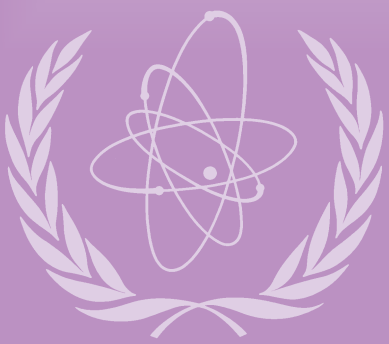
Nuclear Safety Review for the Year 2001



INTERNATIONAL ATOMIC ENERGY AGENCY

Nuclear Safety Review for the Year 2001

July 2002

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IAEA/NSR/2001

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FOREWORD

The Nuclear Safety Review for the Year 2001 reports on worldwide efforts to strengthen nuclear and radiation safety, including radioactive waste safety. It is in three parts:

- Part 1 describes those events in 2001 that have, or may have, significance for nuclear, radiation and waste safety worldwide. It includes developments such as new initiatives in international co-operation, events of safety significance and events that may be indicative of trends in safety;
- Part 2 describes some of the IAEA's efforts to strengthen international co-operation in nuclear, radiation and waste safety during 2001. It covers legally binding international agreements, non-binding safety standards, and provisions for the application of safety standards. This is done in a very brief manner, because these issues are addressed in more detail in the Agency's Annual Report for 2001;
- Part 3 presents a brief look ahead to some issues that are likely to be prominent in the coming year(s). The topics covered were selected by the IAEA Secretariat on the basis of trends observed in recent years, account being taken of planned or expected future developments.

A draft of the Nuclear Safety Review for the Year 2001 was presented to the March 2002 session of IAEA's Board of Governors. This final version has been prepared taking account of the discussion in the Board.

In some places, information has been added to describe developments early in 2002 that were considered pertinent to the discussion of events during 2001. In such cases, a Note containing the more recent information has been provided in the form of a footnote.

CONTENTS

PART 1: SAFETY RELATED EVENTS AND ISSUES WORLDWIDE

This section aims to identify those events or developments during 2001 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.

Intergovernmental agreements

The **Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management** was adopted on 5 September 1997 and was opened for signature on 29 September 1997. On 20 March 2001, Ireland deposited its instrument of ratification with the depositary, bringing the number of States that had adhered to the Convention to 25, of which 17 had at least one operational nuclear power plant. Article 40.1 states that: "The Convention shall enter into force on the ninetieth day after the date of deposit with the Depositary of the twenty-fifth instrument of ratification, acceptance or approval, including the instruments of fifteen States each having an operational nuclear power plant." The Joint Convention therefore entered into force on 18 June 2001.

Pursuant to Article 29 of the Joint Convention, a Preparatory Meeting of Contracting Parties was held in Vienna in December 2001. The Meeting adopted three documents: Rules of Procedure and Financial Rules; Guidelines Regarding the Review Process; and Guidelines Regarding the Form and Structure of National Reports. The Meeting also fixed the date of the first Review Meeting — this will begin on 3 November 2003 — and the deadline for submission of national reports for that Review Meeting, 5 May 2003. The agreed review process follows a Country Group approach similar to that adopted for the Convention on Nuclear Safety, but provision was also made such that the Organizational Meeting may, in addition, decide to hold Topic Sessions on specific issues. The Organizational Meeting for the first Review Meeting will begin on 7 April 2003.

The **Convention on Nuclear Safety** entered into force on 24 October 1996 and, at the end of 2001, had 53 Contracting Parties (including all but two of the States with nuclear installations that have achieved criticality in a reactor core). An Organizational Meeting was held in Vienna in September 2001 to prepare for the second Review Meeting in April 2002. The Meeting decided upon the makeup of the six country groups in which the Contracting Parties will review national reports, and selected officers for the Review Meeting. The deadline for submission to the IAEA of national reports was 15 October 2001, and the reports received have been circulated to all Contracting Parties.

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 2001, they had 87 and 83 Contracting Parties, respectively.

In May 2001, 55 States and five international organizations participated in an international nuclear exercise, JINEX 1. The exercise was jointly sponsored and co-ordinated by the European Commission, the IAEA, the OECD/NEA, the World Health Organization and the World Meteorological Organization, and was based on a hypothetical accident at the Gravelines nuclear power plant in northern France. The main objectives of the exercise were to test existing national and international procedures and arrangements for responding to a nuclear emergency, co-ordinate the release of information and assess the effectiveness of advisory and decision-making mechanisms.

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 Forum of Ibero-American 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 met during 2001 to discuss issues of common interest: the following text covers some selected activities of the groups.

The Western European Nuclear Regulators' Association (WENRA) is made up of the heads of the nuclear regulatory bodies in the western European countries that have nuclear power plants (Belgium, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom). In accordance with its Terms of Reference, WENRA produced in October 2000 a report on nuclear safety in EU candidate countries operating nuclear power reactors, and is currently working on developing common approaches to nuclear safety and regulation for existing nuclear power reactors and for radioactive waste management. For existing nuclear power reactors, the work has been in progress for the past two years. Using an agreed methodology, the various national practices are being compared for selected safety issues, with a view to identifying common safety reference levels, based on best practice and the most recent international standards. Work has just started for radioactive waste management. The WENRA members recently re-affirmed their determination to work together on these issues, which are difficult ones and represent long-term objectives that could result in agreed safety approaches between European regulators.

The Forum of Ibero-American Regulators includes the heads of the regulatory bodies in Argentina, Brazil, Cuba, Mexico and Spain. The sixth meeting was hosted by the Spanish Nuclear Safety Council in Madrid, in March 2001, and included a visit to the Trillo nuclear power plant. The principal items of discussion were: the importance of the practical and legal independence of regulatory bodies; lessons learned from the Agency's IRRT mission to Mexico; the role of regulatory organizations in radiological emergencies; regulatory practices and licensing of nuclear waste storage facilities; and some issues of terminology arising from the translation into Spanish of IAEA safety standards (the participants decided to create a glossary of nuclear and radiological terms in the different dialects of Spanish). The participants held a further meeting in May 2001 in Argentina to discuss preparations for the 2002 Review Meeting of the Convention on Nuclear Safety.

The Senior Regulators from Countries Operating CANDU Type Nuclear Power Plants held their annual meeting in Buenos Aires, Argentina, in October–November 2001, with representatives from Argentina, Canada, India, the Republic of Korea, Pakistan and Romania, and secretariat provided by the IAEA. The topics discussed included: competence of key staff and the use of simulators; inspection and compliance; generic safety issues for pressurized heavy water reactors; the 'power pulse' issue; operating policies and principles and technical specifications; probabilistic safety assessment; the evolution of requirements for CANDU plants; periodic safety review and licence renewal; and deregulation. In addition, staff of the Argentine regulatory body made detailed presentations on applications of root cause analysis methodologies, validation and verification of digital systems, emergency planning, and the PSAPACK computer code for probabilistic safety assessment, and arranged a technical visit to the Atucha NPP.

The Co-operation Forum for WWER Regulators[1] held its annual meeting in 2001 in Sofia, Bulgaria. The Forum's four working groups — on ageing management of equipment and building structures, on accident management, on joint inspection practices, and on regulatory self-assessment of independence and technical competence — reported on their activities since the last Forum meeting. The Forum members agreed that the accident management working group had completed the task assigned to it and had produced a very useful report which could serve as a basis for more specific guidelines at the national level. It was agreed that the other three working groups should continue, and a number of specific areas for their future work were identified.

The Framatome Nuclear Regulators' Association was established in 2000 by nuclear regulators from Belgium, China, France, the Republic of Korea and South Africa. The objectives of the group include exchanging feedback on in-service supervision of reactors designed by the same company, and comparing approaches to deal with generic problems and to assess plant safety.

The International Nuclear Regulators Association (INRA) comprises the heads of the nuclear regulatory bodies of Canada, France, Germany, Japan, Spain, Sweden, the United Kingdom and the United States of America. Their annual meeting held in March 2001 in the United Kingdom agreed a paper entitled "Some Thoughts on Concepts Fundamental to the Delivery of Nuclear Safety Regulation". The paper addresses five fundamental areas — effective independence; the regulatory process; regulatory effectiveness; powers and

[1] The members of the group are Armenia, Bulgaria, the Czech Republic, Finland, Hungary, the Russian Federation, Slovakia and Ukraine. France, Germany, the USA, the IAEA and the OECD/NEA participate as observers.

sanctions; and internal quality assurance — and is available on INRA's Web site[2]. Other issues discussed included oversight strategies, regulatory implications of the need for enhanced safety culture, regulatory challenges of new build programmes, regulating multinational companies, informing the public about regulatory activities, and the Convention on Nuclear Safety.

The Network of Regulators of Countries with Small Nuclear Programmes (NERS) includes representatives of Argentina, Belgium, the Czech Republic, Finland, Hungary, the Netherlands, Slovakia, Slovenia, South Africa and Switzerland and an observer from the IAEA. The fourth meeting of the group was held in Cape Town, South Africa in October 2001. The subjects discussed included general issues, such as public participation in safety related decisions, and more specific ones, such as stress corrosion cracking and the reliability of inspection practices in detecting it. The group decided to prepare papers for the next meeting on development of regulatory expertise and on safety issues specific to small regulatory bodies, including support for research and development.

