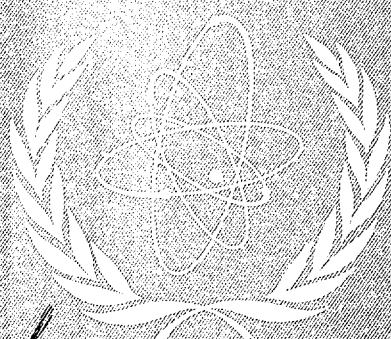
IAEA/NSR--1997

Nuclear Safety Review for the Year 1997



INTERNATIONAL ATOMIC ENERGY AGENCY

Nuclear Safety Review for the Year 1997

October 1998

Nuclear Safety Review
for the Year 1997

IAEA/NSR/1997

Printed by the IAEA in Austria
December 1998

FOREWORD

The Nuclear Safety Review attempts to summarize the global nuclear safety scene during 1997. It starts with a discussion of significant events during the year. This is followed by a brief description of the principal IAEA activities that contributed to global nuclear safety. The third part of the Review highlights developments in Member States, as reported by the States themselves. The Review closes with a description of issues that are likely to be prominent in the coming year(s).

A draft version of the Nuclear Safety Review for the year 1997 was submitted to the March 1998 session of the IAEA Board of Governors. This final version has been prepared in the light of the discussion in the Board, and was submitted for information to the 42nd session of the IAEA General Conference.

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PART I

SAFETY RELATED EVENTS AND ISSUES WORLDWIDE

This section aims to identify those events from which generally applicable lessons can be learned, those with potential long term consequences (whether good or bad) and those that could be indicative of developing trends (again, either good or bad) that might be of longer term importance. It is not intended to provide a comprehensive account of all events during the past year.

INTERNATIONAL CO-OPERATION

Intergovernmental Agreements

Legally binding agreements between States are increasingly important mechanisms for improving nuclear, radiation and waste safety worldwide. The number of bilateral and regional agreements continues to grow, and more and more States are becoming Parties to the international Conventions. There were three major events in this latter context during 1997:

- The Preparatory Meeting of the Convention on Nuclear Safety;
- The Diplomatic Conference to adopt the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management; and
- The Diplomatic Conference to adopt a Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage and the Convention on Supplementary Compensation for Nuclear Damage.

The Convention on Nuclear Safety entered into force on 24 October 1996. In accordance with the terms of the Convention, a Preparatory Meeting of the Contracting Parties was held from 21 to 25 April 1997 in Vienna and adopted rules of procedure, financial rules and guidelines for the preparation of national reports. Thirty-four States participated — 31 that were Contracting Parties, plus 3 who had deposited instruments of ratification less than 90 days before the Meeting — under the chairmanship of Mr. L. Högberg of Sweden. At the end of 1997, 42 States had agreed to be bound by the Convention. Twenty-six of the Contracting Parties have at least one operating power reactor (a "nuclear installation", as defined in the Convention), but there remain five States that have such nuclear installations and are not yet Contracting Parties to the Convention.

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was adopted by vote at the Diplomatic Conference, held in Vienna from 1 to 5 September 1997, and opened for signature on 29 September 1997, the first day of the 41st IAEA General Conference. The discussions at the Diplomatic Conference were dominated by the issue of transboundary movement of spent fuel and radioactive waste (see

discussion in Parts II and IV), and some States continued to express reservations about spent fuel and radioactive waste being addressed together. Nevertheless the Joint Convention was adopted by an overwhelming majority, and by the end of 1997, 26 States had signed it (one State — Norway — deposited an instrument of ratification in January 1998). The Joint Convention, like the Convention on Nuclear Safety on which it was modelled, is an 'incentive convention', and is based on a similar system of national reports on safety activities being subjected to 'peer review' by the other Contracting Parties. The scope of the Joint Convention includes the management of spent fuel and radioactive waste (including discharges of liquid and gaseous radioactive materials into the environment) from civilian applications, with the exceptions of spent fuel held at reprocessing facilities and waste containing only naturally occurring radioactive materials. These excepted materials — along with material from defence or military applications — may be brought into the scope if a Contracting Party chooses to declare them as such.

