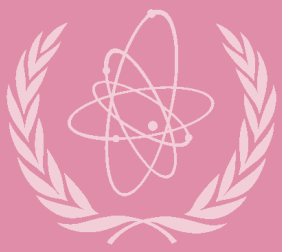
Nuclear Safety Review for the Year 2002



IAEA

International Atomic Energy Agency

Nuclear Safety Review for the Year 2002

Nuclear Safety Review
for the Year 2002

IAEA/NSR/2002

Printed by the IAEA in Austria
August 2003

FOREWORD

The *Nuclear Safety Review* reports on worldwide efforts to strengthen nuclear, radiation and transport safety and the safety of radioactive waste management. The *Nuclear Safety Review for the Year 2002* has a format that differs from that of previous such reviews. In line with suggestions made by the Board of Governors in March 2002, the first part is more analytical and less descriptive.

This short analytical overview is supported by a second part (corresponding to Part 1 of the Nuclear Safety Reviews of previous years), which describes significant safety-related events and issues worldwide during 2002.

A *Draft Nuclear Safety Review for the Year 2002* was submitted to the March 2003 session of the Board of Governors in document GOV/2003/6. The final version of the *Nuclear Safety Review for the Year 2002* was prepared in the light of the discussion by the Board.

CONTENTS

ANALYTICAL OVERVIEW

INTRODUCTION

This report presents an overview of the current issues and trends in nuclear, radiation, transport and radioactive waste safety at the end of 2002. This overview is supported by a more detailed factual account of safety-related events and issues worldwide during 2002.

National authorities and the international community continued to reflect and act upon the implications of the events of 11 September 2001 for nuclear, radiation, transport and waste safety. In the light of this, the Agency has decided to transfer the organizational unit on nuclear security from the Department of Safeguards to the Department of Nuclear Safety (which thereby becomes the Department of Nuclear Safety and Security). By better exploiting the synergies between safety and security and promoting further cross-fertilization of approaches, the Agency is trying to help build up mutually reinforcing global regimes of safety and security. However, the *Nuclear Safety Review for the Year 2002* addresses only those areas already in the safety programme.

INTERNATIONAL SAFETY STANDARDS

As required by its Statute, the Agency has been establishing safety standards since it was founded. The scope and application of the standards have gradually expanded with time. The rigour of the standards has also increased to reflect changing expectations about safety, and the process for establishing the standards has been improved to enhance its transparency, the degree of consensus achieved, and the quality and authority of the product. The Agency's current safety standards reflect the 'best practice' in safety: the levels of safety that are considered to be achievable and that all Member States should strive to achieve.

Although many States use the Agency's safety standards in the formulation of national rules and regulations, with degrees of use varying from direct adoption to use as a reference in the development process, the standards are not yet accepted and applied universally. In the short term, the Agency needs to convey more effectively to the users — and, perhaps more importantly, to potential users — of the standards the message that the standards are rigorous and, if applied effectively, will lead to high levels of safety. For the longer term, the Agency needs to consider how the process of establishing standards, and the standards themselves, can be further improved to ensure that the nature and purpose of the standards are well understood and, more generally, to promote continuously high levels of safety worldwide.

In this regard, the Agency places considerable emphasis on pursuing a goal of global acceptance and application of its safety standards as a key element of the global safety regime. Within this framework, the Commission on Safety Standards' initiative to develop a vision and strategy for the future of the safety standards is welcome and timely. This initiative foresees continuous improvement of the standards to meet the needs of users (making use of feedback from their application), and outreach to broaden awareness of the standards and promote their application.

The issue of proposed European Union (EU) safety standards for nuclear installations represents a new opportunity. The current and likely future members of the EU account for a substantial proportion of the world's nuclear power plants, and some of the main suppliers in

the global nuclear market. At the same time, the current EU Member States have been among the main contributors to the drafting and review of the Agency's safety standards, and yet some are also among the countries that have not, historically, made great use of those standards, having developed their own laws and regulations. The Agency's nuclear safety standards have been endorsed by its Member States — including all of the EU Member and candidate States — as representing best international safety practice. The standards are intended for use by all States that have or might construct nuclear installations. If the EU were to adopt and rely on these standards, and were to co-operate more systematically with the Agency in their future development and application, the effectiveness of the standards would be further increased, as they would be systematically applied in about half of the States that have operating nuclear power plants, representing more than one-third of the plants in the world.

Among the safety standards published in 2002, one of the more notable is the *Safety Requirements on Preparedness and Response for a Nuclear or Radiological Emergency* (Safety Standards Series No. GS-R-2). This publication is co-sponsored by seven organizations and was prepared in consultation with several more. The requirements are also closely and systematically linked to the principles and obligations set out in the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. However, the Safety Requirements go beyond the Early Notification Convention in requiring notification of the Agency and potentially affected States of any 'transnational emergency', this term being defined much more broadly than 'nuclear accident' as defined in the Convention. The Requirements also introduce the concept of a 'dangerous source', meaning a source capable of causing severe deterministic health effects if not properly controlled. This concept is intended to help States and agencies in quickly determining the seriousness of an event involving a radioactive source. Although this concept is intended specifically for use in the context of emergency response, it has been incorporated into the more general categorization of sources developed by the Agency.

In addition, 15 new and revised Safety Guides were published in 2002: four on legal and governmental infrastructure; seven on other aspects of nuclear power plant safety; two on transport safety; and one each on radiological protection of patients and the management of mining and milling waste. As more and more Safety Guides are completed, the updated corpus of safety standards is taking shape: more than half of the new and updated standards planned have now been published, and most of the others are at an advanced stage. Within the next two years, the current major cycle of updating the standards should be complete. The Safety Guides recommend ways in which the relevant safety requirements can be met, and so they often deal more closely with the actual safety measures that are taken in practice. They therefore also form an important basis for recommendations and advice provided by the Agency's safety review services. This in turn helps to promote the Agency's standards in the countries receiving the safety services, particularly in the case of countries that have not previously used them.

SAFETY OF NUCLEAR INSTALLATIONS

Convention on Nuclear Safety

The second Review Meeting of Contracting Parties to the Convention on Nuclear Safety provided evidence of significant progress towards safety-related improvements. The level of

participation in the meeting — around three times as many as at the first meeting in 1999 — also showed the growing importance that Contracting Parties attach to the Convention. The consensus Summary Report adopted by the Review Meeting is an important record of the Contracting Parties' views about the state of nuclear safety in their countries at a given time. The Contracting Parties' overall conclusions were encouraging, particularly in respect of legislation, regulatory independence, financial resources for regulatory bodies and operators of nuclear installations, implementation of safety improvements in installations built to earlier safety standards, and emergency preparedness.

In general, although "some Contracting Parties did not clearly identify the actual changes that had taken place in response to the issues identified at the first Review Meeting", the overall process — particularly the self-assessment inherent in preparing national reports and the feedback provided by the peer review — appears to have had the desired effect, triggering many Contracting Parties to take "steps and measures…to improve implementation of their obligations and to further enhance nuclear safety".

For those States that had safety upgrade programmes in progress at the time of the first Review Meeting, the story was mixed. Some programmes had been completed successfully, but the Contracting Parties felt it necessary to remind others of their commitments "to complete the important safety improvements identified in the review process as planned". There were reassuring indications that many of the earlier problems in finding the resources needed for safety improvement programmes had been solved, but in some States a shortage of resources still remains a major obstacle to completing safety improvements. This is a genuine problem, and resources have to be found.

There continue to be differences in approaches to containment and its role in severe accident management. Some States had made significant improvements to containment structures to enhance their capability to cope with severe accidents; others had improvement plans still awaiting implementation, and some preferred to pursue other approaches to improve severe accident management.

The Contracting Parties acknowledged that there are areas that warrant special attention, including: safety management and safety culture; plant ageing and upgrading; maintaining competence; and effectiveness of regulatory practices. The first two of these issues are addressed elsewhere in this report: the others are discussed briefly below.

The issue of maintaining competence has been identified before as a problem for operating organizations. This is particularly the case where nuclear power is stagnant or declining: experienced and knowledgeable staff are retiring, and sufficient numbers of younger staff of the right calibre are not being attracted to the industry. However, countries with expanding nuclear programmes have a similar problem of finding sufficient numbers of trained and experienced staff to meet the growing need. Since most regulatory bodies (and dedicated technical support organizations) aim to recruit staff with operational experience in the industry, this also in turn makes it difficult for the regulator to maintain its competence. One potential solution for both operators and regulators is to 'buy in' technical support from external consultants, an approach that can be very effective. However, if the pool of suitably qualified consultants is small, regulators in particular may need to exercise special care to obtain the support they need without creating any real or perceived conflict of interest that might compromise their independence.

The debate about the effectiveness of different regulatory approaches continued, particularly in the context of the United States Nuclear Regulatory Commission's (NRC's)

greater emphasis in recent years on risk-informed regulation. There is clearly not international agreement on the optimum balance between deterministic approaches and greater reliance on risk information.

There are still issues associated with the Convention's review process that need further consideration, perhaps the main one being the appropriate balance between confidentiality and transparency in the process. On the one hand it is argued that confidentiality gives Contracting Parties greater freedom to discuss problems in a more frank, and therefore more fruitful, way: insisting on superficial openness may simply lead to sensitive information being withheld. On the other hand, modern expectations of transparency and openness are such that confidentiality can be represented as damaging to the credibility of the whole review process. While the Review Meeting discussions remain confidential, many Contracting Parties have partially bypassed the arguments by placing their own national reports, plus the questions received and answers given, fully in the public domain (usually through the Internet).

One notable addition to the process was the decision by the Contracting Parties to invite the Agency to submit a report to them identifying generic issues and trends observed in the course of performing nuclear safety review services. This is a welcome expansion to the Agency's role in relation to the Convention, and recognition of the value of the Agency's collection of mission reports as an information resource. During the Review Meeting, many Contracting Parties had praised the Agency's various safety review missions and services, which they use widely to help enhance the effectiveness of their national safety arrangements.