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.

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

UNSCEAR's 2001 Report to the UN General Assembly focused on the risks of hereditary effects from exposure to radiation. UNSCEAR concluded in the report that the risks from radiation exposure, particularly those for multifactorial diseases, were likely to be somewhat lower than previous estimates, and that risk coefficients for hereditary effects should therefore be revised downwards. UNSCEAR estimated the total risk of hereditary effects to be in the range 0.3%–0.5% per gray in the first generation after the one exposed, and much less in subsequent generations.

[2] See www.nrc.gov/what-we-do/ip/inra2.pdf

The 2001 UNSCEAR meeting confirmed that health effects from the Chernobyl accident remain a priority for the future work of the Committee. UNSCEAR intends to continue its studies of the affected republics and other countries, and prepare future scientific reports concerning the radiological health consequences of the Chernobyl accident. The Committee expects that new data will be available from Belarus, the Russian Federation and Ukraine. The Committee has established close collaboration with scientists of the three affected republics.

International Commission on Radiological Protection (ICRP)

During 2001, ICRP issued five publications dealing with various aspects of radiation protection in medicine:

- Publication 84, "Pregnancy and Medical Radiation", addresses the management of pregnant patients as well as pregnant workers in medical establishments where ionizing radiation is used.
- Publication 85, "Avoidance of Radiation Injuries from Interventional Procedures", recommends practical actions to control doses to patients and to medical staff during interventional radiology;
- Publication 86, "Prevention of Accidental Exposures to Patients Undergoing Radiation Therapy", provides recommendations for preventing accidental overexposure (or underexposure), drawing upon the lessons learned from accidents that have occurred around the world;
- Publication 87, "Managing Patient Dose in Computed Tomography", provides recommendations for the manufacturers and users of CT equipment on avoiding unnecessary risks; and
- Publication 88, "Doses to the Embryo and Fetus from Intakes of Radionuclides by the Mother", gives dose coefficients for the offspring (embryo, foetus, and newborn child) of female members of the public and female workers following intakes of selected radioisotopes of 31 elements.

A progress report by the Commission, published in the *Journal of Radiological Protection*[3], provided some details of a revised system of radiological protection under discussion by ICRP as a possible basis for its future Recommendations. The system being discussed places more emphasis than previous Recommendations on individual doses and less on collective exposure.

International Commission on Radiation Units and Measurements (ICRU)

ICRU published three Reports in 2001: on Dosimetry of High Energy Photon Beams Based on Absorbed Dose to Water (Report 64), on Quantities, Units and Terms in Radioecology (Report 65), and on Determination of Operational Dose Equivalent Quantities for Neutrons (Report 66).

[3] Journal of Radiological Protection **21**(2), 113–123 (2001).

International Nuclear Safety Advisory Group (INSAG)

INSAG has several reports in various stages of preparation.

A report entitled "Key Practical Issues in Strengthening Safety Culture" has been completed and will be published by the IAEA in the INSAG Series in 2002. INSAG addressed the concept of "safety culture" in its 1991 report INSAG-4 and more recently in INSAG-13 (published in 1999), and the new report discusses ways in which the goals set out in INSAG-4 and INSAG-13 can be achieved in practice.

INSAG also issued in 2001 a Note entitled "Maintaining Knowledge, Training and Infrastructure for Research and Development". The statement stressed the need for greater efforts worldwide to ensure that the knowledge, human resources and R&D support needed to maintain and improve the safety of nuclear activities continue to be available in the future.

Other areas in which INSAG is preparing advice include:

- safety aspects of the management of change in nuclear facilities and organizations;
- the independence of regulatory decisions from unwarranted external influence; and
- maintaining 'design integrity', i.e. 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 24 nuclear power stations during 2001, making a total of 161 since the programme began in 1992.

WANO placed more emphasis on Technical Support Missions, which focus on providing assistance in selected areas. 55 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 three Significant Event Reports and one Significant Operating Experience Report during 2001. In addition, a "Just in Time" database with 45 reports has been established. Plant staff can use these reports 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 1800 personnel from WANO members participated in these activities in 2001.

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) produced 20 reports dealing with various technical and research aspects of nuclear safety. These reports cover areas such as operating experience, structural integrity and ageing, analysis and management of accidents, risk assessment, nuclear fuel safety margins, and human and organizational factors. The Committee on Nuclear Regulatory Activities (CNRA) produced 11 reports on various aspects of regulatory activities. These reports cover topics such as assuring nuclear safety competence into the 21st century, improving nuclear regulatory effectiveness and interface with the public/regulator.

Continuing in its efforts to stimulate international co-operation in safety research, the CSNI continues to support five large experimental R&D projects, and established a new one named SETH. The SETH project will investigate accident management issues related to boron dilution, loss of heat removal during mid-loop operation, etc.

The CSNI and CNRA organized a number of workshops during the year. Of particular relevance was a workshop on "Research in a Nuclear Regulatory Context", which brought together, at the senior level, the three main parties concerned with research — the regulator, the researcher and the licensee — to discuss current challenges and define commonalities and differences. The outcome of the workshop, which is documented in a collective statement of the CSNI and the CNRA, includes data on the current research situation in OECD Member countries, a clear definition of commonalities and differences amongst the three parties and a number of specific recommendations to further intensify international co-operation.

The Radioactive Waste Management Committee (RWMC) continued to work on aspects of the management of long-lived waste, addressing issues such as the retrievability of disposed waste, communication of confidence through a safety case, and step-wise decision making in the long term implementation process for geological repositories. In the technical area, the five-year GEOTRAP project on migration has been completed, and the results will be published soon. A new co-operative project has been launched to define the state of the art in addressing sorption phenomena in repository safety analysis. The RWMC's Forum on Stakeholder Confidence organized a workshop jointly with Finnish stakeholders from government, parliament, municipalities and civil society to discuss the Finnish experience in step-wise decision making and stakeholder involvement. In the area of decommissioning, a new RWMC Working Party brings together regulators, governments and industry to exchange and gather information on current policies and, together with other relevant NEA committees, to set up a framework for successful and coherent policy making in this area. In response to a request from the United States Department of Energy, the NEA organized, as a joint secretariat together with the IAEA, an international peer review on documentation meant to support the site recommendation for the planned Yucca Mountain repository project in Nevada, USA.

The Committee on Radiation Protection and Public Health organized an open dialogue with the International Commission on Radiological Protection (ICRP), to give the regulators' and implementers' views on ICRP's ongoing work on the evolution of the current system of radiation protection. In the area of stakeholder involvement, the committee held a new event of its Villigen workshop series to analyse the means of successful interaction with civil society in risk management. An expert group was set up to develop input to the future recommendations of ICRP.

Institutions of the European Union (EU)

In December 2000, the European Union's Working Party on Atomic Questions (WPAQ) established an Ad hoc Working Party on Nuclear Safety (WPNS). The WPNS was set up to carry out evaluations of nuclear safety[4] in candidate States seeking to join the EU, based on the WPAQ's methodology for defining a "high level of nuclear safety". In May 2001, the Council of the EU issued a "Report on Nuclear Safety in the Context of Enlargement"[5], which included evaluations by the WPNS in relation to civil nuclear power plants in candidate States and by the WPAQ in relation to nuclear installations not within the scope of the Convention on Nuclear Safety (such as research reactors and fuel cycle and waste management facilities).

One of the conclusions adopted by the European Council at its meeting in Laeken, Belgium, in December 2001 was that "The European Council undertakes to maintain a high level of nuclear safety in the Union. It stresses the need to monitor the security and safety of nuclear power stations. It calls for regular reports from Member States' atomic energy experts, who will maintain close contact with the Commission."

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 Japan, the administrative organizations of the central Government were extensively restructured in January 2001, resulting in a strengthening of the regulatory framework. The Nuclear Safety Commission (NSC), which was originally established under the Prime Minister's Office in 1978, is responsible for planning, deliberation and decisions on matters related to ensuring the safety of research, development and utilization of nuclear energy. As part of the restructuring, the NSC was transferred to the Cabinet Office, and an independent Secretariat was established to strengthen the NSC's function.

In the restructured government, the Ministry of Economy, Trade and Industry (METI) acts as the competent ministry in charge of safety regulation for all of the facilities and activities involved in the utilization of nuclear energy. A new Nuclear and Industrial Safety Agency (NISA) was established as a special organization under the METI dedicated to the administration of safety regulation, including authorization, review and assessment, inspection and enforcement. The establishment of the NISA clarifies and improves the definition of responsibilities and accountability for safety regulation.

The Pakistan Nuclear Regulatory Authority Ordinance 2001 was promulgated on 22 January 2001. The Ordinance establishes de jure the Pakistan Nuclear Regulatory Authority (PNRA) as Pakistan's independent nuclear regulatory body. The PNRA replaces the Pakistan Nuclear Regulatory Board and Directorate of Nuclear Safety and Radiation Protection, and will control, regulate and supervise all matters relating to nuclear safety and radiation protection in the country.

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4 Specifically, legislation in the nuclear sector, the organization and management of regulatory authorities and the level of safety of nuclear installations.

5 The main text of the report is available online at register.consilium.eu.int/pdf/en/01/st09/09181en1.pdf. An addendum is available at register.consilium.eu.int/pdf/en/01/st09/09181-a1en1.pdf.