In September 1997, governments took a significant step forward in improving the liability regime for nuclear damage. At a Diplomatic Conference at IAEA Headquarters in Vienna, 8–12 September 1997, delegates from over 80 States adopted a Protocol to Amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage and also adopted a Convention on Supplementary Compensation for Nuclear Damage. The Protocol sets the possible limit of the operator's liability at not less than 300 million Special Drawing Rights; roughly equivalent to 400 million US dollars. The Protocol also contains, inter alia, an enhanced scope which covers costs of reinstatement of damaged environment and costs of preventive measures, extends the geographical scope of the Vienna Convention and extends the period during which claims may be made for loss of life and personal injury. The Convention on Supplementary Compensation provides for additional compensation through contributions by States on the basis of their installed nuclear capacity of civilian reactors and UN rate of assessment. States without nuclear reactors and which are at the minimum UN rate of assessment are not required to make contributions. The Convention is an instrument to which all States may adhere regardless of whether they are parties to any existing nuclear liability conventions or have nuclear installations on their territories. Both the Protocol and the Convention have a phasing-in mechanism which allows a State to join them, during an interim period, with a lower national compensation amount. They also provide, as an exception to the general rule, for jurisdiction of the courts of a coastal State over actions for nuclear damage arising during transport from incidents within its exclusive economic zone. Taken together, the two instruments should substantially enhance the global framework for compensation well beyond that foreseen by existing Conventions. The Protocol and Convention were opened for signature on 29 September 1997, at the 41st IAEA General Conference; by the end of 1997, each had been signed by nine States.

Co-operation between National Regulatory Bodies

The heads of the nuclear regulatory bodies in Canada, France, Germany, Japan, Spain, Sweden, the United Kingdom and the United States of America formed the International Nuclear Regulators' Association (INRA). The inaugural meeting of the Association in May 1997 appointed Ms. S.A. Jackson of the US Nuclear Regulatory Commission as Chairman for two years. These first two years are envisaged as a 'trial period', during which membership will be limited to representatives of the eight States listed above; the question of whether, and if so how, to extend the membership will be addressed after this period of consolidation. The Association aims, inter alia, to provide the regulators with a forum for discussing policy issues of common interest, to identify emerging regulatory challenges and to enhance the stature of nuclear regulators and their work worldwide. Specific issues to be addressed include the regulatory implications of the restructuring of electricity industries and assistance to the regulatory bodies of central and eastern Europe.

The organizations responsible for nuclear safety and radiation protection in Argentina, Brazil, Cuba, Mexico and Spain have established a Forum of Ibero-American Regulatory Bodies for the exchange of technical, legal and organizational information of mutual interest. The initiative will include initially those countries which have nuclear power plants in construction or in operation. The activities of the Forum should be complementary to the existing international programmes of nuclear safety and radiation protection, such as those of the IAEA, and will promote the exchange of experience among countries with close cultural and social relations. The first annual meeting of the Forum took place in Mexico in July 1997.

The creation of the INRA and the Ibero-American Forum follows a pattern established by the formation of regulators' organizations based on reactor type and/or regional considerations, with the aim of improving safety by exchanging regulatory information and experience. For example:

- The Co-operation Forum for WWER Regulators was formed in 1993 to encourage the sharing of information and pooling of experience between regulators from the States operating WWER reactors: Armenia, Bulgaria, the Czech Republic, Finland, Hungary, the Russian Federation, Slovakia and Ukraine (with Germany, USA, IAEA and the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development — OECD/NEA — as observers). The fifth annual meeting of the Forum was held in Helsinki in August 1997, and included progress reports from the participants, reports from working groups on in-service inspection, radiation embrittlement and licensing of dry spent fuel storage facilities, and detailed discussion on the problems and operating experience with WWER-1000 plants.
- A similar group comprising senior regulators from countries with CANDU reactors — Argentina, Canada, China, India, Republic of Korea, Pakistan and Romania — held its third annual meeting in October 1997 (with support from the

IAEA), and discussed issues such as the events at Ontario Hydro (see below), plant safety indicators, generic safety issues, backfitting experience and national reports for the Nuclear Safety Convention.