Design safety

The safety of nuclear power plants in States that are candidates for accession to membership of the EU continues to attract considerable attention. In July 2002, an Agency mission provided a final review of more than a decade of safety upgrades and assessments at Kozloduy-3 and 4 in Bulgaria. The mission team found that many of the safety measures taken exceeded those that were foreseen in the design, operation and seismic areas, and that the design and operational safety corresponded to the level of improvements seen at similar vintage plants. Similar conclusions were obtained from a mission to Bohunice nuclear power plant in Slovakia in 2001.

One specific category of project, namely the completion of nuclear power plants that have been left in a partially built condition for long periods of time, poses special challenges. The Agency has had particular experience in the case of the Bushehr project in the Islamic Republic of Iran, which has many unique features. The Agency has assisted the Iranian operating and regulatory organizations in reviewing the preliminary safety analysis report for the plant and has provided an extensive list of recommendations.

For the majority of nuclear power plants, however, the main design safety issues are concerned with the interlinked topics of re-licensing, plant life extension, ageing and periodic safety review. The Convention on Nuclear Safety Review Meeting observed a trend towards greater use of periodic safety review (PSR) as the main mechanism for regulating the management of plant life. PSRs often include re-evaluation of the site characteristics, seismic re-evaluation, consideration of other external factors and ageing management programmes, in addition to the usual update of the safety analysis, evaluation of the plant against current safety standards and review of operating experience.

An important issue in safety reviews of existing nuclear power plants is often seismic evaluation. This may be to take account of new information or assessment techniques since the original seismic evaluation of the site (e.g. evidence of a greater seismic hazard at the site than expected before), or because of concerns about the adequacy of the original evaluation or the safety margins provided by the design measures taken. Several Member States have ongoing seismic upgrading programmes to improve the safety levels of the relevant plants. Seismic evaluation is also an issue for other nuclear facilities. Some older facilities (including, for example, some laboratories, research reactors and fuel cycle facilities) were designed without taking account of the potential earthquake input to the extent that would be expected today. Generally speaking, the seismic evaluation of these facilities is not so advanced as that for nuclear power plants, and presents a wider range of different situations. An International Symposium on Seismic Evaluation of Existing Nuclear Facilities is scheduled to be held in Vienna from 25 to 29 August 2003. It is hoped that this will help to consolidate an international consensus on the present status of these issues, promote homogeneous engineering approaches to their resolution and identify priorities for future work in this area.

Operational safety

Overall the Agency's operational safety review services continue to confirm the positive picture identified at the Convention on Nuclear Safety Review Meeting. Follow-up missions find, on average, 97% of issues identified by Operational Safety Review Teams (OSARTs) satisfactorily addressed, and this percentage has been climbing steadily for several years. The wider availability of OSART findings through distribution of the OSMIR database[1] appears to have contributed to a greater awareness of good practices and potential pitfalls.

However, the most extensively reported events involving nuclear installations during 2002 were the discovery of serious corrosion of the reactor vessel head at Davis Besse nuclear power plant, United States of America, and the revelations concerning the mis-recording and/or mis-notification of the operator's inspection results at plants operated by the Tokyo Electric Power Company (TEPCO). Both cases have been subject to extensive investigation in the respective countries and improvements have been and are being implemented to prevent recurrences. Since the Agency has not reviewed these events or the organizations or plants concerned recently (although an OSART to a TEPCO plant is now being scheduled), only very brief and general observations can be added here.

Of the two, the event at Davis Besse appears to have had more direct safety significance for the specific plant, as the plant's defence in depth was seriously degraded. Two aspects are of particular concern: the erosion went undetected for several years, and was caused by a known phenomenon. There are lessons to be learned from this event about the operator's inspection practices and the regulator's oversight, and particularly about awareness of operational experience feedback and acting on such feedback.

The implications of the events at TEPCO are of a different nature. The operators of nuclear installations are primarily responsible for their safety, but regulators and the public must be able to trust the operators to be open and honest about safety issues. Individual instances of mis-recording or mis-notification do not necessarily have any relevance per se to safety — the instances reported at TEPCO happened several years ago and do not appear to

[1] The OSMIR (OSART Mission Results) database is a compilation of recommendations, suggestions and good practices from de-restricted OSART reports.

have had any significant safety consequences — but any suspicion of a 'culture' in which mis-recording and/or mis-notification are tolerated must ultimately be considered a potentially serious threat to safety.

Safety management and safety culture

The International Conference on Safety Culture in Nuclear Installations held in Rio de Janeiro, Brazil, in December 2002, highlighted the progress that has been made. Little more than a decade ago, 'safety culture' was a new term to nuclear safety. It was introduced to describe a somewhat intangible and ill-defined organizational quality. The lack of an adequate safety culture was considered to have been one of the causes of the accident at Chernobyl. The Rio Conference demonstrated that safety culture is now recognized throughout the world as a crucial element of nuclear safety. There are many concrete examples in which safety culture has been successfully assessed and improved — tools and models to assist in this process have been developed, and interest is still growing. There is still scope for further progress and there are still issues to be addressed, but the Conference confirmed that there is a common understanding of safety culture as a mature concept, and that there is now a body of experience in the world that can form the basis for further advances. This maturity is further reflected in the fact that the Agency's Nuclear Safety Standards Committee endorsed a proposal in 2002 to develop the first safety standards directly addressing the issues of safety management and safety culture.

Two issues discussed at the Rio Conference are worthy of mention here. The first is the need for all levels of an organization to be part of the safety culture. Great emphasis has been placed on the critical importance of demonstrated commitment to safety culture from the top of organizations, and the Conference provided evidence that this message is getting through. However, while this is a necessary condition, it is not sufficient. The safety culture concept needs to be deepened and broadened so that it can be better understood and applied at all levels from the boardroom to the shop floor, and mechanisms are needed to check that this is actually the case. The second is a perception that safety culture concepts and methods have been embraced and put into action more enthusiastically in countries where the nuclear industry is still developing than in some of the longer-established nuclear programmes. As yet, this remains a tentative perception of a possible trend rather than a clearly observed phenomenon, but it would not be entirely surprising: it is often easier for developing programmes to 'design in' new ideas than for established programmes to accommodate them within or alongside existing (and proven) approaches.

There is some — albeit still very tentative — support for this hypothesis in the small but persistent number of events in recent years that have suggested deficiencies in safety culture in countries with long established nuclear power programmes. In none of these cases was safety seriously threatened, but the deficiencies in safety culture and/or in safety management were in each case sufficient to require some corrective action. The relatively small number of events and their variety mean that there is not enough information to support any clear conclusions as to why these events seem to be concentrated in advanced nuclear countries. In June 2003, the Agency held a workshop on safety culture and safety management in nuclear installations to discuss lessons learned from the recent events in these countries.

Safety of research reactors

The Agency has initiated an international research reactor safety enhancement plan, including a survey of the safety status of research reactors in Member States, preparation of a code of conduct, and exploration of possible means to strengthen the system for monitoring the safety of research reactors. The results of the survey, along with those of missions conducted by the Agency, have provided some reassurance about the safety of a number of research reactors. In particular, concerns have been expressed about research reactors that are shut down for extended periods without definite plans for either restarting or decommissioning. The survey indicated that most such reactors are in States with good regulatory supervision, and that some are in a state of extended shutdown for valid reasons, such as major modifications. Research reactors in extended shutdown should not, therefore, be assumed necessarily to present a safety issue. However, concerns remain, particularly about reactors in those States that did not respond to the survey (about 20% of the States with reactors) and do not receive Agency missions.

Another safety concern associated with some research reactors has been the storage of spent fuel and nuclear waste at research reactor sites. The research reactor at the Vinča Institute of Nuclear Sciences, Federal Republic of Yugoslavia, has attracted particular attention in this regard, and a number of advisory missions have visited the site in recent years. Following the removal of fresh highly enriched uranium fuel from the site with technical and financial assistance from the Russian Federation and the United States of America, Agency assistance is now being focused on decommissioning, spent fuel and waste management issues at the reactor site. It should be recalled that, while there is no legally binding equivalent to the Convention on Nuclear Safety for research reactor safety, and efforts are continuing to develop a non-binding Code of Conduct, the safety of management of spent fuel at research reactors is covered by the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

The Agency is organizing an International Conference on Research Reactor Utilization, Safety, Decommissioning, Fuel and Waste Management, which will be hosted by the Government of Chile in Santiago, from 10 to 14 November 2003. This will provide a forum for reactor operators, designers, managers, users and regulators to share experience, exchange opinions and to discuss options and priorities.

Security of nuclear installations

The security of nuclear installations is essential to their safety, and safety and security issues often interact very closely, for example in the case of protecting nuclear installations from malicious external acts. These topics are therefore being addressed through close co-operation between staff from safety and security backgrounds, and one of the early tasks has been to try to harmonize terminology between the two areas. Among other activities during 2002, draft guidelines for the self-assessment of safety and security of nuclear installations were prepared and reviewed by a group of safety and physical protection experts, and the guidelines will start to be applied at nuclear installations in 2003.

SAFETY OF TRANSPORT OF RADIOACTIVE MATERIAL

Despite the rarity of significant incidents, the safety of transport of radioactive material remains high on the international safety agenda. In particular, a number of coastal States

continue to express concern about the possible health, environmental and economic impacts of a potential accident or incident during the transport of radioactive materials by sea[2].

The Transport Safety Appraisal Service (TranSAS) was introduced by the Agency at the request of its Member States as one way of providing assurance that the Agency's Transport Regulations were consistently implemented. The 2002 missions to Brazil and the United Kingdom, and the planned missions to Turkey, Panama and France represent a very significant development. In particular, the United Kingdom and France are two major shippers of radioactive material, while Panama and Turkey control two important waterways for international maritime transport: the Panama Canal and the Bosporus respectively. The publication of the full mission reports is also a significant step towards greater transparency about the transport of radioactive material. It is to be hoped that this trend will contribute towards fostering constructive and soundly based technical discussion of this issue.