In March 2001, the President of Ukraine signed an order defining the role of the new nuclear regulatory body, the State Nuclear Regulatory Committee (SNRC). SNRC will regulate nuclear and radiation safety, physical protection, nuclear materials, and radioactive waste management in Ukraine.

Safety of nuclear installations

The following is a selection of events related to the safety of nuclear installations during 2001, which had some safety significance or which received particular attention.

Debate continued throughout the year on the safety of the Temelin NPP in the Czech Republic, which is a WWER-1000/320 reactor design with western instrumentation and control, fuel, radiation monitoring, diagnosis and physical protection systems. The plant, which is in the commissioning phase, encountered problems with non-nuclear parts of the plant, particularly the turbines. The State Office for Nuclear Safety (SUJB) has continuously monitored the developments, and issued permits for the plant to proceed to new testing phases upon the completion of each successive phase. Pursuant to the agreement between Austria and the Czech Republic in December 2000 (the "Melk Protocol"), the Czech Republic voluntarily undertook an environmental impact assessment of the Temelin plant, elaborated by a Commission set up by the Czech Government, which was published in April 2001, and concluded that the environmental impact would be assessed as "low, insignificant and acceptable." After public consultations, the aforementioned Commission published a "standpoint" in July 2001 containing 21 recommendations. In addition, the European Commission (EC) organized an expert mission on Temelin with trilateral participation to assess nuclear safety issues. The expert mission addressed 29 issues of concern raised by Austria, and the outcome of discussions on each issue was summarized in a Working Paper, drafted under the sole responsibility of EC experts involved in the process and sent to the heads of government of Austria and the Czech Republic at the end of July 2001. At the request of the Czech Government, the IAEA assembled a team of experts from five Member States, with an observer from Austria, which visited the plant in November 2001. The experts concluded that most of the design safety issues identified as relevant to reactors of the generic Temelin design had been addressed and resolved and that work is near completion on the few remaining issues. The experts' judgement was that these remaining issues would not preclude the safe operation of Temelin. Also in November 2001, the Czech Prime Minister and Austrian Chancellor agreed on the "Conclusions of the Melk Process and Follow-up", which covered safety standards, early warning systems and the exchange of information.

In February 2001, the United States Nuclear Regulatory Commission (NRC) published the findings of its safety evaluation relating to the discovery in late 2000 of a leaking through-wall axial crack in a weld in the hot leg of the Virgil C. Summer PWR. The NRC's Special Inspection Team in February 2001 found the operator's root cause analysis to be acceptable and did not identify any licensee performance issues related to the original construction weld, replacement welds, or non-destructive examination of welds. The team identified potentially generic issues involving the limitations of non-destructive examination in detecting certain small stress corrosion cracks, and the potential for multiple weld repairs to result in high residual stresses which can contribute to stress corrosion cracking. Axial (but not through-wall) cracks were also discovered in late 2000 in similar locations in units 3 and 4 (both PWRs) at Ringhals in Sweden. In November 2001, piping in the high pressure injection system of the Hamaoka-1 BWR in Japan ruptured during testing. Investigations of the incident

indicated that a hydrogen explosion had occurred in the pipe. Modifications made in the early 1990s had apparently made possible an accumulation of hydrogen in a bend in the pipe.

In March 2001, the Maanshan-1 nuclear power plant in Taiwan, China, lost its main off-site power supply as a result of short-circuits and an electrical fire caused by accumulated salt crystals (from onshore winds) on the power lines into the site. One backup generator started automatically but could not supply power because of damage from the fire, and attempts by staff to start a second were unsuccessful. A third backup generator was used to restore power to the plant after an interruption of about two hours. About eight hours later, the second generator was successfully started, and the off-site supply was restored after two days. At the time of the blackout the plant was in a hot standby state, having been scrammed as a precaution a day earlier when instabilities in the off-site power supply were first observed. An auxiliary feedwater pump started up when power was lost, and the temperature and pressure in the core decreased during the blackout. A subsequent investigation found that the second backup generator had been operable and could have been started had staff persisted in their original attempts to start it. The accumulation of salt was known to be a problem and the operators had periodically carried out maintenance to remove it. When the transmission instabilities started, the operators began preparing to clean the lines, but had not done so by the time the blackout occurred.

During routine refuelling of the Dampierre-4 PWR in France in April 2001, one fuel assembly early in the sequence was inadvertently skipped following a shift change. The error was not noticed until near the end of the refuelling sequence, by which time the core configuration was quite different from that intended. In particular, the number of fresh fuel assemblies in one area of the core was about twice what it should have been. Because of the plant conditions at the time, the reactivity of the core never encroached upon the relevant safety margins. However, subsequent analysis by EDF of the potential consequences of a similar error under plant conditions that were less favourable, but within technical specifications, identified hypothetical scenarios in which localized criticality could have occurred before the end of the refuelling. Furthermore, the criticality would have been in a part of the core some distance from the flux counting channels, and therefore the increase in reactivity might not have been detected before criticality was reached.

In July 2001, the Slovak regulatory body issued a long term operating licence for the Bohunice-V1 nuclear power plant. The plant had previously been licensed for one year at a time while a major safety upgrading programme, begun in 1991, was being carried out. An IAEA review of the modification programme in 2000 concluded that the safety issues previously identified at the plant had been appropriately addressed and that the new design basis met or exceeded IAEA recommendations. In principle, the new licence is valid until the next due date for periodic safety review of the plant in ten years, although the Slovak Government, in the context of negotiations on possible future accession to the European Union, has already committed itself to closing the plant in 2006.

In August 2001, Philippsburg-2 PWR in Germany was restarted for operation after a refuelling outage. The boron concentrations in the borated water tanks for the emergency core cooling system were not tested until almost two weeks after the restart. Tests then showed that the boron concentration in three of the four tanks was below that required by the technical specifications. Plant personnel took measures over the following days to increase the boron concentration in the tanks, but did not shut the reactor down. It was also subsequently discovered that the water levels in all four tanks had been below the specified levels when the plant was first restarted, although they had been filled before criticality was reached. The plant

was shut down in October 2001 after a re-evaluation of the August events, commissioned by the regulatory body, gave both incidents an INES rating of level 2. The reactor was restarted in December 2001 after the operators had taken a number of technical and other measures to address safety culture issues identified as having contributed to the August incidents.

Safety of radiation sources and security of radioactive materials

In January 2001, a customs officer found 245 small radioactive metallic plates buried in a forest near Thessaloniki in northern Greece. The plates appeared to come from static electricity eliminators as used in various industries, and each contained megabecquerel quantities of plutonium-239 and americium-241. The Greek Government requested assistance from the IAEA under the terms of the Assistance Convention. An Agency mission visited Greece and assisted with the characterization and identification of the sources, and with the development of a plan for their storage and final disposition.

In February 2001, following a power cut at the Bialystok Oncology Centre in Poland, components in the Centre's linear accelerator malfunctioned, resulting in much higher doses than intended being delivered. Five radiotherapy patients were severely overexposed: the fault was discovered after the fifth patient complained of pain and itching in the treated area. In November 2001, the Polish Government requested assistance from the IAEA under the terms of the Assistance Convention. An IAEA team of medical and radiation protection experts visited Poland and provided recommendations on medical treatment plans for the affected individuals and assistance in identifying and correcting the deficiencies in equipment and procedures that led to the overexposures.

In May 2001, the IAEA was informed of the accidental overexposure of 28 radiotherapy patients at the National Oncology Institute in Panama. This had arisen as a result of a change in August 2000 in the way that the co-ordinates of shielding blocks were entered into the treatment planning system. Some ways of entering the data led to incorrect calculation of doses and hence to treatment times up to 100% higher than they should have been. Some symptoms began to appear in overexposed patients in November and December 2000, but the cause was not established until May. The Panamanian Government then requested Agency assistance under the terms of the Assistance Convention, and a mission team travelled to Panama. Of the 28 patients affected, eight had died by the time the Agency was notified. The mission team confirmed that five of these deaths were probably attributable to the overexposure, one was probably attributable to the patient's cancer and for the other two there was insufficient information to draw conclusions. In addition to the assistance provided to Panama by the mission team, the Agency issued advisory information to its Member States explaining the apparent causes of the accident.[6]

In early January 2002, the Agency received 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 IAEA mission team sent to Georgia was initially unable to reach the sources due to heavy snow. (As can be seen from previous Nuclear Safety Reviews, this was the latest of several incidents in Georgia in which 'orphan' sources, believed to have been left in the country after the break-up of the Soviet Union, have been found in an uncontrolled condition in public areas.)

[6] See www.iaea.org/worldatom/Press/P_release/2001/panam_adv_info.shtml

In late December 2001, a 366 TBq iridium-192 source was dispatched from a radioisotope supplier in Studsvik, Sweden to New Orleans, USA, via Stockholm, Paris and Memphis. On arrival of the source in New Orleans, abnormally high dose rates were detected around the package (up to 4 mSv/h at 25 metres). Although there was no immediate evidence of anybody having been exposed to a high dose, the dose rates were high enough that the possibility of acute radiation health effects could not initially be ruled out.[7]

Management of spent fuel and radioactive waste

Management of spent fuel and solid radioactive waste

In 1999 the company responsible for spent fuel management in Finland, Posiva, requested a "decision in principle" to permit the construction of a spent fuel repository at their preferred site, Olkiluoto. In 2000 the regulatory body STUK gave its preliminary safety assessment and the municipality in which Olkiluoto is situated formally supported the selection of Olkiluoto as the repository site. The Government announced in December 2000 its intention to allow the project to go ahead: this "decision in principle" was ratified by the Finnish parliament in May 2001. Following this decision, Posiva plans between 2003 and 2006 to construct an underground rock characterization laboratory at the site.