- The IAEA has since 1989 organized peer discussions on regulatory practices, aimed at promoting information exchange and identifying and disseminating commonly accepted good practices. These discussions take the form of a series of meetings between regulators discussing a specific issue chosen by the Agency's Advisory Commission on Safety Standards. The subject for the discussions in the 1996–1997 session — in which regulators from 22 Member States participated — was "Approaches Relating to the Decommissioning of Nuclear Facilities", and a report describing the conclusions will be published in the near future. The first meeting of the 1997–1998 series on "Regulation of the Life Cycle Management of Nuclear Installations" was held in September 1997.

On 30 October 1997, officials from eight Asian countries on the Pacific, as well as from Australia, met in Seoul, Republic of Korea, for the second annual conference on nuclear safety in Asia. Observers from ten other countries, and from the IAEA and OECD/NEA also attended. Participants agreed on the need to take concrete measures to further improve nuclear safety in the region. They exchanged views on safety related issues and made suggestions to develop concrete measures for co-operation.

Activities of International Organizations

Some of the safety related activities of the IAEA are described in more detail in Section II. Other international organizations active in nuclear safety related areas include the World Association of Nuclear Operators (WANO) and the Nuclear Energy Agency of the OECD (OECD/NEA).

WANO's mission is to maximize the safety and reliability of the operation of nuclear power plants by exchanging information and encouraging communication, comparison, and emulation amongst its members. All organizations operating commercial nuclear power plants are members of WANO. In 1997 WANO conducted peer reviews at 24 of its members' nuclear power plants, and there are 24 peer reviews scheduled for 1998. Although WANO peer reviews and IAEA OSART missions are each unique and separate, they are complementary in that each strives to enhance nuclear plant safety and reliability. Scheduling of these visits is co-ordinated between the two organizations. WANO has also established a new Technical Support and Exchange Programme to provide response to specific requests for assistance from its members. Twenty-two technical support missions were conducted in 1997 as part of the development of this programme. Other ongoing WANO programmes — operating experience, good practices, performance indicators, workshops and exchange visits between plants — contribute to the safe and reliable operation of WANO members' nuclear

power plants and continue to develop and expand with increasing member participation and use.

The OECD/NEA has programmes of work in nuclear safety and regulation, radiation protection and radioactive waste management. Some of their work is mentioned elsewhere in the Review, but other areas of current interest include:

- The preparation of reports describing the 'state of the art' in OECD States (and sometimes non-OECD States) on a range of safety related issues;
- The Information System on Occupational Exposure (ISOE) aims to provide its participants (regulatory authorities and utilities) with an information and data exchange on occupational exposure in nuclear power plants and methods to improve the protection of workers. The ISOE is now co-sponsored by the IAEA, allowing non-OECD States to participate; and
- The second part of International Emergency Exercise programme INEX 2 was held at Loviisa, Finland, in April 1997, and included participants from 28 countries and 5 international organizations (including the IAEA). Two further regional exercises scheduled for 1998 — in Canada and Hungary — will complete the INEX 2 programme.

REACTOR FACILITIES

A number of events in 1997 highlighted the need for continuous efforts to maintain and improve nuclear safety, even in long established nuclear programmes such as those of western Europe and North America. The three examples described below — from Canada, USA and Sweden — suggest that successful nuclear programmes can experience a gradual deterioration in safety performance. This issue is discussed further in Part IV.