A problem that has been developing for some time, and has been exacerbated by heightened security concerns since 11 September 2001, is the decreasing number of commercial transport options for radioactive sources. Several potential carriers, including some prominent airlines, now systematically refuse to carry radioactive sources even though they are packaged in full accordance with international safety regulations. This clearly has the potential to create serious problems for those using radioactive sources for a wide range of applications, but air transport is particularly important as a rapid means of delivering short-lived sources over long distances for medical applications. Problems could also arise with returning disused sources to the manufacturer or transferring them to third parties for safe disposal: if such transport is not available, then the risk that some of those disused sources might eventually become orphaned is increased. Given the importance of maintaining the air transport option, ways may need to be found to try to overcome the airlines' misgivings.

To this same end, the Agency is organizing an International Conference on the Safety of Transport of Radioactive Material, which was hosted by the Austrian Government in Vienna from 7 to 11 July 2003. The conference was co-sponsored by the International Civil Aviation Organization, the International Maritime Organization and the Universal Postal Union and held in co-operation with the International Air Transport Association and the International Organization for Standardization.

SAFETY AND SECURITY OF RADIOACTIVE SOURCES

Previous Nuclear Safety Reviews have described many events, in different parts of the world, in which 'orphan' sources have caused serious overexposure of individuals. Some of these events involved theft of radiation sources, typically in the belief that their containers would have value as scrap metal, but none appeared to involve any deliberate malicious intent to cause radiation exposure. The events of 11 September 2001 were a reminder that one cannot be sure that this will always be the case, and brought a new sense of urgency to measures to address the problem of orphan sources. The launch by the Russian Federation, the United States of America and the Agency of a tripartite initiative to address the problem in the former Soviet Union is an important and welcome step in this direction. Successive Nuclear Safety Reviews have described a series of events in Georgia. However, Agency staff members on missions in several of the other Newly Independent States have reported seeing substantial

[2] As reflected, for example, in General Conference resolution GC(46)/RES/9.B.

sources of various types apparently under inadequate control, and there is some evidence of other sources not properly accounted for.

Important as this remedial work is, it would be futile to devote such efforts to recovering sources that have already been orphaned without also taking measures to prevent sources from becoming orphaned in the future. The Model Project on Upgrading Radiation Protection Infrastructure, delivered through the Agency's technical co-operation programme, has for several years been assisting more than 50 developing Member States in establishing and strengthening basic systems for keeping radiation sources under proper control. This project is now being extended to include another 30 Member States. Although there have been many notable successes in the Model Project, events such as that during 2002 in Bolivia[3] — one of the original Model Project participants — suggest that there is still room for improvement. Furthermore, the problem is not confined to developing countries: for example, the NRC reports that companies have lost track of nearly 1500 radioactive sources within the United States of America since 1996, and more than half were never recovered. It has also been estimated that every year up to about 70 sources are lost from regulatory control in the EU. These States too need not only to deal with the legacy of orphaned sources but also to make their control procedures more consistently effective in keeping sources under control.

In many of the recent accidents involving orphan sources, the sources involved were no longer in use but had not been properly managed. Disused sources constitute one of the most vulnerable — and therefore potentially dangerous — classes of sources, and the root of the problem is often one of funding: disused sources have almost by definition ceased to contribute to income generation and so managing such sources safely as radioactive waste is sometimes seen as an unnecessary expense. Some sources are therefore abandoned or 'stored' indefinitely, often in insecure locations, making it easier for them to be stolen (typically for the scrap value of the container rather than with malevolent intent) or otherwise lost from control. An essential element of any programme to address the problem of orphan sources is therefore to provide safe and affordable means for the proper management of disused sources. The return of sources to the manufacturer for recycling is the most common approach, but this could be made easier. One of the difficulties is referred to in the transport safety section of this report, but there are others, and continued effort is needed to overcome these difficulties. Other solutions are also being investigated for certain circumstances, such as the possibility of constructing deep boreholes for use as regional disposal facilities for States in Africa.

The Code of Conduct on the Safety and Security of Radioactive Sources was developed as a crucial part of the Agency's Action Plan[4]. Since 11 September 2001, it had become clear that the Code needed to be modified to reflect the change in the perception of threats. However, modifying the Code is only a first step: it is the systematic and universal application of the Code that will bring real improvements in the safety and security of sources.

A closely related issue is the categorization of sources. It was recognized that the need to revise the Code of Conduct also implied a need to revisit the source categorization scheme developed to accompany the Code. The wider range of scenarios considered since 11 September 2001 has resulted in a categorization system that is slightly more complex, but

---

[3] In Bolivia, four industrial radiographers and about 30 passengers on a public bus were exposed to radiation from defective industrial radiography apparatus containing an ^{192}Ir source that had not returned to its shielded position.

[4] The Action Plan for the Safety of Radiation Sources and the Security of Radioactive Materials is laid out in Agency document GOV/1999/46-GC(43)/10.

potentially more useful for general use (for example, the 'dangerous source' concept in the Safety Requirements for emergencies: see the section on safety standards above).

An International Conference on Security of Radioactive Sources was organized by the Agency in Vienna from 10 to 13 March 2003, hosted by the Government of Austria, co-sponsored by the Governments of the Russian Federation and the United States of America, and in co-operation with the European Commission, the European Police Office (Europol), the International Criminal Police Organization (Interpol) and the World Customs Organization.

RADIATION PROTECTION

Occupational radiation protection

An estimated 11 million workers worldwide are monitored for occupational radiation exposure. The fact that occupational radiation protection is rarely mentioned in safety reviews of this type is, paradoxically, a measure of its success. However, this should not be taken to mean that all issues have been resolved. The International Conference held in August 2002 at the headquarters of the International Labour Organization (ILO) in Geneva, Switzerland, highlighted both the successes and the issues that need further attention. It is perhaps surprising that there remains a need for greater harmonization in the use of terminology, quantities and units. This in turn requires a degree of stability in the standards that define them. It may be less surprising that more needs to be done to bring what is done in non-nuclear fields of medicine, industry and mining more into line with the standards and procedures applied in the nuclear industry. This does not mean that the same requirements must apply, but there should be a more consistent and coherent 'graded approach' to occupational radiation protection, such that the protection measures in place are more systematically and objectively based on the levels of exposure and the feasibility of control.

Progress in these areas requires co-operation between employers, their regulators and workers. While the Agency has good contacts with the first two, the involvement of the ILO is crucial to ensure that workers' representatives have a voice. The Agency has worked closely with the ILO in the development of safety standards for occupational protection, and is now continuing this co-operation to develop an international action plan addressing issues raised at the Geneva Conference.

Radiological protection of patients

Medical diagnosis and treatment are by far the largest sources of man-made radiation exposure — and if current growth rates continue, could even exceed exposure from natural sources (at least in developed countries) within a few decades. As the benefits for patients far outweigh the risks, the use of radiation in medicine can be expected to continue to increase. However, there is great variation from place to place in the doses being received by patients for the same routine radiology procedure, which means that substantial reductions could be achieved without losing diagnostic information. At the same time, while new diagnostic equipment and techniques are bringing new benefits, some of the procedures involve the delivery of relatively high radiation doses to patients. In addition, a number of radiation injuries in interventional radiology and accidental exposures in radiotherapy have been reported. These facts have focused attention on the need to improve the radiological protection of patients in diagnostic and interventional radiology, nuclear medicine and

radiotherapy. Although several standards address the protection of workers conducting medical procedures, and the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* include basic requirements for controlling medical exposure, the Safety Guide on *Radiological Protection for Medical Exposure to Ionizing Radiation* (Safety Standards Series No. RS-G-1.5) published in 2002 (co-sponsored by the Pan American Health Organization and the World Health Organization) is the first Agency safety standard to be devoted exclusively to the protection of patients. An international action plan, drawing upon the findings of an international conference held in Málaga, Spain, in March 2001, has been prepared by the Agency. This has been developed through close co-operation between experts from the radiation protection and medical fields: 15 organizations and professional bodies were involved in the preparation of the action plan.

The action plan highlights, among other issues, education and training as one of the key mechanisms to improve the radiation protection of patients. Since the number of health professionals worldwide who could benefit from such education and training is vast, there is no way that the Agency or other centralized organizations could hope to provide it directly. Therefore, great emphasis is placed on co-operation with professional bodies to train the trainers who can, in turn, train other trainers and so, it is hoped, create a 'cascade' effect that can reach all of the relevant groups, from consultants to technicians.

RADIOACTIVE WASTE

Radioactive discharges to the environment

There was considerable debate at the Convention on Nuclear Safety Review Meeting in April 2002 and at the International Conference on Issues and Trends in Radioactive Waste Management in December 2002 about trends in the control of radioactive discharges. In some States, policies are increasingly based on the 1998 Sintra statement of parties to the OSPAR Convention[5], the ultimate aim of which was to "achieve concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances". It is argued that this is a political statement, not necessarily consistent either with the risk-based approach of constrained optimization recommended by the International Commission on Radiological Protection (ICRP) and reflected in Agency standards, or with the principle that radioactive waste management decisions should take account of all interdependencies.

Another development that may in time influence discharge-control policies is the growing attention to protection of the environment (as distinct from humans). Protection of the environment is universally accepted as a good thing, but is often defined vaguely or not at all. For decades, it was assumed that protection of the environment from the effects of radiation would normally be an automatic consequence of protecting humans to an acceptable standard. It was recognized that, if criteria for the protection of human individuals and populations were satisfied, individual non-human organisms might sometimes be harmed, but

[5] The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) entered into force in 1998 as the successor to the Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft and the Paris Convention for the Prevention of Marine Pollution from Land-Based Sources. The Contracting Parties are Belgium, Denmark, the European Commission, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

it was assumed that populations or species would not be significantly affected. It was further assumed that this situation represented an acceptable level of protection of those organisms. These assumptions have been challenged to an extensive degree in recent years: if they are valid, their validity needs to be demonstrated more convincingly than hitherto.