In June 2001, the United States Environmental Protection Agency (EPA) published its public health and environmental radiation protection standards for the proposed repository for spent fuel and high level waste at Yucca Mountain, Nevada[8]. These standards will be incorporated into the licensing regulations of the Nuclear Regulatory Commission (NRC). The standards include an individual protection standard of 150 μSv/a, for releases from the disposal system or for any reasonably foreseeable human intrusion within 10 000 years, and groundwater protection standards in the form of maximum concentrations of alpha emitters and a maximum dose of 40 μSv/a from beta–gamma emitters in groundwater. In August 2001, the United States Department of Energy (DOE), which proposes to build the repository at Yucca Mountain, issued its Preliminary Site Suitability Evaluation. The preliminary evaluation concluded, inter alia, that "the preliminary postclosure dose estimates ... are below the final EPA and NRC standards for individual protection."

The near surface repository for short lived low and intermediate level radioactive waste at El Cabril, Spain, was granted a normal operating permit in October 2001. Although the facility had been operating for five years, it had been doing so under a provisional licence. The new operating permit is valid for the operational phase of the repository (i.e. the time during which it is receiving waste), subject to ten-yearly periodic safety review.

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7 In early 2002, the Swedish competent authority, having judged that the supplier had violated Swedish law, filed a complaint with the public prosecutor, who decides whether or not to take the case to court. At the time of finalizing this report in mid-2002, preliminary results from blood tests on mail handlers at the airport in Paris indicated that one individual may have received a dose higher than the annual occupational dose limit over the period during which the package passed through the airport. The competent authorities in the countries involved were continuing to investigate. A full report on the event will be included in the Nuclear Safety Review for the Year 2002.

8 Available at www.epa.gov/radiation/yucca/docs/yucca_mtn_standards_060501.pdf.

In November 2001, the Swedish Government formally endorsed the KBS-3 method for deep geological disposal of spent fuel as a "planning basis"[9] for the next step in siting a disposal facility. This provided the waste management company SKB with the necessary political endorsement at the national level to proceed with site investigations, including extensive test drilling, at the three sites so far selected by SKB. However, test drilling also requires political consent at the local level. In December 2001, the municipality of Östhammar approved investigations at one of the selected sites, Forsmark.

Management of residual radioactive waste

In June 2001, the President of the Russian Federation approved a law allowing (in principle) the import of spent fuel. It is intended that part of any income generated from storing or reprocessing foreign fuel would be used to finance cleanup operations at radioactively contaminated sites in the Russian Federation.

There has been widespread controversy in the past two years about claims that various groups of people had suffered or could suffer health effects as a result of exposure to depleted uranium (DU) from munitions used in the 1991 Gulf War and in conflicts in the Balkans during the 1990s. Among the developments in 2001:

- In February 2001, the United Nations Environment Programme (UNEP) issued a report on the preliminary mission it led to Kosovo, Yugoslavia, in November 2000[10]. UNEP concluded, inter alia, that there was "no detectable, widespread contamination of the ground surface" by DU, and that the "corresponding radiological … risks are insignificant and even non-existent." Nevertheless, UNEP recommended a number of precautionary measures;
- In March 2001, and in response to claims that military personnel performing peace-keeping duties in the Balkans had suffered severe health effects as a result of exposure to DU, the European Union's "Article 31 Group" of experts issued a collective opinion on the possible radiological health effects of DU.[11] They concluded that, on the basis of available information, "exposure to DU could not produce any detectable health effects under realistic assumptions of the doses that might be received.";
- In April 2001, the World Health Organization (WHO) issued a report entitled "Depleted Uranium: Sources, Exposure and Health Effects"[12]. The report concluded that: "Under most circumstances, use of DU will make a negligible contribution to the overall natural background levels of uranium in the environment. However, levels of DU may be significantly raised over background levels in close proximity to DU contaminating events.", and recommended precautionary actions to be taken to deal with such areas; and

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9 The term "planning basis" was used to indicate clearly that this decision does not in any way prejudge the licensing of an actual repository at a specific site.

10 Available at balkans.unep.ch/du/reports/uranium.pdf

11 Available at europa.eu.int/comm/environment/radprot/opinion.pdf

12 Available at www.who.int/environmental_information/radiation/depleted_uranium.htm

- 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 to Kuwait is planned for early 2002.

Transport of radioactive materials

Previous Nuclear Safety Reviews have reported on the suspension in 1998 of rail transport of spent nuclear fuel between Germany, Switzerland and France. France and Switzerland resumed shipments in 1998 and 1999 respectively. The German federal authorities authorized the resumption of shipments to and from the reprocessing plants in France and the United Kingdom in 2000, but the resumption was delayed by the French Government's condition that further spent fuel from Germany would be accepted for reprocessing in France only if casks already loaded with vitrified high level waste were taken back. Shipments of vitrified high level waste from COGEMA's plant at La Hague to the interim storage facility at Gorleben were made in March and November 2001 and transport of spent fuel to France and the United Kingdom resumed in April.

At the 2001 General Conference of the IAEA, a paper referring to a number of recent declarations made by States and international organizations on the issue of the maritime transport of radioactive material, expressing their concern over the risks involved in the transport of this type of material for the health of coastal populations and the environment of coastal regions, and over the potential economic damage, was circulated at the request of a group of Member States.[13] A General Conference resolution inter alia urged Member States shipping radioactive materials and spent fuel to provide, as appropriate, assurances to potentially affected States that their national regulations accord with the Agency's Transport Regulations, welcomed the practice of some shipping States and operators of undertaking timely consultations with relevant coastal States in advance of shipments and invited others to do so.

Chernobyl

Following the closure in December 2000, in accordance with Ukraine's international commitments, of the last unit of the Chernobyl nuclear power plant, the Cabinet of Ministers in 2001 transferred the plant from the generating company to an independent operating organization. The main tasks of this organization are to decommission the plant and manage the resulting radioactive waste.[14]

Two major international conferences were held in Kiev, Ukraine, to mark the 15th anniversary of the Chernobyl accident. The first, entitled "Fifteen Years After the Chernobyl

[13] The declarations referred to were: a communiqué of August 2001 by the Pacific Islands Forum; a joint declaration of December 2000 by the Governments of Argentina, Brazil, Chile and Uruguay; a declaration of January 2001 by the Permanent Commission for the South Pacific; a declaration by the Rio Group in March 2001; a declaration by 34 participating Heads of State or Government from North America, Central America, the Caribbean and South America at the Third Summit of the Americas in April 2001; recommendation 21(h) of the United Nations Commission on Sustainable Development in April 2001; and the August 2000 Santiago Declaration by the countries of the Rio Group.

[14] In April 2002, a licence was granted for work to proceed on the decommissioning units 1, 2 and 3.

Accident: Lessons Learned" was held in April 2001. The conference was organized by the Ministry of Ukraine of Emergencies and Affairs of Population Protection from the Consequences of the Chernobyl Catastrophe. The second, entitled "Health Effects of the Chernobyl Accident: Results of 15 Years of Follow-up Studies", was held in June 2001. As well as providing an update on the incidence of radiation induced thyroid cancer in people who were infants or young children at the time of the accident, both Conferences reflected on other health problems in the affected region. Both Conferences concluded that there was some evidence — as yet, not conclusive — of an excess of leukaemia cases among liquidators involved in clean-up operations at the site in 1986 and 1987 who received significant radiation doses, but no significant increase in leukaemia incidence in the wider population. There were also some data indicating a possible increase in the incidence of solid cancers in the affected areas, but little or no evidence of any causal link to radiation exposure.

Both Conferences addressed other types of health problem, such as cardiovascular disease and neuropsychiatric disorders, in the affected areas of Belarus, the Russian Federation and Ukraine. The April Conference concluded that "Health effects of the consequences of the accident have been observed in clean-up workers and the population of contaminated areas for which the radiation dose effect relationship has not been established. Further studies are necessary to include other possible causes, such as, psychological and social consequences, ageing and the effect of screening, so as to identify their relevance to the … data". The June Conference concluded that "A number of factors inherent to the Chernobyl accident, including worsening socio-economic conditions, continuing residence in contaminated territories, diminished food supply, vitamin deficiency, relocation, and psychological stress, may contribute to these effects."

Previous Nuclear Safety Reviews have reported on the Chernobyl Shelter Implementation Plan (SIP). In March, the Ukrainian Government selected the design for a new shelter to be built around the existing Chernobyl-4 'sarcophagus'. The selected design is an arch-shaped steel structure, which will be slid on rails into place over the existing structure. The European Bank for Reconstruction and Development, which manages the Chernobyl Shelter Fund to finance the SIP, confirmed its non-objection to Ukraine's decision in April. This allowed the process of developing technical specifications and obtaining tenders for the work to begin.

