action plan for the strengthening of the international response system for nuclear and radiological emergencies.

71. Since the attacks on the United States of America in September 2001, many countries have been reviewing their arrangements for response to deliberate attacks that might involve radioactive material. Some countries have already run tabletop and field exercises to test updated national arrangements. Key lessons identified include: the importance of coordination of the emergency services, technical support and security/law enforcement personnel, both during the response itself and at the planning stage; and the importance of having radiation protection criteria that are not overly conservative. Co-ordinated, timely and effective public communication was emphasized as a crucial factor to avoid confusion. Experience has shown that after the theft of dangerous sources, prompt public communication is effective to obtain intelligence for their successful recovery.

72. The Early Notification and the Assistance Conventions place specific obligations on the States party to them as well as conferring obligations on the Agency. In order to meet these responsibilities, the Agency established in 1986 the Emergency Response Centre (ERC), to which States and relevant international organizations can promptly and effectively direct initial notification, advisory messages, requests for emergency assistance, requests for information, etc.

73. In 2003, the ERC received reports on 19 events that resulted in further actions to verify, provide information or advice and/or offer the Agency's good offices. Three field response team missions were carried out under the Assistance Convention in Ecuador, Nigeria and Qatar.

⁷See <http://www.salzburg-symposium.at> for more details.

I. Infrastructure for nuclear safety

I.1. National infrastructures

74. In the area of safety of nuclear installations, progress continues to be made in Member States to address issues identified in national and international peer reviews such as the Convention on Nuclear Safety. Within the framework of the Agency's TC activities, more than 80% of the 89 Member States participating in Model Projects on Upgrading Radiation Protection Infrastructure have promulgated their legislation or an action plan to this end is in the final stage of implementation. Around 70% have adopted regulations compatible with the Basic Safety Standards.

75. On the whole, national regulatory authorities were effective in assuring the safe implementation of nuclear applications in 2003. However, work continues to address challenges related to the effectiveness of national regulatory authorities and the independence of regulatory authorities from the organizations that are undertaking or promoting nuclear activities.

76. An International Conference on National Infrastructures for Radiation Safety: Towards Effective and Sustainable Systems was organized by the Agency in September 2003, hosted by the Moroccan Government in Rabat, and held in cooperation with the ILO, WHO, EC and OECD/NEA. The Conference brought a large representation of senior government officials, decision makers, experts and national counterparts dealing with radiation and waste safety programmes and activities in Agency Member and non-Member States. Nearly 400 participants, from 108 countries (including 11 non-Member States), ICRP, ISO, the PAHO and the International Radiation Protection Association (IRPA) attended the Conference. This Conference provided an opportunity to review the overall situation with respect to the establishment and maintenance of safety and security infrastructures.

77. The General Conference⁸ welcomed the findings of the Morocco Conference, and requested the Secretariat to convene a group of experts to advise the Secretariat on their implementation. In March 2004, in response to the General Conference resolution GC(47)/RES/7, the Secretariat is convening a Technical Meeting to formulate an international action plan on the basis of the findings, conclusions and recommendations of this Conference.

I.2. Education and training in nuclear, radiation, transport and waste

78. Sustainable programmes of education in training are essential elements for ensuring adequate nuclear safety infrastructure.

79. The strategic plan on education and training in nuclear radiation and waste safety for sustainable education and training programmes in Member States continues to be implemented by the Agency. As part of the strategic plan, a steering committee for education and training representing regional, collaborating and national training centres and international organisations was formed in 2002 to advise on policy development, the maintenance of the Agency's training programme and the monitoring of the long term action plan in education and training.

80. A considerable amount of work has been completed in 2003 and made available to Member States. This work includes networking training centres, developing training modules and various mechanisms of training modalities (e.g. e-learning) and providing training of trainers.

⁸See General Conference resolution GC(47)/RES/7.

81. As part of the strategic plan on Education and Training, the inter-centre network is considered essential to facilitate implementation of the long term action plan at the working level and to improve the effective information exchange and communication among the training centres.

82. The Agency has been working with the Asian Network for Higher Education in Nuclear Technology, the European Nuclear Engineering Network and the OECD/NEA, and will be working with the World Nuclear University, established in 2003, and others.

J. Knowledge management and networking

83. The issue of maintaining competence has been identified before as a problem facing the operating organizations, the regulatory bodies and their technical support organizations. During the past couple of years, it has become evident that this challenge is not limited to countries where nuclear power is stagnant or declining but, instead, is an issue for the entire nuclear community. Nuclear safety knowledge is needed for the safe regulation and utilization of nuclear energy. It is essential for the safe operation of nuclear facilities and further for their safe decommissioning and for managing and disposing of radioactive waste.

84. In response to this challenge, the Agency established knowledge management as an Agency-wide cross-cutting activity since all Major Programmes are engaged in activities to address preservation and enhancement of knowledge and maintaining competence in nuclear science and technology.

85. There is a great volume of safety knowledge not fully utilized, therefore nuclear safety networks are being established to pool, analyse and share nuclear safety knowledge and experiences at national, regional and international levels. Prominent examples are the establishment in the frame of Agency's programmes of the Asian Nuclear Safety Network and the Ibero-American Radiation Safety Network. The first is entering full operation in 2004 after completion in 2003 of a pilot project focused on education and training. The latter was launched during the General Conference by the Government of Spain and will be closely associated with the activities of the Ibero American Forum of Nuclear Regulators.

86. Training in nuclear safety and networking is also mentioned as a cornerstone of the Centre for Nuclear Safety in Central and Eastern European countries.

87. Moreover, as a further step to provide a clear linkage between the Agency safety related statutory functions and activities an integrated safety approach has been developed. It aims at integrating the Agency's safety standards and all aspects of their application with consideration to feedback mechanisms, and integrating efficient management and use of a knowledge base and networking to share existing and to create new knowledge.

88. Seeking creative techniques, either via education, training and process driven applications to ensure the effective transfer of knowledge, skill, and abilities from the experienced nuclear workforce that currently exists to the workforce of the future must be a community-wide priority.