The Agency is organizing, in co-operation with the United Nations Scientific Committee on the Effects of Atomic Radiation, the European Commission and the International Union of Radioecology, an International Conference on the Protection of the Environment from the Effects of Ionizing Radiation, to be hosted by the Government of Sweden in Stockholm from 6 to 10 October 2003. Ultimately, it is hoped that, through conferences like this, advice from ICRP and other activities, an international consensus will emerge that can form the basis of Agency safety standards.

Decommissioning

Although plant life extension is being successfully pursued in many States, the natural corollary of an ageing fleet of nuclear installations is that decommissioning is an issue of ever-growing importance. From the findings of an international conference held in Berlin in October 2002, the more pressing issues are typically planning the decommissioning process (including defining the end-points for the decommissioning) and finding the resources. Most of the evidence to date suggests that thorough and detailed planning, starting as early as possible, is key to successful decommissioning projects. This should include detailed identification in advance of all the waste streams to be expected during decommissioning and of the intended management approach for each of these waste streams. The technology for safe long term management of each waste should not only exist, but also be implemented: for example, appropriate disposal facilities should actually be available when needed. For newer facilities, this concept of early planning can be extended to include designing and operating the facility so as to facilitate its decommissioning and management of the wastes.

However, there is still not international agreement on some of the key ‘end points’ for decommissioning; in particular on criteria for recycling or disposing of large amounts of very lightly contaminated construction materials and for releasing decontaminated land or buildings for general reuse. Since these are important parameters for planning decommissioning, this lack of clear criteria is a significant impediment. The levels currently being discussed internationally to define the scope of regulatory control should, when they are agreed, help to address this problem as well as several others.

Funding for decommissioning is not obviously a safety issue, but lack of funding can make it become one. The problem has already reached some prominence in relation to research reactors. There have been repeated expressions of concern about the safety of research reactors around the world that are shut down, with little or no likelihood of restarting, but with no progress either towards decommissioning. This is often attributed to a lack of funding to decommission reactors when the income from operation or research funding has stopped. For nuclear power plants, most countries now have requirements that decommissioning funds be established during operation, but this was not always done in the past. Therefore, some plants that have shut down or will soon shut down will have to find funding from some other source. The Agency is already assisting in planning the decommissioning of the BN-350 fast reactor in Kazakhstan and units 1–3 of the Chernobyl nuclear power plant in Ukraine (which are already closed) and of unit 1 of the Ignalina nuclear power plant in Lithuania (scheduled to close by 2005), but the main funding for these projects will have to come from international donors.

Recognizing the importance and multidisciplinary nature of the topic of decommissioning, the Agency has established a technical group on decommissioning made up of Member State experts with experience in a variety of relevant fields, to advise on issues and priorities for the Agency in this area. The group will start its work in 2003.

Radioactive waste management

The first Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management will be held in November 2003. Although the number of Contracting Parties — currently 31 — is sufficient for the Convention to operate, it is only a little more than half the number of Contracting Parties to the Convention on Nuclear Safety. Full participation in the first Review Meeting will be open only to those States that have deposited an instrument of ratification, acceptance, approval or accession with the depositary by 5 August 2003.

The decision to proceed towards the construction of a geological repository for spent fuel and high level waste at Yucca Mountain is an important practical step for the United States of America. Globally, it is an important symbolic step, following as it does recent examples of progress in Finland and Sweden. For years, if not decades, political inertia, fuelled in part by public mistrust, has been regarded by the technical community as the primary impediment to the implementation of geological disposal, which is considered the only safe and feasible long-term solution for the management of very long lived wastes. There is considerable opposition to the Yucca Mountain project, some of it based on detailed technical arguments claiming flaws in the safety case for a repository. It now remains for the United States Department of Energy and its contractors to demonstrate that they can deliver a real repository and demonstrate convincingly that it is safe.

The European Commission's proposal for a directive on radioactive waste management is another interesting development. The directive would, inter alia, set a timetable for Member States to identify sites and construct repositories for the disposal of high level waste and spent fuel (if it is treated as waste). Despite notable developments in a few countries, concerns about public acceptability of deep geological disposal have contributed to repeated delays in decision-making at the national level. In response, more emphasis has been given to the decision-making processes for siting and constructing repositories. In general, the more successful approaches have involved proceeding step-by-step, systematically involving all stakeholders in each step of the process. In this context, while the desire of the European Commission to force the pace towards disposal is understandable, the suggested timescales might create some debate. According to current plans, Sweden and Finland, the two EU Member States that have made most progress in the process, might have difficulty meeting these time limits, and other States' programmes are considerably less advanced.

The International Conference on Issues and Trends in Radioactive Waste Management, held in Vienna in December 2002, provided a timely update on the major issues in radioactive waste management, and introduced a few new issues. One of the most telling messages from the Conference was strong reinforcement of a trend identified at the Córdoba Conference in 2000, namely a greater recognition of the importance of the social and political aspects of radioactive waste management. The debate about discharge control discussed in an earlier section of this report is a case in point, as is the rapidly changing attitude to 'retrievability' as a feature of repositories, particularly those for high level waste and spent fuel. There are undoubtedly some who favour indefinite surface storage of such materials primarily because it supports the perception that the 'problem' of the waste has not been solved and therefore

undermines nuclear technology. More generally, though, a much broader section of society appears to be unwilling at present to trust the judgement of scientists or engineers by allowing the 'final' closure of a geological repository. On the other hand, the scientists and engineers remain reluctant to leave the safety of such wastes dependent on the continued stability and diligence of human society over periods of hundreds of years and more. Hence there seems to be a movement towards a possible compromise of a geological repository that is kept open for an extended period of time, until such time as a future generation decides either to close it or to retrieve the waste and do something else with it.

In relation to the principles of radioactive waste management, as set out, for example, in the Agency's Safety Fundamentals or the Joint Convention, this seems to reflect a subtle shift in interpretation. One of the long-established principles is that waste is to be managed so as to give rise to "no undue burden on future generations". This was usually interpreted to mean the current generation disposing of the waste it generated in a manner requiring minimal monitoring or intervention in the future. More recently, there has been much greater attention to another 'obligation' to future generations, linked to the issue of sustainability, namely that the current generation should avoid taking irreversible actions that foreclose options for the future.

INFRASTRUCTURE FOR SAFETY

Regulatory infrastructure

Due to the fact that it typically developed in parallel with a national nuclear power programme, the basic governmental and regulatory infrastructure for nuclear safety tended to be taken for granted. Furthermore, in countries that had nuclear power programmes, the corresponding infrastructure for radiation safety was often reinforced by the presence of the nuclear safety infrastructure. As a result, the importance of these infrastructures was often overlooked. Over the years, however, it became clear that many other countries had adopted certain applications of nuclear technology — particularly medical and industrial applications — without also acquiring adequate infrastructures to provide the basis for ensuring the safety of these applications. This problem was highlighted when the Basic Safety Standards were established in the mid-1990s, and the Model Project on Upgrading Radiation Protection Infrastructure was introduced to help address it. In spite of the progress achieved in establishing and strengthening national radiation safety infrastructures, the objective of all States having infrastructures in accordance with the Basic Safety Standards is still some way off.

This is not to suggest that the regulatory infrastructure in States with nuclear power programmes is static. There has been a significant trend since the entry into force of the Convention on Nuclear Safety — examples in the past year or so include Bulgaria, France, and Pakistan — to reorganize or change the status of regulatory bodies in order to improve their de jure independence from organs of the State that are responsible for promoting nuclear energy. It should be emphasized that the regulatory bodies were in most cases already de facto independent, meaning that, in practice, there was no evidence of improper influence on their regulatory decisions. Nevertheless, improving the de jure independence of regulatory bodies provides an important additional safeguard, and can be an important aid towards increasing their credibility.

This formal de jure independence is desirable in States where there is an adequate pool of qualified staff. One problem identified at the Geneva conference on occupational radiation protection was that some States have a very limited number of staff with the necessary education, training and experience relevant to safety. In these cases, formal separation of organizations may have the effect of further thinning the expertise in each organization. It may then be preferable for safety overall to have regulators who are de facto independent and fully competent rather being than de jure independent but less competent.

Education and training

A common and recurring theme pertinent to many of the safety issues discussed above is education and training. Results from Agency missions in many different areas of safety confirm the crucial importance to safety of people with a thorough knowledge and understanding of safety principles and approaches, underpinning relevant and up-to-date training in specific topics. The Agency's strategic plans for education and training in nuclear safety and in radiation and waste safety aim to address this concern by promoting self-sustaining capabilities in the Member States, at the national level and, where appropriate, the regional level. The main elements of the plans therefore aim to provide the infrastructure and support to allow sustainable national and regional programmes to be established and maintained: training the trainers, developing and disseminating standardized training materials for a wide range of courses (and making them available in appropriate languages), providing models to help harmonize on-the-job training programmes, establishing national and regional centres for education and training and networks of such centres, and exploiting modern technology to provide for distance and e-learning and for networks of knowledge and experience providing easy access to information from around the world. As a further means of supporting Member States in developing their programmes, the Agency now offers review services to advise on the creation or improvement of education and training programmes. In radiation and waste safety, where the range and diversity of topics on which education and training might be provided is particularly large, a steering committee has been set up to monitor progress in relation to agreed performance indicators and provide feedback to the Agency on emerging issues and priorities. This will help to ensure that the Agency's efforts are focused on the real needs of the Member States.

Networks of knowledge and experience

A large amount of information relevant to safety of nuclear installations and radiation sources has not, to date, been fully analysed and shared worldwide. Therefore there is a need to strengthen efforts to pool, assess and effectively share existing and new technical knowledge and practical experience to further improve the safety of nuclear installations and various applications of ionizing radiation. Such networks can also promote mutual learning through the pooling of questions and answers, and the fertilization of ideas leading to the development of innovative approaches.