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 2001 meetings were held in St. Petersburg, Russian Federation, in May and at Oskarshamn, Sweden, in November. The meeting in St. Petersburg discussed the role and future activities of the CEG, including proposals to update the group's terms of reference. Two project proposals presented by the Russian Federation were discussed and one of them (on interim storage for spent nuclear fuel at the Mayak reprocessing plant) was endorsed for further development and implementation. Further new projects were endorsed by the CEG at its November 2001 meeting, including rehabilitation of the Murmansk RADON centre and construction of a repository for solid radioactive waste at Novaya Zemlya.

Remediation of the former Navy technical base at Andreeva Bay on the north shore of the Kola peninsula has been identified as one of the most important CEG projects. About 100

submarine reactor cores have been accumulated there and stored in conditions which are reported as not meeting current safety requirements. In October 2001 a special CEG project workshop on Andreeva Bay was organized in Idaho Falls, USA, the conclusions of which were fully endorsed by the CEG meeting in November 2001. Negotiations on several specific projects aimed at establishing the necessary infrastructure at this site have been initiated, and preparatory activities in the area of spent fuel and radioactive waste management are being conducted.

Under ongoing projects in the Russian Federation, work is continuing to decommission retired nuclear submarines, including defuelling submarines to await dismantling. Two new installations for treatment of liquid radioactive waste have been commissioned, one in Murmansk (built under co-operation with Norway and USA) and one at the Zvezda plant near Vladivostok, built under an assistance programme of Japan. Commissioning of these installations will allow releases into the sea of radioactive wastes generated during nuclear submarine decommissioning activities to be eliminated.

PART 2: AGENCY ACTIVITIES IN NUCLEAR, RADIATION, TRANSPORT AND WASTE SAFETY

The Agency's activities can be addressed in the context of the three main elements of the global safety culture:

(a) Legally binding international instruments, such as safety related conventions;
(b) Internationally accepted safety standards; and
(c) Application of those safety standards.

Only a very brief summary of some of the main activities in relation to the issues raised in Parts 1 and 3 (and not already covered in those parts) is given here; the Agency's safety related work in its various programmes is described in detail in the IAEA Annual Report, in the report submitted annually by the Secretariat to the IAEA General Conference, and on the Agency's WorldAtom web site at www.iaea.org.

Conventions

The major safety related agreements are the Convention on Early Notification of a Nuclear Accident, the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Up-to-date lists of the Parties and Signatories to these Conventions can be found on the Agency's WorldAtom web site at www.iaea.org/worldatom/Documents/Legal/.

The Agency's functions in relation to these Conventions include a secretariat role and, in the person of the Director General, the function of depositary. Important developments during 2001 are outlined in Part 1. In addition, when incidents or accidents occur, the Assistance Convention in particular specifies certain tasks that the Agency is obliged to carry out. During 2001, the Agency provided such assistance in relation to events in Greece (discovery of buried radioactive plates), Panama and Poland (in both cases overexposure of patients during radiotherapy). These events, and the nature of the assistance provided, are described in Part 1.

Safety standards

The full text of recently published safety standards was made available on the Agency's Web site for the first time in 2001.[15]

Five Safety Guides were published during 2001: on building competence in radiation protection and the safe use of radiation sources; on decommissioning of nuclear fuel cycle facilities; and three relating to nuclear power plants - on modifications, on the operating organization, and on safety assessment and verification. A further 16 Safety Guides (four in the general safety area, six nuclear safety, one radiation safety, three waste safety and two transport safety) have been approved and are awaiting publication. Safety Requirements on preparedness and response for a nuclear or radiological emergency have been endorsed by the

[15] www.iaea.org/ns/CoordiNet/safetypubs/inclSStandardsPublished.htm

Commission on Safety Standards and are being submitted to the Board of Governors in March 2002 for approval.

The four Safety Standards Committees established by the Agency to review and agree on the text of draft safety standards — NUSSC (nuclear safety), RASSC (radiation safety), TRANSSC (transport safety) and WASSC (waste safety) — reached the end of their three-year terms at the end of 2001. The Committees will be reconstituted in 2002, and all Member States have been invited to nominate members.

The current status of all safety standards can be found on the Agency's WorldAtom Web site at www.iaea.org/ns/committees/css/STATUS.PDF.

Providing for the application of safety standards

Providing for the application of safety standards at the request of Member States is a statutory function of the Agency, and includes:

- Providing direct safety related assistance to Member States;
- Fostering the exchange of safety related information;
- Encouraging education and training;
- Rendering a wide range of safety review services; and
- Co-ordinating and supporting safety related research and development.

The various activities are increasingly being integrated to provide a coherent support package for Member States in applying the safety standards.

Safety related assistance

In addition to the IAEA's Regular Budget, there are two major sources of direct safety related assistance from the Agency to Member States: the technical co-operation (TC) programme and extrabudgetary programmes (EBPs).

By far the larger of the two is the safety related TC programme, through which the Agency supported about 150 projects during 2001 in the various areas of nuclear, radiation, transport and waste safety, amounting to about US$18 million. The budgets of the three current EBPs in nuclear safety total more than $1.5 million, of which the majority is for the Extrabudgetary Programme on the Safety of Nuclear Installations in the South East Asia, Pacific and Far East Countries.

Information exchange

The Agency fosters the exchange of safety related information through conferences and seminars, a wide range of publications and electronic media.

Two major international conferences on safety related subjects were organized by the Agency in 2001:

- on the Radiological Protection of Patients in Diagnostic and Interventional Radiology, Nuclear Medicine and Radiotherapy, co-sponsored by the Agency, the European Commission, the Pan

American Health Organization and the World Health Organization, and hosted by the Government of Spain in Málaga in March 2001.

- on Topical Issues in Nuclear Safety, held in Vienna in September 2001. The issues discussed were: risk informed decision making; the influence of external factors on safety; the safety of fuel cycle facilities; the safety of research reactors; safety performance indicators; and maintaining competence.

Further information on the results of and follow-up to these conferences is given in Part 3.

The Agency, in co-operation with WANO and the OECD/NEA, has set up a Nuclear Events Web-based System (NEWS) to improve and speed up the dissemination of information worldwide on reported events. The system was operated on a trial basis in 2001 and will go into full operation in 2002.

Education and training

Safety related training courses, workshops and seminars are supported by the Agency, mostly under the TC programme, but also through the EBPs and regular budget activities (in addition, a number of TC projects are dedicated to establishing/strengthening infrastructure for plant personnel training).

About 110 training courses and workshops on safety related topics were organized during 2001, the majority under the TC programme. In addition, almost 350 fellowships and scientific visits were awarded.

Advisory Group Meetings in 2001 agreed strategies for education and training in nuclear safety and in radiation, transport and waste safety aimed at promoting education and training programmes in Member States that will be self-sustaining in the long term. The main elements of these strategies are developing standard courses and materials in the Agency's official languages, training the trainers, and establishing and strengthening the role of regional and national centres. The strategies were endorsed by the General Conference.

Safety related services

The Agency renders a range of safety review services to its Member States on request. During 2001, the Agency conducted:

- three full scope OSART[16] missions, one reduced scope OSART, one OSART follow-up mission and two preparatory meetings, plus six seminars on the OSART methodology for self-assessment;
- six workshops and one seminar under the Safety Culture Enhancement Programme (SCEP);
- one PROSPER[17] assistance mission, one preparatory meeting, one introductory mission and two workshops/seminars on the service;

[16] Operational Safety Review Team.

[17] Peer Review of Operational Safety Performance Experience.

- five IPSART[18] missions (three for level 1 PSAs, two for level 2/3), one follow-up to an IPSART level 1 mission, and one pre-IPSART mission;
- one design safety review, one seismic safety review and one seismic review follow-up, one preliminary site safety review, four reviews of aspects of Preliminary Safety Assessment Reports, one review of regulatory requirements and one review of a periodic safety review programme;
- a pilot RAMP[19] mission;
- one INSARR[20] mission, seven pre-INSARRs and seven other expert missions to research reactors under IAEA Project and Supply Agreements;
- three full scope IRRT[21] missions, one reduced scope IRRT, one IRRT follow-up mission and four preparatory missions;
- five peer reviews of national regulatory infrastructure for radiation safety, three under the Model Project and two under the RCA;
- one ORPAS[22] mission, the first mission of this new service;

TranSAS[23] missions to Brazil, Turkey and the United Kingdom are in the planning stage: a pre-mission visited the United Kingdom in December 2001.

At the request of the United States Department of Energy (DOE) the Agency, jointly with the OECD/NEA, organized an international peer review of the DOE's Total System Performance Assessment (TSPA) for a proposed repository at Yucca Mountain, Nevada. The IAEA had earlier conducted, also at the request of the DOE, a more detailed peer review of the assessment methodology being used in the biosphere modelling programme of the TSPA.

Research and development

13 Co-ordinated Research Projects (CRPs) on safety related topics were active during 2001: four in nuclear safety, six in radiation safety one in radioactive waste safety and two in transport safety. One CRP came to an end during the year, and three new CRPs — on the safety significance of postulated initiated events for different research reactor types and assessment of analytical tools, on exploring the possibility of establishing guidance levels for interventional radiology, and on radiological aspects of package and conveyance non-fixed radioactive contamination — have been approved and will start in 2002.