In August 1997, Ontario Hydro — Canada's main nuclear power plant operator — announced a major plan of action for its production facilities, including the closure for an indefinite period of 7 reactors at the Bruce A and Pickering A nuclear power plants and major improvements in the management of operation and maintenance at the 12 reactors at Bruce B, Pickering B and Darlington stations. This followed the report of a team of experts from Canada and the USA, commissioned by Ontario Hydro's management to provide an independent assessment of their nuclear operations. The team concluded that the overall standard of safety at the operating stations was "minimally acceptable"; i.e. their operation met defined regulations and accepted standards of nuclear safety, but fell substantially below industry standards of good practice. Many specific and detailed criticisms of Ontario Hydro's operations, particularly in areas of management, were made in the report. A general overall conclusion was that the company had failed to adapt sufficiently well to the different needs of day-to-day safety in the operational phase — particularly the increased importance of safety management concepts such as safety culture and self assessment — as compared to the design

and construction phase. The independent review confirmed the position that the Canadian regulator had expressed over a number of years, namely that safety performance was deteriorating and that corrective action was necessary if unrestricted operation was to be permitted.

In June 1996, the Millstone nuclear power plant in Waterford, Connecticut, USA, was designated a Category 3 facility by the Nuclear Regulatory Commission (NRC), meaning that it could not be restarted until the licensee, the Northeast Utilities Service Company (NU), demonstrates that adequate programmes have been established and implemented to ensure substantial improvements in safety. This followed several years in which there was a high volume of employee concerns and allegations about safety at the three Millstone units, and about management attitudes towards staff raising such concerns. An independent review group established by the NRC reported in September 1996 its view that the problems were primarily attributable to "top management failure to provide the dynamic and visible leadership needed to bring about required, basic attitude changes", and noted that the problems identified in their review had all been identified to NU management previously. Following the regular reviews of their 'watch list' in January and June 1997, the NRC determined that Millstone should continue to be designated a Category 3 facility. As of the end of 1997 the station remains shut down.

In August 1997, it was discovered that operators at the Ringhals-2 nuclear power plant in Sweden had preheated the reactor — a preliminary to powering up after a maintenance outage — without realizing that the emergency core cooling system was not in a poised state. Before an internal investigation was completed, a similar incident occurred at Ringhals-3 in September. A further incident in which control room staff failed to notice that a safety system valve was not correctly set was detected in October at Oskarshamn-1; the operators immediately took the plant off-line. The nuclear safety authority SKI responded by requiring plant managers from all nuclear power plants to submit by the end of 1997 detailed plans for guarding against such incidents.

The previous Nuclear Safety Review reported on concerns about the 6.5 MW(th) heavy water research reactor at the Institute of Nuclear Sciences at Vinča, near Belgrade. In 1995, concern about the condition of the spent fuel storage pool — which contains about 7500 spent fuel slugs in aluminium drums and stainless steel fuel channel holders — prompted the Institute to request assistance from the IAEA. Missions to Vinča, in November 1995 and October 1996, assessed the situation and identified the remedial actions needed. The most acute problem was considered to be the possible overpressure in the aluminium drums. A third mission — supported, like the previous missions, by a contribution from the Italian Government — visited Vinča in February 1997, and assisted in producing a detailed work plan for the necessary remedial actions. The first stage of this plan, removing the sludge and cleaning the pool, was started by local staff, and a contract has been signed with a Russian company for the task of venting the drums. The project is being financed by the Yugoslav

Government and, as requested by the reactor management and the Government, the Agency will continue to provide expertise and advice as necessary.

Responding to concerns about the stability of the 'sarcophagus' containing the remains of Chernobyl Unit 4, a phased approach to address the safety issues was proposed by groups of international experts. The concept was developed into a Shelter Implementation Plan (SIP) in the Spring of 1997, including in the first phase measures to stabilize the present sarcophagus conditions. It is expected that the SIP will take eight or nine years to complete, at a cost of approximately $750 million. A Pledging Conference took place in November 1997 at the UN Headquarters in New York, for prospective donors to subscribe funds in addition to the original $300 million pledged by the 'Group of Seven' (G-7) countries during their Denver Summit of June 1997. The European Bank for Reconstruction and Development (EBRD) was invited by the G-7 to establish and administer the Chernobyl Shelter fund. The Board of the EBRD approved the participation of the Bank in September 1997 and the Rules of the Fund in November 1997.