The Agency is assisting Member States to develop nuclear safety networks to exchange knowledge among regional hubs and national centres using modern information technology tools. In Asia, a pilot project is under way that focuses on networking knowledge related to education and training in nuclear safety. Nuclear safety portals are being developed in China, Japan and the Republic of Korea. This model could be further used for other regional centres and eventually for a global safety network.

In 2002, the General Conference requested the Secretariat in resolution GC(46)/RES/11, to further increase (within available resources) the level of attention given to activities for preserving and enhancing nuclear knowledge, and also to assist Member States in their efforts to ensure sustainable nuclear education and training, which is a necessary prerequisite for succession planning. Networking nuclear safety knowledge will be a most important tool for the Agency to respond to these requests, and the developments in knowledge management may in turn provide new ways to enhance the networking and contribute to continuous improvement of nuclear safety among Member States.

Conference on safety infrastructures

An International Conference on National Infrastructures for Radiation Safety: Towards Effective and Sustainable Systems is being organized by the Agency in co-operation with the World Health Organization, the International Labour Office, the European Commission and the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development, and is scheduled to be hosted by the Government of Morocco in Rabat from 1 to 5 September 2003. This will provide an opportunity to review progress made, and to consider priorities for the coming years.

SAFETY RELATED EVENTS AND ISSUES WORLDWIDE, 2002

This section aims to identify those events or developments during 2002 that:

(a) were of particular importance in their own right; and/or

(b) provided lessons that may be more generally applicable; and/or

(c) have potential long term consequences or could be indicative of developing trends that might be of longer term importance.

It is not intended to provide a comprehensive account of all events during the past year. It should be noted in particular that some events reported for reasons of the type indicated in (b) and (c) might not have been considered significant in their own right.

This report supports the *Nuclear Safety Review for the Year 2002*.

INTERGOVERNMENTAL AGREEMENTS

The **Convention on Nuclear Safety** entered into force on 24 October 1996. Indonesia ratified the Convention during 2002, bringing the number of Contracting Parties at the end of 2002 to 54 (including all but two of the States with nuclear installations that have achieved criticality in a reactor core).

In April 2002, the second Review Meeting of Contracting Parties to the Convention was held in Vienna, under the Presidency of Mr. M. Gregorič, Slovenia. More than 400 delegates from 46 of the Contracting Parties participated in the Meeting, at which the National Reports submitted by 47 Contracting Parties were reviewed in six Country Groups, each group including countries with nuclear power programmes of different sizes, as well as countries not having nuclear power plants. After hearing presentations by each Country Group's Rapporteur summarizing the discussions in the Group, the plenary adopted by consensus a Summary Report addressing issues discussed and conclusions reached during the meeting.[6] The Contracting Parties concluded that the review process had demonstrated the strong commitment by all to the objectives of the Convention and that, although additional steps are required in order to reach the principal objective of the Convention, all Contracting Parties participating in the Review Meeting are taking steps in the right direction. The Summary Report listed several areas in which significant progress had been observed since the first Review Meeting and a number of other areas that warrant special attention.

The **Convention on Early Notification of a Nuclear Accident** (the Early Notification Convention) and the **Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency** (the Assistance Convention) entered into force in October 1986 and February 1987 respectively. At the end of 2002, they had 87 and 84 Contracting Parties, respectively, Canada having ratified the Assistance Convention during 2002. The Assistance Convention was formally invoked during 2002 in relation to events involving radiation sources in Afghanistan, Bolivia, Uganda and the United Republic of Tanzania, which are described later in this report.

Representatives of 19 Contracting Parties to the Early Notification and Assistance Conventions, represented by their national competent authorities, met in Oslo, Norway, in

[6] The Summary Report can be found at www.iaea.org/ns/nusafe/publish/papers/conv_2002.pdf.

May 2002. This was the second meeting of competent authorities, and was aimed at preparing a plan of actions to be taken by relevant competent authorities to follow up on recent IAEA General Conference resolutions and the recommendations of the first meeting of competent authorities, held in Vienna in June 2001. The meeting produced a detailed action plan for competent authorities and international organizations. As part of the action plan, terms of reference were established for three working groups of experts — on long-term sustainability, on international assistance, and on international communication — to be nominated by volunteering competent authorities and international organizations.

New editions of the Joint Radiation Emergency Management Plan of the International Organizations (the "Joint Plan") and the Emergency Notification and Assistance Technical Operations Manual (ENATOM) were published by the IAEA, effective from 1 December 2002. These documents take account of a number of developments since the previous issue in 2000, particularly the publication in 2002 of Safety Requirements on Preparedness and Response for a Nuclear or Radiological Emergency, feedback from the first meeting of representatives of competent authorities, held in June 2001, lessons identified from exercises and events, recommendations from the Inter-Agency Committee on Nuclear Accidents (IACRNA), and increased recognition that emergency situations can arise from both accidents and deliberate acts. The revised Joint Plan was jointly sponsored by nine organizations — three more than the previous version, with the addition of the European Commission, the Pan American Health Organization and the UN Office for Outer Space Affairs — and issued in co-operation with the International Civil Aviation Organization.[7]

The **Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management** entered into force on 18 June 2001. Three States — Belarus, Belgium and the Republic of Korea — ratified the Convention during 2002. As of the end of 2002, 30 States had deposited instruments of ratification, acceptance or approval with the depositary. The Organizational Meeting for the first Review Meeting of the Contracting Parties will be held in Vienna starting on 7 April 2003, and the Review Meeting itself will start in Vienna on 3 November 2003.

A **Code of Conduct on the Safety and Security of Radioactive Sources** was agreed by a meeting of technical and legal experts in July 2000, and the IAEA's General Conference in September 2000 invited Member States to take note of the Code and to consider, as appropriate, means of ensuring its wide application. In the light of changes since 11 September 2001 in the perception of the potential hazards associated with radioactive sources, the Code of Conduct is being revised. It is expected that a draft revised text will be presented to the IAEA's Board of Governors in September 2003.

A draft **Code of Conduct on the Safety of Research Reactors** was developed by two open-ended meetings of technical and legal experts in May and December 2002 and discussed by the Board of Governors in March 2003. The proposed scope of the draft Code included civil nuclear reactors used mainly for the generation and utilization of neutron flux and ionizing radiation for research and other purposes, critical assemblies and associated experimental facilities, and storage, handling and treatment facilities for radioactive materials that are on the same site and are directly related to the safe operation of the research reactor. The proposed objective was to achieve and maintain a high level of nuclear safety in research

[7] The 2000 and 2002 editions are jointly sponsored by the Food and Agriculture Organization of the United Nations, the IAEA, the Nuclear Energy Agency of the Organisation for Economic Cooperation and Development, the UN Office for the Co-ordination of Humanitarian Affairs, the World Health Organization and the World Meteorological Organization.

reactors worldwide through the enhancement of national measures and international co-operation. The draft Code specified the respective roles of the State, the regulatory body, the operating organization and the IAEA Secretariat in pursuing this objective.[8]

CO-OPERATION BETWEEN NATIONAL REGULATORY BODIES

Several forums exist in which regulators can exchange information and experience with their counterparts in other countries. The different groupings are based on various criteria, including:

- regional or linguistic considerations, e.g. the Western European Nuclear Regulators' Association and the Ibero-American Forum of Nuclear Regulators;
- common reactor type, e.g. Senior Regulators from Countries Operating CANDU Type Nuclear Power Plants, the Co-operation Forum for WWER Regulators and the Framatome Nuclear Regulators' Association (FRAREG); and
- size of nuclear power programme, e.g. the International Nuclear Regulators' Association and the Network of Regulators of Countries with Small Nuclear Programmes.

All of these forums meet regularly to discuss issues of common interest.

ACTIVITIES OF INTERNATIONAL ADVISORY BODIES

A number of international expert bodies issue authoritative findings and recommendations on safety related topics. The advice provided by these bodies — inter alia — is an important input into the development of the Agency's safety standards and many national safety regulations. In particular:

- the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), a Committee of the UN General Assembly, provides information and recommendations on sources and effects of ionizing radiation;
- the International Commission on Radiological Protection (ICRP), an independent group of experts, provides recommendations on all aspects of protection against ionizing radiation;
- the International Commission on Radiation Units and Measurements (ICRU), a sister organization of ICRP, provides recommendations regarding relevant quantities and units, measurement procedures and data; and
- the International Nuclear Safety Advisory Group (INSAG) advises the IAEA's Director General on nuclear safety issues.

[8] In view of concerns expressed by some Member States and the Board, the Secretariat sent the draft Code of Conduct to all Member States for consideration and comment by 1 September 2003. Following further work to resolve the issues raised, it is expected that a revised draft Code of Conduct will be submitted to the Board in 2004.

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

In Resolution A/RES/56/50, the UN General Assembly took note with appreciation of UNSCEAR's 2001 Report on the risks of hereditary effects from exposure to radiation, described in the *Nuclear Safety Review for the Year 2001*.

For budgetary reasons, UNSCEAR was able to hold only one meeting in the 2002–2003 biennium, in January 2003. Therefore only a very brief (and largely procedural) report was submitted to the 57th UN General Assembly in 2002. In Resolution A/RES/57/115, the General Assembly inter alia reaffirmed the functions and independent role of UNSCEAR and requested it to continue its work, and emphasized the need for UNSCEAR to hold regular sessions on an annual basis so that its report to the General Assembly can reflect the latest developments and findings.