18 International Probabilistic Safety Assessments Review Team.

19 Review of Accident Management Programmes.

20 Integrated Safety Assessment of Research Reactors.

21 International Regulatory Review Team.

22 Occupational Radiation Protection Appraisal Service.

23 Transport Safety Appraisal Service.

PART 3: LOOKING AHEAD

This section provides a brief discussion of some forthcoming events, and of some safety related issues that are likely to be prominent in the coming years. (The order in which items appear is not intended to imply their relative importance.)

Strengthening the global safety regime

The public demands ever greater reassurance about safety as well as greater transparency and accountability. At the same time, the nuclear industry is increasingly characterized by globalized businesses striving to be more competitive. As a result, there is pressure for greater international consistency in regulatory approaches. These pressures call for a strong and visible global safety regime. The elements of such a regime are in place:

- legally binding conventions on safety;
- internationally agreed safety standards; and
- the application of those safety standards.

Since a major aim of the safety related conventions is to promote adherence to internationally agreed safety objectives and principles, safety standards play a central role in this regime. The first challenge to strengthen the regime is therefore to strengthen the safety standards. The Agency has taken a number of initiatives over recent years aimed at ensuring that its safety standards are up to date, are of high quality and represent international consensus on good safety practice. Further changes to the process for preparing and reviewing safety standards — notably the invitation for all Member States to participate actively in the safety standards review committees — should increase transparency and provide further progress in this regard. But the overall strength of the standards also depends on the strength, and breadth, of adherence to the standards. The challenge for the coming years, therefore, is to accelerate the acceptance of the Agency's safety standards as the global standards.

The second challenge is to integrate the standards more thoroughly with the various application mechanisms. This means that assistance and advice, appraisal services, education and training, information exchange and research and development activities should be systematically and explicitly underpinned by the safety standards in all areas. But it also means that these practical activities applying the current standards should provide feedback to improve the next generation of standards.

The need to meet these two challenges creates a third challenge: to improve the global sharing of knowledge and experience, as a basis for improving safety performance — both in preventing accidents and in mitigating the effects of any accidents that do occur — worldwide. Such a 'global network' requires that the knowledge and experience, both of individual experts and of organizations and centres of excellence, be pooled and disseminated to those responsible for safety in Member States and to the public. Modern information technology provides unprecedented means to achieve this dissemination, but these means can only be exploited effectively if the necessary skills and resources exist, and if there is the necessary degree of openness and transparency that will allow information to be disseminated freely.

Integrated evaluation of safety

The Agency's safety services continue to be in high demand, particularly those providing peer review missions in which international experts provide independent advice based on the IAEA's safety standards and best international practice. The benefits of these services are proven by the increasing degree to which follow-up missions find that previously identified safety problems have been resolved. Some services cover a broad scope, such as reviews of design or operational safety or evaluations of national regulatory programmes; others focus on specific areas, such as seismic or fire safety or equipment ageing concerns.

The Agency is focusing increasingly on the development of a more comprehensive approach to assessing the safety of a country's overall nuclear programme — an "Integrated Safety Evaluation". This would draw together results from existing appraisal services covering specific aspects of safety to assemble a complete picture. The current intention would be to divide this service into two tracks. The first would evaluate the State's legal and governmental infrastructure in terms of the effectiveness of the national regulatory body. The second track, conducted in parallel, would focus on all aspects of the safety of nuclear activities, including facility design and operation, radiation safety, control of radioactive sources, spent fuel and waste management, and the transport of radioactive materials.

The Integrated Safety Evaluation would thus provide a diagnostic of a country's overall 'nuclear safety profile', tailored to the stage of development of the country's nuclear programme, and identifying those areas where safety enhancements should be focused. The results of the Integrated Safety Evaluation would be consolidated in a report to be prepared by the Agency in consultation with the respective country. Periodic report updates — for example, every two years — would serve as the technical basis for prioritizing safety actions and adjusting the focus of Agency safety services to be provided.

Convention on Nuclear Safety

The second Review Meeting of Contracting Parties to the Convention on Nuclear Safety takes place in Vienna from 15 to 26 April 2002. The deadline for Contracting Parties to submit their national reports has passed, and these reports will be examined in detail at the Review Meeting.

The first Review Meeting in 1999 provided a 'snapshot' of the measures that States had taken and were taking to achieve and maintain a high level of nuclear safety. It also opened a new forum for the sharing of information between States and learning from each others' experiences. In a sense, the first Review Meeting established a 'baseline'. The second Review Meeting will provide a more focused review, both by highlighting progress in individual States since the first meeting and by concentrating on some specific issues identified in the Summary Report of the first meeting. This will be a more informative test of the effectiveness of the 'incentive' nature of the Convention, showing how Contracting Parties have responded to the issues raised by their peers three years ago, and how they have made use of the information and experience obtained through the peer review process.

Joint Convention on the Safety of Spent Fuel Management and on the Safety of 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 Vienna, starting on 3 November 2003. Participation in this meeting will be open to States that have deposited instruments of ratification, approval or acceptance with the depositary on or before 5 August 2003. It is to be expected that the greater the number of States that participate, the greater will be the effectiveness and credibility of the Joint Convention as a mechanism for improving the safety of management of spent fuel and radioactive waste.

A session of the International Conference on Issues and Trends in Radioactive Waste Management — being organized by the IAEA, in co-operation with the OECD/NEA and the European Commission, in Vienna from 9 to 13 December 2002 — will address the question of what can be achieved through the mechanism of the Joint Convention.

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

As noted in Part 2, the Agency has specific obligations assigned to it by the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (the Assistance Convention). The Agency's capabilities for fulfilling these obligations are co-ordinated by its Emergency Response Centre. As well as responding to real events, the Agency regularly tests its capabilities, inter alia by participating in emergency exercises such as the JINEX-1 exercise described in Part 1. (The Agency also has specific obligations in the event of the Convention on Early Notification of a Nuclear Accident — the Early Notification Convention — being invoked, but the obligations are similar in nature to some of those under the Assistance Convention.)

In June 2001, the Agency convened the first meeting of national competent authorities under the Early Notification and Assistance Conventions, at which 58 States, and two international organizations, Parties to one or both of the Conventions were represented. The meeting, inter alia, suggested a number of actions to be considered by the Secretariat in developing its future plans for strengthening the emergency preparedness and response system. The two suggestions assigned highest priority by the meeting both related to measures to improve communications for responding to nuclear or radiological emergencies, including the development of an overall consolidated communications strategy. This would imply improving the facilities of the Agency's Emergency Response Centre, and may also create a need for upgrades in Member States' capabilities. The reliability of communications systems is also critical, and therefore improved systems would need extensive testing: this might be achieved, for example, through emergency exercises designed solely or primarily to test communications.

Topical issues in nuclear safety

The International Conference on Topical Issues in Nuclear Safety, organized by the Agency in Vienna in September 2001, highlighted some of the main challenges facing the nuclear safety community. Two of the topics covered — the safety of research reactors and maintaining competence for safety — are addressed in separate sections of this report. The other topics covered were risk informed decision making, the influence of external factors on

nuclear safety, the safety of nuclear fuel cycle facilities and safety performance indicators. Brief summaries of the conclusions and recommendations in these areas are given below.

Many of the conclusions and recommendations of the Conference were consistent with the priorities already established in the IAEA's programme of work for 2002–2003: other recommendations will be taken into account in planning the Agency's programme for the following biennium.

Risk informed decision making

Risk informed decision making has advantages, but is not a panacea: it places particular demands on the capabilities of operators and regulators, and not all countries are yet in a position to meet these demands. There also needs to be a degree of common understanding between operators and regulators on what is expected and what criteria will be applied. On the specific issue of probabilistic safety assessment (PSA) in support of risk informed decision making, emphasis needs to be put on improving the quality and consistency of PSAs. The results of PSAs, and the meaning of those results, also need to be effectively explained to the decision makers and stakeholders. The main roles for the IAEA would be in promoting the exchange of experiences and supporting Member States in improving the relevant capabilities.

Influence of external factors on nuclear safety

An important conclusion from other industries that have experienced major external changes is that these changes need not of themselves threaten safety but that, because of their impact on the people in the organization, the transitions need to be well managed. A solid safety culture throughout operating organizations is the best means to ensure safety in times of change. The IAEA should therefore continue its efforts to promote good management of safety and safety culture.

Safety of nuclear fuel cycle facilities

The overall flavour of the conclusions and recommendations in this area was that many of the features of the global safety regime developed for nuclear power plants — international safety standards, peer review services, education and training, information exchange — are needed for fuel cycle facilities. These will need to be tailored to the characteristics of the diverse types of fuel cycle facility, but the types of guidance and assistance needed are functionally the same as for nuclear power plants. The Agency has started work on safety standards, and the application mechanisms will be adapted to reflect those standards.

Safety performance indicators

Safety performance indicators are a valuable tool to enhance safety performance, and particularly to provide 'early warning' of declining performance, but they are just one such tool, to complement other safety assessment tools. For example, quantitative safety performance indicators should be complemented by periodic qualitative evaluations of the safety culture and safety management in the organization. The framework proposed by the IAEA in TECDOC-1141 provides a good approach for establishing a comprehensive operational safety performance indicator programme and can help nuclear installations to

achieve the objectives discussed above. Further work is needed in a number of areas, including the use of safety performance indicators by regulators and for informing the public, application to facilities other than nuclear power plants, and harmonization of indicators. The Agency aims by 2003 to have developed an internationally harmonized set of indicators for use by nuclear power plants and regulatory bodies.