SAFE MANAGEMENT OF RADIOACTIVE WASTE

In October 1997, the US Environmental Protection Agency (EPA) announced its proposed decision that the Department of Energy's (DOE) Waste Isolation Pilot Plant (WIPP) will meet the necessary protection standards for disposal of long lived transuranic radioactive waste from defence activities. This proposed decision is based on the DOE's formal application made in May 1997; a final decision — which will follow a round of public consultation — is required within one year of receipt of the application, i.e. by May 1998. The DOE's application had been considered in the light of a review by the US National Academy of Sciences of the standards being applied, and a review of the DOE's assessment by an International Review Group organized by the OECD/NEA and IAEA.

Also in the USA, the Nuclear Regulatory Commission (NRC) published its Final Rule on radiological criteria for termination of nuclear facility licences after decommissioning. The rule allows sites to be released for unrestricted use if the doses from residual radioactive material are below 25 mrem (0.25 mSv) per year and as low as reasonably achievable. If institutional controls are needed to keep the doses below 25 mrem/y, then the site may be released for restricted use (which excludes, inter alia, use for housing), subject to certain administrative requirements designed to demonstrate the reliability of the controls and assurance that failure of the institutional controls would not lead to doses in excess of 100 mrem (1 mSv) per year. The choice of the 25 mrem/y criterion, and the NRC's decision not to include a separate criterion specific to doses from groundwater, were the source of disagreement between NRC and EPA. As the need grows to decommission old facilities, several other States are considering criteria to be applied for licence termination, and the developments in the USA will be watched with interest.

Considerable controversy surrounded proposals by the Taiwan Power Company of Taiwan, China to export low level radioactive waste to the Democratic People's Republic of Korea (DPRK). A resolution by the National Assembly of the Republic of Korea (reproduced in the Attachment to INFCIRC/534) strongly urged that the proposals be revoked, noting international practice that radioactive wastes should be disposed of in the country in which they were generated and recalling the Lomé Convention, which prohibits the direct or indirect export of radioactive waste from Member States of the European Union to the contracting States in Africa, the Caribbean and the Pacific (the ACP States). As of the end of 1997, no waste had been transferred to the DPRK.

Transports of radioactive waste were also very much in the news in 1997; these are addressed below in the section on transport of radioactive materials.

MEDICAL USES OF RADIATION SOURCES

As reported in the previous Nuclear Safety Review, it emerged in September 1996 that 115 radiotherapy patients at a hospital in San José, Costa Rica had received higher than intended doses from an incorrectly calibrated cobalt-60 source. Assistance was requested under the terms of the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. At the request of the Costa Rican Government, an international team of experts assembled by the IAEA visited San José in July 1997. In collaboration with local professionals, they evaluated the causes and effects of the accident, provided advice on follow-up actions and made recommendations on improving safety in radiotherapy (a new report on this issue is being prepared by the IAEA). The team estimated that the calibration error had resulted in the actual doses delivered being 50–60% higher than intended; they concluded that this overexposure had been the direct cause of the deaths of 3 patients, and a contributory factor in the deaths of a further 5 (in total, 42 of the patients had died by the time of the team's visit). In addition, 20 of the patients who were still alive had suffered major adverse health effects. The cause of the overexposure was determined to have been an arithmetical error, and inadequate quality assurance made it possible for this error to become an accident.

The first global requirements for the radiation protection of patients were established in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources in 1996. In June 1997, the Council of the European Union adopted the "Council Directive on Health Protection of Individuals against the Dangers of Ionising Radiation in relation to Medical Exposures" (97/43/EURATOM). This is intended to clarify and extend the scope of the previous Directive on the subject, issued in 1984, and is mandatory in the Member States of the European Union. The new Directive highlights some particular situations, such as exposure of children, pregnant women and nursing mothers, use of radiation in health screening programmes, high dose procedures and potential exposures, and also gives greater attention to training. The Directive requires justification and