UNSCEAR is preparing several reports that will, when completed, be included as annexes in future reports to the General Assembly. The topics covered include: exposure of workers and the public from various sources of radiation; 'sources-to-effects' assessment for radon in homes and workplaces; radioecology; epigenetic effects of ionizing radiation (effects on the cell other than DNA mutations); health effects due to radiation from the Chernobyl accident (for which UNSCEAR has established official collaborations with scientists in Belarus, the Russian Federation and Ukraine); evaluation of new epidemiological studies of radiation and cancer; epidemiological evaluation and dose response for diseases other than cancer that might be related to radiation exposure; medical radiation exposure; and the next overview of the sources and effects of ionizing radiation exposure. A progress report on this work to the 58th UN General Assembly was submitted for the approval of the 51st session of UNSCEAR in January 2003.

International Commission on Radiological Protection (ICRP)

As reported in the *Nuclear Safety Review for the Year 2001*, ICRP has recently published a number of reports relating to radiological protection in medicine. The Commission has also now published a report entitled *Radiation and Your Patient: A Guide for Medical Practitioners* (ICRP Supporting Guidance 2). This is designed to provide — using a question and answer format — basic information on radiation mechanisms, the dose from various medical radiation sources, the magnitude and type of risk, and answers to frequently asked questions (for example, those concerning radiation and pregnancy).

A draft report prepared by a Task Group on the protection of non-human species was issued for consultation through the ICRP Web site in August 2002. The draft report examines and suggests what could be done by the ICRP — given the present state of knowledge — to develop more detailed approaches to addressing the many issues that do, and will, arise with regard to protection of non-human species. The Task Group recommends that the Commission develop a framework for radiological protection of non-human species that is harmonized with the proposed approach for the protection of humans. To achieve this, an agreed set of quantities and units, a set of reference dose models, reference dose-per-unit-intake data and reference organisms will be required. The Task Group recommends that the Commission, as a first step, develop a limited number of reference organisms, so that others can develop more area- and situation-specific approaches to assess and manage risks to non-human species.

Two other draft reports were placed on the ICRP Web site in December 2002 for information. The two reports deal respectively with biological effects on the embryo and foetus after prenatal irradiation and with the dosimetric concepts of relative biological effectiveness, radiation weighting factor and quality factor.

International Commission on Radiation Units and Measurements (ICRU)

ICRU published two Reports in 2002: on Absorbed Dose Specification in Nuclear Medicine (Report 67), and on Retrospective Assessment of Exposures to Ionising Radiation (Report 68).

Report 67 addresses biological considerations in radionuclide dosimetry (radiobiological factors in the selection of radionuclides and the dose response of tumour and normal tissue), the MIRD (medical internal radiation dose) approach to nuclear medical dosimetry, non-uniform distributions of activity and varying dose rates in the body, and relevant techniques and procedures.

Report 68 defines basic dose quantities used in dose reconstruction and reviews a range of dose reconstruction methods, including those based on measurements performed for individual persons and those based on measurements in environmental media. The application of different methods of dose reconstruction to the same individuals is reviewed for the atomic bomb survivors of Hiroshima and Nagasaki and the workers of the Mayak Production Association. Examples are described of reconstruction of absorbed doses in environmental media from Hiroshima and Nagasaki, the Nevada test site and settlements contaminated by the Chernobyl accident. The Report concludes with an overview discussing under which conditions the various methods of dose reconstruction are best applied.

International Nuclear Safety Advisory Group (INSAG)

INSAG's three-year term of office came to an end in 2002. A reconstituted Group with a new mandate and composition is expected to begin its term in 2003.

The outgoing INSAG submitted three reports to the IAEA Director General, which will be published by the IAEA in the INSAG Series in 2003:

- Managing Change in the Nuclear Industry: Recognizing and Managing the Effects of Change on Safety;
- Independence in Regulatory Decision Making: ensuring that the day-to-day decision making of regulatory bodies is free from unwarranted external influence; and
- Maintaining the Design Integrity of Nuclear Installations Throughout their Operating Life. This report addresses the issue of ensuring that a complete record and understanding of the design, and the rationale for it, is maintained throughout the plant's life.

ACTIVITIES OF OTHER ORGANIZATIONS

World Association of Nuclear Operators (WANO)

WANO conducted peer reviews at 22 nuclear power stations during 2002, making a total of 183 since the programme began in 1992.

WANO continues to emphasize Technical Support Missions, which focus on providing assistance in selected areas. 43 Technical Support Missions were undertaken during the year.

A central operating experience team, based in WANO's Paris Centre with representatives from all four WANO regional centres, continues to develop operating experience products and information for members. This team produced four Significant Event Reports and two Significant Operating Experience Report during 2002. In addition, 20 topics were added to the "Just in Time Training" database. Plant staff can use the database for relevant operating experience immediately prior to undertaking specific operations and maintenance activities.

The workshop/seminar/training course programme has developed both in scope and in numbers. Approximately 40 workshops and seminars were held in 2002.

WANO performance indicators continue to show a trend of continuous improvement.

Nuclear Energy Agency of the Organisation for Economic Cooperation and Development (OECD/NEA)

The Committee on the Safety of Nuclear Installations (CSNI) continued its activities in the areas of operating experience, structural integrity and ageing, analysis and management of accidents, risk assessment, fuel safety margins, and human and organizational factors. The Committee issued 23 technical reports and organized 12 major workshops. These reports are generally available to experts from countries that are not OECD members.

Continuing in its efforts to maintain an adequate safety research capability, in 2002 the CSNI started three new internationally funded projects bringing the total number to ten. These projects cover technical areas such as thermal-hydraulics, fuel, human factors, severe accidents and operating data. In addition, the CSNI carried out a study of the role of regulatory versus industry-sponsored research and provided guidance in this respect to its Member countries.

The Committee on Nuclear Regulatory Activities (CNRA) carried out a number of activities related to inspection practices, public communication, regulatory requirements for advanced reactors, etc. In particular, the CNRA prepared reports that provide practical guidance to regulators on licensee self-assessment and on decommissioning. Furthermore, the CNRA is sponsoring a pilot project on regulatory effectiveness indicators in which ten regulatory bodies participate. The Committee also established a dialogue with WANO and held a senior level Forum to discuss regulator–licensee interface issues.

The Radioactive Waste Management Committee (RWMC) further supported the development of geologic disposal through new projects, which address the role of engineered barriers (EBS project), the handling of time scales, and geosphere stability in long-term safety

assessment. In addition, a series of workshops has been launched to help to better integrate geological science into repository development (AMIGO project).

The importance of interaction with stakeholders at all stages of the process of repository development has been recognised by the RWMC, and the Forum on Stakeholders' Confidence (FSC) is addressing these issues through analysis of national experience in organizing a stakeholder dialogue. A workshop held in Canada brought together a wide range of stakeholders involved in the Port Hope repository projects.

To support Member countries in decision making on the development of their radioactive waste management programmes, international peer reviews on important safety studies of the Belgian and the French programmes for geological disposal have been organized.

The RWMC also collected experience from its decommissioning groups in a booklet on the status, approach and challenges in decommissioning, which is meant to inform the interested public and to support specialists and policy makers in their work. Associated with the release of the booklet is a database of national fact sheets that will be kept up to date on the NEA Web site.

Through its Committee on Radiation Protection and Public Health (CRPPH), the NEA has started an intensive dialogue with the ICRP on the evolution of the current system of radiological protection. The implications of new ICRP recommendations on the current policy, regulation and practice in Member countries have been intensively discussed with the help of an expert group and during two international workshops in Italy and Japan. Various international stakeholders from radiation protection associations, international organizations, and civil society groups participate in these activities. A set of international case studies is being analysed to further contribute to this work.

In order to better prepare for and manage the response to a nuclear or radiological emergency, the NEA promotes a programme to identify and analyse measures needed to manage long-term consequences and to improve regional co-operation. In close co-operation with the NEA Nuclear Law Committee, implications for compensations mechanisms, as stipulated in international conventions (e.g. the Paris Convention) are also studied.

At a conference in Slovenia in April 2002, the Information System on Occupational Exposure (ISOE), which is supported by a joint NEA–IAEA secretariat, looked back on ten years of successful information exchange and support for radiation protection managers in the nuclear industry.

Institutions of the European Union (EU)

During 2002, the European Commission (EC) issued three proposed Council Directives related to safety. All three were submitted for the opinion of the 'Article 31 Group', as provided for by the Euratom Treaty.[9]

The first of these — *on the control of high activity sealed sources*, issued in March — aims to prevent exposure to ionizing radiation arising from inadequate control of high activity

[9] All three directives were adopted by the Commission in January 2003 after the Article 31 Group had given its opinions. The directive on sealed sources was transmitted to the European Parliament and the Council of the EU; the other two were first transmitted to the Economic and Social Committee.

sealed radioactive sources and to harmonize controls in place in the member States of the European Union (EU) by setting out specific requirements ensuring that each such source is kept under control. The draft includes a table defining what would constitute a "high activity source" for the purposes of the Directive, based on the activity of a radionuclide that would create a dose rate of 1 mSv/h at a distance of 1 metre. The Directive would impose requirements on member States and their competent authorities concerning authorization and transfer of sources, record-keeping, training and information, management of orphan sources (including guarantees for damage to human health caused by orphan sources, and associated intervention costs, where the holder cannot be traced or is insolvent), and on manufacturers and holders of high activity sources.

The other two proposed Directives, described briefly below, were issued in November as part of a 'package' of measures under the heading *Towards a Community approach to nuclear safety*.

The draft Directive *setting out basic obligations and general principles on the safety of nuclear installations* is aimed at introducing common safety standards for EU member States and making them legally binding in those States. The Commission argued that, although a start has been made on harmonization of safety practices, they still vary widely from one EU member State to another. The draft Directive, if adopted by the Council of the EU, would (inter alia) provide for the definition of EU-wide nuclear safety standards, a system of national reporting and 'peer review' among EU member States similar to that existing under the Convention on Nuclear Safety, and a "system of independent verification", comprising some oversight of the actions of national authorities and periodic inspection of installations by teams of experts from the member States.