Safety of research reactors

The safety of research reactors has been engaging the attention of the Agency in recent years, particularly in relation to ageing reactors, reactors that are shut down but not decommissioned, and reactors that may not be under adequate regulatory supervision. In response to a resolution from the 2000 General Conference, the Agency has developed an international research reactor safety enhancement plan, aimed at strengthening the safety, monitoring of safety and regulatory supervision of research reactors worldwide. This plan calls for the Agency, in addition to continuing to provide guidance and existing services, to:

- conduct a survey of research reactor safety in Member States;
- prepare a Code of Conduct on the safety of research reactors with a view to establishing the desirable attributes for management of research reactor safety; and
- explore possible means to strengthen the system for monitoring the safety of research reactors, taking account of the experience of organizations working in other fields.

The main features of this plan are consistent with the conclusions and recommendations of the session on research reactor safety at the International Conference on Topical Issues in Nuclear Safety. The plan was endorsed by the Agency's Board of Governors and General Conference in September 2001, and the survey is already under way. The first open-ended meeting of technical and legal experts to work on a Code of Conduct is scheduled for May 2002.

Safety culture

The term "safety culture" was coined by the International Nuclear Safety Advisory Group (INSAG) a decade ago to describe a culture within an organization such that proper consideration of safety pervades all aspects of the organization's work, where there is clear and consistent commitment to safety throughout the organization with visible leadership from the top, and where staff at all levels have a keen awareness of the importance of safety in their work and that of their colleagues. The safety culture 'philosophy' has gradually spread through the nuclear industry, and is now widely recognized as a vital element of the overall safety of nuclear installations. At the same time, greater emphasis on safety culture has created new challenges for operating organizations (from the corporate boardroom to the shop floor) and for regulators. The IAEA has been active in providing advice and assistance to its Member States on building and enhancing safety culture through the Safety Culture Enhancement Programme (SCEP) and other operational safety services.

The Agency is organizing a Conference on Safety Culture in Nuclear Installations, which will be held in Brazil, 2–6 December 2002. This will provide an opportunity for operators and regulators from Member States to exchange experiences.

Occupational radiation protection

An estimated 11 million workers are monitored for exposure to ionizing radiation. They incur radiation doses attributable to their occupation, which range from a small fraction of the global average background exposure to natural radiation up to several times that value. There is a downward trend in the exposure of several groups of workers, but occupational exposure is affecting an increasingly large group of people. Less than half of the occupationally exposed workers are exposed to artificial radiation sources. The remainder are exposed due to elevated levels of natural radionuclides. Notably, this latter group receives a higher average annual dose than those workers exposed to artificial sources. The principal natural sources of radiation exposure, other than the mining and processing of uranium ores, are radon in buildings; non-uranium or thorium ores that contain significant traces of natural radionuclides, radon in other underground workplaces, and cosmic rays at aircraft altitudes. Some of these exposures are amenable to control but others are not.

The IAEA is organizing its first International Conference on this topic, entitled "Occupational Radiation Protection: Protecting Workers Against Exposure to Ionizing Radiation". The Conference is being convened jointly with the International Labour Organization, co-sponsored by the European Commission and held in co-operation with the OECD/NEA and WHO, and will be hosted by the Government of Switzerland in Geneva from 26 to 30 August 2002. The objective of the Conference is to foster the exchange of information on current issues and to formulate recommendations, as appropriate, regarding measures to strengthen international co-operation in occupational radiation protection. The Conference will address the issue of establishing occupational radiation protection standards and providing for their application. It will focus on a number of specific problems, inter alia, the complex issue of controlling occupational exposure to natural sources of radiation.

Security of nuclear facilities and radioactive materials

One of the responses to the events of 11 September 2001 in the USA was that many countries undertook reviews of the potential vulnerability of their nuclear facilities and their systems for protecting radioactive material to terrorist acts. In Resolution GC(45)/RES/14, the IAEA General Conference requested the Director General "to review thoroughly the activities and programmes of the Agency with a view to strengthening the Agency work relevant to preventing acts of terrorism involving nuclear materials and other radioactive materials", and urged all Member States "to co-operate fully with the Director General and to support the Agency's efforts in this regard". The Director General presented a report to the IAEA Board of Governors in November 2001 providing an initial overview of measures that might be included in an Agency programme, and established an interdepartmental 'task force' to refine these proposals in the light of comments provided by Member States, with a view to presenting more concrete proposals to the Board in March 2002. The UN General Assembly in December 2001 adopted a resolution, inter alia urging all UN Member States to support the IAEA in preventing acts of terrorism committed with nuclear and other radioactive materials.

To a very large extent, the security measures needed to prevent actions of this type are the responsibility of national authorities, and many States have already taken or are taking a range of actions at the national level. Not all Member States have the same capabilities to respond to these challenges and some may need assistance, either on a bilateral basis from other Member States or through the Agency. Furthermore there may be some types of action that can best be taken at the international level. The Agency, in close consultation with its

Member States, is considering carefully where and how specific forms of international action might usefully complement national measures. Some existing international initiatives are already contributing to improving the situation; for example, the Agency has for several years been promoting programmes to improve national control systems for radiation sources, to find and recover 'orphan sources', and to strengthen measures to prevent, detect and respond to illicit trafficking in radioactive materials. The aim will be to ensure that such existing initiatives are continued, and refocused and/or strengthened where necessary, and are complemented by any new initiatives that may be considered necessary, including those in relation to the security of nuclear facilities. The Agency's existing emergency response capabilities could be applied in the event of acts of terrorism but, again, there may be a need to further strengthen these capabilities in the light of possible terrorist threats.

Radiological protection of patients

Medical practice involving the use of ionizing radiation accounts for about 95% of human exposure from man-made sources of radiation. Furthermore, as can be seen from Part 1 and from previous Nuclear Safety Reviews, accidents during medical treatment with radiation continue to occur occasionally, with severe and sometimes fatal consequences.

The International Conference on the Radiological Protection of Patients in Diagnostic and Interventional Radiology, Nuclear Medicine and Radiotherapy, held in Málaga, Spain, in March 2001, was attended by more than 800 senior officers and scientists from 88 Member States and 12 intergovernmental organizations and professional bodies. The Conference confirmed that there is scope for reducing the radiological risks involved in both diagnostic and therapeutic uses of radiation without reducing the medical benefits, and made many recommendations of specific means by which this could be achieved. The Málaga Conference's overall conclusion was that "The relevant international organizations should convene a group of experts, including experts from professional societies and regulatory bodies, to formulate an action plan based on the findings of the conference for future work relating to the radiological protection of patients." The IAEA's Board of Governors and General Conference endorsed this conclusion, and a technical meeting to make proposals for such an action plan is scheduled for the end of January 2002.

The scope of radiation safety regulations

It has long been recognized in radiation protection that there are certain situations in which regulation cannot produce reductions in exposure that outweigh the costs (in the broadest sense, i.e. not just monetary costs) of regulation. The term 'de minimis'[24] has been used to describe the general concept: more recently, the specific concepts of exemption, clearance and exclusion have been used to describe the different types of situation. These qualitative concepts cannot, however, be used directly to define the scope of regulation, and various numerical criteria have therefore been developed nationally and internationally. For example, the scope of application of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources is effectively defined in terms of radionuclide specific exemption levels.

Work by the Agency to develop criteria for long lived radionuclides in commodities has been hampered by the wide range of terminology that has arisen to describe subtly different,

[24] From the Latin phrase "de minimis non curat lex" ("the law is not concerned with trivialities").

but closely related, concepts and by the different sets of numerical criteria that have been derived through the use of different approaches to essentially similar problems. It has become apparent that it would be beneficial to address the issue more holistically and develop a more fundamental definition of the boundary between what needs to be subject to radiation safety regulations and what does not.

Safety of transport of radioactive materials

Work is under way on reviewing the 1996 Edition of the IAEA's Regulations for the Safe Transport of Radioactive Material. The review group, meeting in November 2001, recommended 36 changes to the Regulations and the issuing of the updated edition in 2003 as the "1996 Edition (As Amended 2003)". It would then be expected that those international organizations that issue regulations for the safe transport of dangerous goods by particular modes of transport — such as the International Civil Aviation Organization, the International Maritime Organization and the UN Economic Commission for Europe's Inland Transport Committee — would incorporate the changes to the IAEA Regulations into their own 'modal' regulations to take effect in 2005. At the same time, in accordance with the recently adopted two-year cycle for reviewing the IAEA Regulations, the Agency will already be considering proposals for further changes, with a view to a possible update in 2005.

In relation to the application of the Transport Regulations in Member States, the Agency is planning to conduct in 2002 missions to appraise the application of the IAEA Transport Regulations in Brazil, Turkey and the United Kingdom.

The IAEA is also planning an international conference on the safety of transport of radioactive material in 2003.

Safety of radioactive waste management

The 2000 Córdoba Conference on the Safety of Radioactive Waste Management provided a snapshot of the most important and urgent issues facing the waste safety community. At the request of the 2000 General Conference, the Secretariat prepared a report assessing the implications of the Córdoba Conference's conclusions and recommendations for the Agency's programme of work. As well as the Conference conclusions and the views of Member States, the report also took account of the discussions at a Specialists' Meeting on geological disposal organized by the Agency in June 2001. The report was endorsed by the 2001 General Conference.