optimization arguments to be applied at two levels: generically, for a particular type of procedure, and individually, in the context of a particular patient undergoing a particular procedure. It also places the justification requirement on both the person prescribing the procedure involving radiation and the person delivering the exposure. In its explicit requirement to consider alternative diagnosis or treatment methods in every case, the new Directive goes beyond the requirements for the justification of practices involving radiation in the 1996 Euratom Basic Safety Standards Directive. In addition to the justification principle, the Directive also stresses the value of optimization as a very important tool for radiation protection purposes. It introduces concepts such as quality assurance and diagnostic reference levels, and requires special attention to the exposure of volunteers and persons helping a patient.

EVENTS AT OTHER FACILITIES

On 11 March 1997, a fire broke out in a bituminization demonstration facility at the Tokai reprocessing plant in Japan, operated by the Power Reactor and Nuclear Fuel Development Corporation (PNC). A sprinkler system was activated, and the incident seemed to be over, but ten hours later an explosion or explosions occurred. Thirty-seven workers received small doses, mainly from inhaled radioactive material, and there was a small release of radioactivity (within the authorized limits for normal operation) from the site. The direct cause of the fire was found to have been a chemical reaction in a drum containing bitumen and low level radioactive waste; the reason for the subsequent explosion was apparently that the time for which the water sprinkler operated was insufficient to extinguish the fire completely, and there was no proper verification that the fire was out.

On 17 June 1997, a worker at the All-Russian Research Institute of Experimental Physics in Arzamas-16 (Sarov), Russian Federation was exposed to a sudden abnormally high neutron flux from a critical assembly on which he was working. The whole body dose was estimated, from a dosimeter on his chest, to have been 45–50 Gy (predominantly neutron dose), and doses to the worker's hands were estimated to have been 350–450 Gy. He suffered widespread edema, and died 64 hours after the exposure from multiple organ failure. Investigations into the accident suggested that the direct causes were procedural and calculation errors by the worker himself, and that the work was being carried out alone, in contravention of safety regulations. Assistance was requested by the Russian Federation under the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; the requested medical materials were urgently obtained by the Agency, and promptly delivered to Moscow (where the victim was being treated), but arrived on the day on which he died.

In June 1997, an explosion and fire occurred at a gas extraction well in Bangladesh, operated by a petroleum company, at which neutron and gamma radiation sources were being used. On 26 June, the IAEA received a request from the Bangladesh Atomic Energy

Commission (BAEC) for assistance under the Convention on Assistance in the Event of a Nuclear Accident or Radiological Emergency, reporting that a number of the sources had not been accounted for. The Agency was, however, informed that the site was inaccessible as a result of the fire and risk of further explosions. An Agency mission to investigate the situation was eventually approved and went ahead in October. On the day of arrival, the mission team was informed that the sources had been located a few days earlier by petroleum company workers. The mission team then worked with representatives of BAEC and the petroleum company to check the sources, which were still in their containment. No residual contamination was detected and the sources were removed to safe storage.

On 9 October 1997, the Georgian Ministry of Health reported that nine servicemen of the Lilo Centre Detachment of Frontier Troops had developed radiation induced skin injuries, and requested assistance from the IAEA. The injuries were reported to have been caused by exposure to caesium-137 sources found on the military base where the men had been stationed, having apparently been left there by the Soviet Army. An Agency mission was sent immediately to the base, and found that the caesium and radium-226 sources were securely stored with adequate physical protection. The mission team also confirmed that dose rates at the site were at background levels, and detected no surface contamination. Medical treatment was provided under existing agreements between the World Health Organization (WHO) and the Agency; the injured servicemen were taken to either France or Germany for treatment. Under a rapidly introduced and implemented Technical Co-operation project, monitoring equipment and training is being provided to Georgia. A follow-up IAEA mission in December established that there are three other military sites near Tbilisi with radioactive sources and surface contamination. Georgian authorities reported that they are monitoring more than 300 other places for radioactive sources or surface contamination.