The draft Directive *on the management of spent nuclear fuel and radioactive waste*, if adopted by the Council, would (inter alia) require EU member States to establish clearly defined programmes for the management (including disposal) of radioactive waste and of spent nuclear fuel not subject to reprocessing contracts or take-back agreements, and to specify a step-wise approach to long term management and disposal with a definite timetable for each step of the process, including authorization for development of appropriate disposal site(s) by 2008, and authorization for operation of the disposal facility to be granted by 2013 (for short lived low and intermediate level waste) or 2018 (for high level and long lived waste). It would also provide for a system of national reporting and 'peer review' among EU member States similar to that existing under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, and a "system of independent verification", as described above.

In December 2002, the European Court of Justice ruled[10] that the provisions of the Euratom Treaty relating to health and safety should be interpreted to include the safety of sources of ionizing radiation, including nuclear installations. Although the specific case before the Court concerned declarations made by Euratom about its competences at the time of its accession to the Convention on Nuclear Safety, the Commission interprets the ruling as confirming its power to propose legislation pursuant to the Euratom Treaty concerning the safety of nuclear installations.

[10] In *Commission of the European Communities v Council of the European Union* (Case C-29/99).

SAFETY LEGISLATION AND REGULATION

The following is a selection of changes to national legislation and/or regulatory arrangements considered to be of particular significance.

In February 2002, the General Directorate for Nuclear Safety and Radiation Protection (DGSNR) was established in France to replace the existing regulatory bodies for nuclear safety (DSIN) and radiation protection (OPRI). A new independent technical support organization, the Institute of Radiation Protection and Nuclear Safety (IRSN), was also established to replace IPSN, which was a branch of the Atomic Energy Commission (CEA).

A new Act on the Safe Use of Nuclear Energy entered into force in Bulgaria in July 2002, which, inter alia, made significant changes to the provisions concerning the regulatory body. By a decree of August 2002, the Committee on the Use of Atomic Energy for Peaceful Purposes was transformed into the Nuclear Regulatory Agency, an independent body responsible for the state regulation of the safe use of nuclear energy and ionizing radiation and the safe management of radioactive waste and spent fuel.

Nigeria established a regulatory body — the Nigerian National Regulatory Authority (NNRA) — in August 2001, as provided for in the Nuclear Safety and Radiation Protection Act 1995. During late 2001 and 2002, it developed regulations covering radiation protection and licensing of research reactors, recruited specialist staff in nuclear safety and radiation protection and, through Technical Advisory Committees, assessed an application to operate the miniature neutron source research reactor at Zaria.

A law promulgated in October 2002 in the Democratic Republic of Congo inter alia established an independent regulatory body, the National Committee for Protection against Ionizing Radiation (CNPRI), with regulatory responsibility for the safety of the research reactor at Kinshasa as well as for radiation protection matters.

SAFETY OF NUCLEAR INSTALLATIONS

The following is a selection of events related to the safety of nuclear installations during 2002, which had some safety significance or which received particular attention.

In February 2002, it was discovered that a hydrogen explosion in December 2001 had ruptured a pipe in the core spray system at the Brunsbüttel BWR in Germany. Although the control room instrumentation had at the time indicated a leak of radioactive steam, the nature of the event had not been fully recognized: operators had isolated the leak and continued operation. Investigations suggested that the hydrogen (formed by radiolysis of the water) accumulated in a part of the pipe between catalytic recombiners. In the Brunsbüttel design, the core spray system provides extra cooling when shutting down the reactor but does not serve a safety function during operation. The explosion was close to a valve connected to the reactor pressure vessel, but the valve was closed at the time and was not affected. A subsequent investigation of all German BWRs indicated that the Brunsbüttel design had a unique vulnerability to this type of event.

During the inspection and repair of vessel head penetration nozzles in March 2002, severe corrosion was discovered in the reactor pressure vessel head at the Davis Besse PWR in Ohio, USA. A cavity (of area about 150 cm^2) had been created, which had penetrated the full thickness of carbon steel (about 17 cm), so that only a thin internal liner of stainless steel cladding had maintained the integrity of the pressure boundary. The corrosion had been

caused by boric acid due to borated water leaking from the primary coolant system through cracked nozzles, and had apparently been under way for several years before being discovered. A Lessons Learned Task Force, established by the United States Nuclear Regulatory Commission, concluded in a report published in September 2002[11] that the event was preventable. Cracking in Alloy 600 vessel head penetration nozzles (and resulting leakage) had been known about for at least 15 years. The specific possibility of extensive damage to the vessel head due to undetected nozzle leaks had been identified in 1993, but it had been assumed that the leaks would be detected before significant damage could result. The Task Force found that there had been deficiencies on the part of both the operator and the regulator. The operator had, inter alia, failed to act effectively on industry guidance and NRC recommendations or operating experience data. The regulator had, inter alia, failed to put together and act upon various pieces of information about symptoms and indications, in part because of focusing on other plants that were subject to increased regulatory oversight.

There have been concerns for a number of years about conditions at the Vinča research reactor in the Federal Republic of Yugoslavia. In August 2002, 48 kg of fresh highly enriched uranium fuel from the research reactor site was transferred to the Russian Federation. Although this measure was taken primarily for non-proliferation reasons, it may also help to facilitate the safety related issues of managing the spent fuel (mostly from low enriched uranium fuel) and decommissioning activities at the plant.

In late August 2002, it was revealed that irregularities had been found in the results of several inspections conducted by contractors for the Tokyo Electric Power Company (TEPCO) at nine units of its Fukushima-Daiichi, Fukushima-Daini and Kashiwazaki Kariwa nuclear power plants (all BWRs) in the late 1980s and the 1990s. Examples of irregularities included cracks in core internals being detected and repaired but not recorded and/or mis-notified to the regulator (or notified later with false dates), or being recorded as not requiring any action without an adequate safety evaluation having been carried out. These inspections were conducted pursuant to the licensee's responsibility for the safety of the plants: they were not specifically mandated or supervised by the regulatory body. The Nuclear and Industrial Safety Agency (NISA) of the Ministry of Economy, Trade and Industry requested TEPCO and their contractors to submit detailed documents on those cases in which cracks had not already been repaired (or the components replaced), conducted, with support from external experts, a thorough analysis of these cases and judged that there was no urgent threat to the safety. NISA also conducted on-the-spot inspections at the three stations. It was subsequently discovered that, in 1991 and 1992, primary containment vessel leak rate data for Unit 1 of Fukushima-Daiichi had been deliberately distorted by injecting compressed air into the containment during the tests. This test was part of the periodic safety inspection by the regulatory body. A report issued in December 2002 by NISA concluded that a combination of pressures due to very high electricity demand and major modification work at the plant and the attitudes of staff at TEPCO and its contractors had resulted in insufficient priority being given to safety. Tests conducted in 2002 at the request of NISA confirmed the integrity of the containment. NISA also made a number of recommendations to prevent any recurrence of such incidents.

[11] The report is available online at http://www.nrc.gov/reactors/operating/ops-experience/vessel-head-degradation/vessel-head-degradation-files/lltf-report.pdf.

SAFETY OF RADIATION SOURCES AND SECURITY OF RADIOACTIVE MATERIALS

As reported in the *Nuclear Safety Review for the Year 2001*, the Agency received in early January 2002 a request from Georgia for assistance in making safe two strontium-90 heat sources found in December 2001 in a forest and in treating three local people who were seriously ill after being exposed to high doses from the source. The combination of mountainous terrain and heavy snow made it impossible to reach the sources during an Agency mission in early January 2002. The sources were finally recovered and secured in early February by a Georgian recovery team trained and accompanied by Agency experts.

In April, representatives from eight Member States, the Organization for Security and Cooperation in Europe (OSCE) and the IAEA reached agreement on a multi-step action plan to conduct IAEA-supported radiological surveys of selected areas in Georgia. The first phase in June 2002 specifically sought to recover two further strontium-90 sources believed to be at large in a specific region of Georgia, but the sources were not found. The second phase was aimed more generally at assisting the Georgian authorities in locating and recovering other known or suspected orphan sources in the country. A searching strategy and an operational plan were developed, and the search was conducted in September 2002, but no further sources were found.

A tripartite initiative involving the Russian Federation, the United States of America and the IAEA was launched in June 2002 with the aim of locating, recovering, securing and recycling orphan sources in the Newly Independent States. Missions were conducted during 2002 in the Republic of Moldova and Tajikistan, and further missions are planned for 2003. Other Newly Independent States will be addressed in order of priority, based on the number and nature of orphan sources believed to be present.

In March 2002, a number of sources were found in Kabul, Afghanistan, during UN environmental monitoring missions of sites damaged or destroyed during recent conflicts. The UN Secretary General asked the Agency to provide assistance. One powerful cobalt-60 source in an old radiotherapy machine in former hospital buildings was secured, and several smaller sources were recovered from disused laboratories at the University of Kabul. Secure temporary storage was established for all of the sources, and advice given on the actions needed to provide a longer term solution. In carrying out the mission, the Agency worked with the UN International Security Assistance Force (ISAF), and UN authorities working with the interim government in Afghanistan.

Also in March 2002, the Ugandan Government requested Agency assistance under the terms of the Assistance Convention to assess the safety and security of a cobalt-60 source that had been impounded by the police, and to advise on further actions. The source appeared to have originated outside Uganda and was apparently being illicitly trafficked for financial motives. The source had been taken to Mulago hospital in Kampala and placed in a bunker used to store small sources for medical applications. The mission team sent by the Agency found that the canister containing the source was intact, and therefore concluded that people handling the canister were unlikely to have received significant doses. Advice was provided to the Ugandan authorities on the safe disposal of the source.

In June 2002, the Bolivian authorities requested the Agency's assistance in relation to three separate incidents that had occurred in the country. The most serious of these events involved overexposure due to an ^{192}Ir industrial radiography source. Four industrial radiographers were accidentally overexposed in April 2002 when manipulating or

transporting the equipment with the source outside the container. In addition, more than 30 passengers were apparently exposed during an eight-hour bus journey during which the source was carried as normal luggage without appropriate shielding. The other two events involved the export of ^{192}Ir sources from Argentina to Bolivia without appropriate authorization and the theft of a moisture probe containing an americium–beryllium neutron source.