Most of the actions proposed in the report address technical issues, many of which are already being addressed in the Agency's programme. However, one of the proposed actions — to "develop a step-by-step programme of work aimed at addressing the broader social dimensions of radioactive waste management" — represents a new area of work for the Agency; hence the cautious "step-by-step" approach proposed. This action reflects an increasing recognition within Member States of the need to include societal aspects in the decision-making processes related to radioactive waste management and when making certain decisions - for example, on the acceptability of safety criteria and the standard of proof needed to comply with these criteria. The Agency intends to foster international exchange of experiences and lessons learned on the most effective ways of interacting with stakeholders as an essential part of the decision-making process in radioactive waste management.

Radioactive waste from non-power applications

Most of the volume and activity of radioactive waste arisings come from a relatively small number of waste producers in the nuclear fuel cycle. However, most producers of radioactive waste are engaged in activities unconnected to nuclear power generation. These include large numbers of hospitals and other medical establishments, a wide variety of non-nuclear industries, and various research and educational organizations. These applications give rise to a diverse range of radioactive wastes — often in relatively small amounts and rarely of the most hazardous kinds, but nevertheless requiring safe and responsible management — and many of the 'operators' have very limited expertise in radioactive waste management.

An International Conference on "Management of Radioactive Waste from Non-Power Applications - Sharing the Experience" took place in Malta, from 5 to 9 November 2001, organized by the IAEA and hosted by the Government of Malta. More then 130 technical experts, researchers, regulators and senior officials from 52 Member States and three international organizations attended.

The Conference strongly recommended enhanced co-operation to solve particular technical, organizational and regulatory problems, and emphasized the important role of the Agency in promoting, supporting and co-ordinating these efforts. In particular it was recommended that the Agency should take initiatives in promoting good practice for management of some specific waste types (e.g. disused sealed radioactive sources, wastes from the chemical processing of minerals or ores containing naturally occurring radionuclides, decommissioning and dismantling waste, mixed waste[25], etc.), encouraging development of innovative technologies through supporting and co-ordination of research and development, organizing training and providing methodological support in management of specific wastes, setting safety standards for management of mineral/ore processing waste, decommissioning and dismantling waste, recycling and reuse of materials after decommissioning.

Decommissioning and the termination of practices

When practices involving radiation or radioactive materials are terminated, for whatever reason, a number of specific safety related technical, administrative and regulatory issues can arise. These issues need to be addressed within the normal decommissioning process. Structures may need to be decontaminated and/or dismantled, the site itself may need to be decontaminated, and wastes must be disposed of in a manner appropriate to the hazard they pose. A regulatory process is then necessary to define the future status of the site. In particular, if the site is to be 'released' for general use (i.e. without any continuing safety related controls, or with a reduced level of control), the regulatory body needs to have criteria by which to judge when this can be done, but must also have the legal authority and administrative procedures to relinquish regulatory control. A particular challenge may be to manage the removal of regulatory controls over a site in which a significant amount of radioactive material is to be left in situ (on the basis that barriers are in place to ensure that the corresponding risk is very low), the obvious example being a repository for long lived waste.

[25] Waste that contains both radionuclides and chemical toxins at sufficiently high levels as to require the precautions applied both to radioactive waste and to chemically hazardous waste.

The IAEA is organizing an International Conference on Safe Decommissioning for Nuclear Activities: Assuring the Safe Termination of Practices Involving Radioactive Materials, from 14 to 18 October 2002 in Berlin, Germany. Topical sessions will address: national and international policies and criteria; safety lessons learned from ongoing or completed activities; improvement of safety through the use of new and innovative technologies; management and optimization of occupational radiation protection during decommissioning and restoration operations; safe management of material, waste and sites resulting from the termination of practices; procedures for demonstrating compliance with safety criteria for practice termination; and experience from radiological assessments associated with practice termination.

Protection of the environment from the effects of radiation

Most radiation protection standards, including the IAEA's, are based largely on ICRP's basic recommendations, as set out in ICRP Publications 26 and 60. These recommendations focus primarily on protection of humans against radiation: an underlying presumption is that radiation protection measures designed to provide the recommended degree of protection for individual humans will automatically lead to adequate protection of non-human species (at least for populations, if not necessarily for individual organisms). No detailed justification has been provided for this presumption, and its validity is increasingly being questioned. More fundamentally, the pertinence of this presumption is also being challenged, for example by those who argue that protection of 'the environment' should go far beyond simply avoiding observable impacts on populations of organisms.

Interest in this issue has increased rapidly in recent years, and several significant events are planned within the next year or two:

- ICRP has established a Task Group on Protection of the Environment to report by 2003 so that the major ideas can be incorporated into the next recommendation of the Commission;
- The OECD/NEA is organizing a Forum, in collaboration with ICRP, to be hosted by the Agenzia Nazionale per la Protezione dell'Ambiente in Taormina, Italy, from 12 to 14 February 2002;
- The Supervising Scientist Division of Environment Australia and the Australian Radiation Protection and Nuclear Safety Agency are organizing, in co-operation with the IAEA, the Third International Symposium on the Protection of the Environment from Ionising Radiation, in Darwin, Australia, from 22 to 26 July 2002; and
- The IAEA is organizing an international Conference on the Protection of the Environment from the Effects of Ionizing Radiation, planned for late 2003 in Sweden.

The issue is also likely to be among those considered by the World Summit on Sustainable Development ('Rio+10') in Johannesburg, South Africa, in August–September 2002.

Education and training for safety

A key element in maintaining knowledge and competence is to ensure a continuing supply of staff with the necessary education, training, practical knowledge and experience to design, operate, maintain and decommission facilities and activities safely and to regulate those activities.

In response to resolution GC(44)/RES/13, the Secretariat prepared a strategic plan for a long-term and sustainable education and training programme, which was submitted to the Board of Governors and General Conference in September 2001. In summarizing the relevant discussion in the Board, the Chairman noted that "there had been widespread appreciation" of the document, and in GC(45)/RES/10, the General Conference, inter alia, urged the Secretariat "to implement the Strategic Plan .. and conclude long-term formal agreements with regional centres for education and training activities". An important premiss of the strategic plan is that there is a gap between the knowledge needed in Member States and the ability of the Agency to provide training. Therefore, as a complement to training courses, the Agency will concentrate on helping Member States to establish sustainable national education and training programmes that are consistent with international safety standards. An essential element of this effort is the development by the Agency of model training programmes which can be used in training the trainers, who will ultimately implement the national programmes, both in the subject matter and in training methods. Other measures to be adopted include greater use of distance learning as a complement to — or prerequisite for — more traditional training, development of more modular training material, which allows flexibility in the choice of material, increasing use of and access to computer based material and a systematic approach to the establishment of regional and national training centres and to the development of the network of such centres.

Clearly, the success of these programmes will depend on the commitment of Member States to establishing their own sustainable training programmes modelled on the exemplary training provided by the Agency. To support Member States, the Secretariat will provide, on request, advisory services to Member States wishing to evaluate their national training needs and to organize and assist with the required training, or peer reviews of existing national programmes.

The broader topic of maintaining knowledge in nuclear science and technology will be addressed by a meeting of experts being organized by the Agency in May 2002, with the aim of defining the key issues in this area.

Safety of innovative nuclear reactors

The IAEA General Conference in 2000 invited "all interested Member States to combine their efforts under the aegis of the Agency in considering the issues of the nuclear fuel cycle, in particular by examining innovative and proliferation-resistant nuclear technology", and invited Member States to consider contributing to a task force on innovative nuclear reactors and fuel cycles. In response to this invitation, the IAEA initiated the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO). The objective of INPRO is to support the safe, sustainable, economic and proliferation resistant use of nuclear technology to meet the global energy needs of the 21st century. During Phase I of INPRO, activities focus on the development of user requirements in various areas of

importance, among them safety. These user requirements are being developed. The next steps will be to establish methodologies and criteria for comparing concepts and to compile a list of innovative design concepts; a report on these first three steps should be issued in 2002. In 2003, participating Member States will examine the design concepts against the user requirements, making their own judgements about the relative importance of the different user requirements.

As scientific knowledge and technology advance, it is not possible to predict in any detail developments several decades in the future. Therefore, user requirements for future nuclear installations represent an idealization of what is desirable in safety, as well as in economical and environmental respects, based both on current trends and on a general sense of what might be achievable technologically. From the safety point of view, the application of defence in depth will continue to be the dominant approach for achieving the general safety objectives in future nuclear power plants, but emphasis is shifting from mitigation of accident consequences to prevention of severe accidents.

The IAEA is also actively participating in the US Department of Energy (DOE) Generation IV initiative for the development of a technology 'road map' to help guide future nuclear power plant development and evaluations.

The Agency has initiated work to establish a general approach to the safety of innovative reactors, and to develop a methodology, based on the concept defence in depth, for establishing safety requirements. This work, co-ordinated with the Agency's participation in the Generation IV initiative, will contribute to the harmonization of approaches to the safety of innovative reactors among Member States and to the establishment of a consensus set of safety requirements.