In July 1996, a worker at the Gilan Combined Cycle Power Plant in Iran found a lost industrial radiography source and, not knowing what it was, put it in his shirt pocket. When he became aware that the object could be harmful, he discarded it, but not before he had received a large radiation dose to his chest. This ultimately caused extensive injuries to the skin and underlying tissues. He was treated at the Curie Institute in Paris, where he received skin transplants. Although he has permanent scarring of the skin and some restriction of movement, he is otherwise now in good health. In collaboration with Iranian specialists, the Agency is preparing a report of the accident in order to disseminate the lessons learned from it.

TRANSPORT OF RADIOACTIVE MATERIAL

Transports of radioactive materials generated a great deal of publicity during 1997 as pressure groups intensified their efforts to stop such shipments. In Germany, protesters attempted to block a number of rail transports of spent fuel and radioactive waste, with some such demonstrations ending in violence. There were also increased diplomatic concerns

expressed in relation to sea transports of vitrified high level waste between Europe and Japan by States en route, although the shipments were carried out in accordance with international regulations and agreements, notably the IAEA's Regulations for the Safe Transport of Radioactive Material and the International Maritime Organization's (IMO) Code for the Safe Carriage of Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes in Flasks on Board Ships. Concerns which had been expressed by some Member States to the IMO — particularly with reference to the prior notification of States on the route of shipments — were echoed in other forums. Both the Diplomatic Conference on the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and the IAEA General Conference adopted resolutions on the issue of transboundary movement of radioactive materials, and the Governments of Argentina, Brazil, Chile and Uruguay issued a Joint Declaration on the Transport of Radioactive Waste (see Part IV).

PART II

AGENCY ACTIVITIES IN NUCLEAR, RADIATION AND WASTE SAFETY

In previous years, the Nuclear Safety Review has referred to a global nuclear safety culture comprising three key elements:

- Legally binding international agreements;
- Non-binding safety standards; and
- The application of safety standards.

As noted in Part I, legally binding international Conventions play an increasingly important role in improving nuclear, radiation and waste safety. The Agency assists this process by providing a range of functions, including acting as secretariat to meetings of Contracting Parties, and maintaining records of national points of contact. The Director General of the IAEA acts as depositary for the Conventions. Further information on the Conventions can be found in Part A of the Attachment to IAEA General Conference document GC(42)/INF/5, or on the Agency's WorldAtom web site, at www.iaea.org/worldatom/glance/legal/.

The development of international consensus standards and guidance on nuclear, radiation and waste safety are high priorities for the Agency. The process for the preparation and review of safety standards involves, in addition to the Agency's internal review and approval procedures, five advisory bodies made up of senior regulators nominated by Member States: four Advisory Committees concentrating on the specific areas of nuclear safety, radiation safety, radioactive waste safety and transport safety, and an Advisory Commission on Safety Standards addressing more general safety issues and overseeing the work of the Advisory Committees. The advisory bodies approve plans for the development of new or revised safety standards, review draft versions of documents (Member States also have an opportunity to comment directly on proposed standards) and eventually approve them. Over 60 safety related documents — some new, some being revised — are currently at various stages of the preparation and review process. A status report on the Agency's safety standards is given in Part B of the Attachment to IAEA General Conference document GC(42)/INF/5.

The International Nuclear Safety Advisory Group (INSAG) — an independent advisory group to the Director General of the IAEA — is currently working on four main reports: a 'high level document' (as yet untitled) addressing the fundamental objectives and principles of nuclear, radiation and waste safety, an updated version of an earlier report (INSAG-3) on basic safety principles for nuclear power plants, and new reports on the safe management of ageing of nuclear power plants and on safety management.

THE APPLICATION OF SAFETY STANDARDS

The IAEA has an extensive ongoing programme of work to provide for the application of safety standards. This includes:

- Providing direct safety related assistance to Member States, through the Agency's regular budget, Technical Co-operation programmes and special extrabudgetary programmes;
- Fostering the international exchange of safety related information;
- Promoting education and training;
- Providing a wide range of safety related services, including radiological assessments, to Member States on request; and
- Co-ordinating safety related research and development projects.