In November 2002, the Agency was requested by the United Republic of Tanzania to provide assistance in identifying five suspicious objects, which had been seized by the police apparently in the course of being illicitly trafficked, and to advise on appropriate actions. Three of the objects had labels indicating the presence of ^{238}U, but no uranium was detected. Four of the objects appeared to be the type of container used for sealed sources in industrial applications, but only one was found to contain a source: a 1 GBq ^{226}Ra source. These containers had been tampered with, and there was no indication of the whereabouts of the sources they would have been used to house.

MANAGEMENT OF SPENT FUEL AND RADIOACTIVE WASTE

Management of spent fuel and solid radioactive waste

In July 2002, the President of the United States of America signed a joint Congress resolution endorsing a recommendation from the Secretary of Energy that Yucca Mountain, Nevada, be used as the site for development of a repository for spent fuel and high level waste. In submitting his recommendation, the Secretary of Energy stated that the information provided by the Department of Energy (DOE) in support of the construction of a repository at Yucca Mountain "provides a sound scientific basis for concluding that the site can perform safely during both the pre- and post-closure periods, and that it is indeed scientifically and technically suitable for development as a repository." Although legal challenges by the State of Nevada and others are continuing, the next formal step in the process is for DOE to submit an application for a construction licence, which will be subject to formal review, including public hearings, and will require authorization from the Nuclear Regulatory Commission (NRC), which has the statutory responsibility to ensure that any repository built at Yucca Mountain meets stringent tests of health and safety. The NRC licensing process is expected to take a minimum of three years. DOE would then have to seek and obtain an operating licence from the NRC before any wastes could be received. The process altogether is expected to take a minimum of eight years.

In April 2002, the municipal council of Tierp, Sweden, decided not to allow a site in the municipality to be investigated as a possible site for a repository for spent fuel. Tierp was one of three potential sites identified by SKB, the national spent fuel and waste management company. The municipalities at the other two potential sites — Forsmark and Oskarshamn — have approved site investigations. SKB is only required to investigate two sites, but might nevertheless consider seeking an additional site for investigation.

Management of radioactive discharges to the environment

In July 2002, the United Kingdom Government issued its strategy for radioactive discharges for the period 2001–2020. The strategy in particular describes how the UK will

implement the OSPAR Strategy with regard to Radioactive Substances[12]. The Government strategy will provide the policy base for future reviews of discharge authorizations by the regulatory bodies and for strategic planning by the nuclear operators.

In September 2002, the Nord-Cotentin Radioecology Group published its second study for the Minister of Ecology and Sustainable Development and the Minister of Health relating to a postulated link between discharges from nuclear facilities on the Nord–Cotentin peninsula — which include the Cap de la Hague reprocessing plant — and the incidence of leukaemia in young people living in the nearby Beaumont–Hague canton. Two aims of the second study were to perform an uncertainty analysis on the first study of the leukaemia risk associated with discharges, and to assess the impact of chemical discharges from facilities in the area. The Group concluded that it was not very likely that radioactive discharges were responsible for the high incidence of leukaemia observed in the Beaumont–Hague canton. The uncertainty apparently associated with the risk that could be attributed to radioactive discharges would not alter the order of magnitude of the results obtained during the first study. The consideration of chemical discharges was inconclusive with regard to any possible health or environmental impact, and the Group's main recommendation was that an environmental measurement programme be conducted to validate the mathematical models used in chemical discharge impact calculations. The Group also stressed the need for further knowledge to be gained on the toxicological and ecotoxicological properties of the chemical substances.

Management of residual radioactive waste

The *Nuclear Safety Review for the Year 1998* reported on the results of a safety audit by regulators of the United Kingdom's Dounreay nuclear research site and the operators' plans to address the audit recommendations. In January 2002, the regulators — the UK Health and Safety Executive and the Scottish Environment Protection Agency — issued a "Final Report" on the audit confirming that the operators (the UK Atomic Energy Authority) had satisfactorily responded to all of the recommendations of a short-term nature and had in place plans and timescales for addressing the longer term recommendations. The report also provided details of the Dounreay Site Restoration Plan developed by UKAEA as part of its response to the audit. This Plan sets out a programme of work spanning several decades to clean up the site.

At the request of the Kuwaiti Government, an IAEA mission visited Kuwait in September 2001, with the participation of UNEP and WHO. The mission team visited sites potentially affected by DU and took measurements and samples. A further mission in February 2002 conducted a sampling campaign at eleven sites in Kuwait, based on a plan devised by the IAEA on the basis of the earlier results. A report describing the results of the sampling campaign is scheduled to be completed in early 2003.

---

[12] The 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic (known as the OSPAR Convention due to its origins in the earlier Oslo and Paris Conventions) entered into force in 1998 and has 16 Contracting Parties: Belgium; Denmark; the European Union; Finland; France; Germany; Iceland; Ireland; Luxembourg; the Netherlands; Norway; Portugal; Spain; Sweden; Switzerland; and the United Kingdom. The OSPAR Strategy with regard to Radioactive Substances was adopted by the Contracting Parties in July 1998 at the Ministerial Meeting of the OSPAR Commission in Sintra, Portugal.

Contact Expert Group

The Contact Expert Group (CEG) for International Radioactive Waste Projects in the Russian Federation was established in 1995 to promote international co-operative efforts aimed at resolving radioactive waste management issues. The CEG's 2002 meetings were held in Vienna, Austria, in April and in Brussels, Belgium, in October.

The Russian Federation reported to the Group on significant progress in defuelling retired submarines (since 2000, 18 submarines have been defuelled per year) and in increasing capacity for reprocessing spent fuel and for treating liquid wastes. Many reactor compartments are still stored in submarines afloat, representing a continuing risk to the marine environment, and international assistance is needed to construct storage facilities on land. The main priority in the management of spent fuel from submarines remains remediation of the spent fuel storage facility at Andreeva Bay. Discussions at the April meeting indicated that the situation at Andreeva Bay is critical and getting worse, and that urgent improvements are needed. A number of projects have been agreed and are getting under way, although problems with nuclear liability issues continue to hinder agreements with donor States. The October meeting heard that the Gremikha site has similar problems to those at Andreeva Bay, though they are somewhat less severe.

TRANSPORT OF RADIOACTIVE MATERIALS

A package containing 366 TBq of iridium-192 sources was despatched by a radioisotope manufacturer at Studsvik, Sweden, on 27 December 2001. The package was transported by courier aircraft from Stockholm, Sweden, to Paris, France, and from there to Memphis, USA, then by road from Memphis to New Orleans, USA. On its arrival in New Orleans on 2 January 2002, the package was found to be giving rise to a high directional dose rate (a few mGy/h at 25 metres above the top of the package). The caps from two of the three capsules in the package were found to have come off, and some iridium wafers had come out of these capsules and were loose in the containment vessel within the package. The results of biodosimetry tests conducted on staff at the airport in Paris indicated that one worker received a dose of about 100 mSv and two others about 30 mSv over the period in question. These results suggest that the caps were already off by the time the package left France. Dosimeters worn by the pilots who flew the package from Paris to Memphis indicated that they received doses well below 1 mSv. Investigations in the USA indicated that the highest individual doses after the sources entered the country were probably no more than 20 mSv, to staff of the courier company who handled the package in New Orleans.

All the requirements of the 1996 Edition of the IAEA Transport Regulations were for the first time incorporated into the UN Model Regulations in its 1999 edition. These Model Regulations were used by the International Civil Aviation Organization (ICAO), the International Maritime Organization (IMO) and the United Nations Economic Commission for Europe (UN/ECE) as the basis for the 2001 editions of their regulations that apply to the international transport of dangerous goods by air, sea, rail, road and inland waterways. In December 2002, the United Nations Sub-Committee of Experts on the Transport of Dangerous Goods adopted changes to the UN Model Regulations for the Transport of Dangerous Goods to reflect the changes to the IAEA Transport Regulations already approved by the Agency's Transport Safety Standards Committee for incorporation in the 1996 Edition (As Amended 2003). This will allow the modal organizations referred to above to implement these changes in their regulations in 2005.

CHERNOBYL

A report entitled *The Human Consequences of the Chernobyl Nuclear Accident: A Strategy for Recovery* was published in February 2002. The report described a study commissioned by the United Nations Development Programme (UNDP) and the UN Children's Fund (UNICEF) with the support of the UN Office for the Coordination of Humanitarian Affairs (OCHA) and the World Health Organization (WHO). The report recommended new developmental approach by the international community to tackling the problems caused by the Chernobyl accident and the events that followed, working towards normalising the situation of the individuals and communities concerned in the medium and long-term. Rather than focusing narrowly on the issue of radioactivity, the approach should be holistic, integrating health, ecological and economic measures to address the needs of those concerned.

Many parts of the United Nations family have become involved in projects relating to one or other aspect of the accident and its aftermath. As a means of trying to improve communication and co-ordination between the different organizations and projects, the IAEA in 2002 took the lead in establishing a "Chernobyl Forum", involving seven UN family organizations plus representatives of the three affected States: Belarus, the Russian Federation and Ukraine. The Forum has been launched in February 2003 with a general 'kick-off' organizational meeting, to be followed by expert meetings to address particular aspects of the subject. One function of the Forum will be to refine current scientific assessments of the long-term impacts of the Chernobyl accident on human health and the environment and to promote consensus on related issues. Another important practical aspect will be to provide authoritative advice on ways to help countries and individuals in the ongoing recovery from the accident. Examples include advising on programmes to make contaminated land usable, and advising physicians on special health care for the local population. Other important functions include identifying gaps in research, and informing decisions makers, the general public and mass media on the effects of the accident.