Safety Related Assistance

The Agency provides assistance in nuclear, radiation and waste safety to Member States through its regular budget, the Technical Co-operation programme and extrabudgetary programmes. Assistance on specific matters at the request of Member States has been provided by the Agency for many years, including assistance in the case of accidents (see the examples in Part I) and assistance related to the Agency's nuclear safety services to Member States (see below). Over the past few years, this 'assistance on request' has been supplemented by the development of more systematic programmes to improve basic safety infrastructure. Some examples are described below.

Radiation and Waste Safety Infrastructure

The Technical Co-operation Model Project on "Upgrading Radiation and Waste Safety Infrastructure" was initiated in 1994, and had progressed by 1997 to include 52 Member States (see Table I). The Model Project has been based on a systematic approach of assessing each State's existing safety infrastructure, comparing it to a reference model of an acceptable level of infrastructure — based on the requirements of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources — and thus deriving an action plan of necessary improvements, and then implementing the action plan. The majority of these Country Safety Action Plans were completed by early 1997, and implementation is under way. Some results have already been achieved, notably in the control of radiation sources; by the end of 1998, over 80% of the participating countries should have approved (or be in the process of approving) legislation and regulations and established systems of notification, licensing and control of sources in accordance with the Basic Safety Standards, and over 70% should have a national inventory of sources. It is expected that all but a very small number of participating States will achieve a reasonable system of control for radiation sources.

TABLE I Member States participating in the Model Project "Upgrading Radiation and Waste Safety Infrastructure"

Africa	West Asia/East Asia	Latin America	Europe
Cameroon	Bangladesh	Bolivia	Albania
Côte d'Ivoire	Jordan	Costa Rica	Armenia
Democratic Republic of the Congo	Kazakhstan	Dominican Republic	Belarus
Ethiopia	Lebanon	El Salvador	Bosnia and Herzegovina
Gabon	Mongolia	Guatemala	Cyprus
Ghana	Myanmar	Haiti	Estonia
Madagascar	Qatar	Jamaica	Georgia
Mali	Saudi Arabia	Nicaragua	Latvia
Mauritius	Sri Lanka	Panama	Lithuania
Namibia	Syrian Arab Republic	Paraguay	Republic of Moldova
Niger	United Arab Emirates		The former Yugoslav Republic of Macedonia
Nigeria	Uzbekistan		
Senegal	Viet Nam		
Sierra Leone	Yemen		
Sudan			
Uganda			
Zimbabwe			

Nuclear Safety Infrastructure

A new programme on nuclear installation safety — the "Integrated Strategy for Assisting Member States in Establishing/Strengthening their Nuclear Safety Infrastructure" — was proposed in 1996, and implementation was begun during 1997. This will be available only to those States receiving Agency assistance which have research reactors or nuclear power plants, and the number of States involved is therefore likely to be smaller than for the Model Project. The key element of the strategy is that country nuclear safety profiles describing each State's existing safety infrastructure will be compared with a reference situation based on international safety standards — in this case the IAEA's Nuclear Safety Standards (NUSS) documents — to identify systematically where the Agency's assistance could most effectively be applied. During 1997 a set of questionnaires, based on the safety requirements in the five NUSS Codes, was developed for use in this comparison process. These questionnaires will be sent, together with draft narratives of the country nuclear safety profiles, to the Member States concerned early in 1998, allowing work on preparing country nuclear safety action plans to begin later in 1998.

Extrabudgetary Programmes

In 1990 the Agency started an extrabudgetary programme (EBP) on the Safety of WWER and RBMK nuclear power plants to enhance nuclear safety assistance to the countries of eastern Europe and the former Soviet Union. This has been supplemented in recent years by Technical Co-operation projects. The Member States supporting the EBP have requested

that it be completed by 1998, with subsequent assistance being provided from the Agency's regular budget. As a result, the work in 1997 was increasingly focused on those areas considered to have the highest priority for the time remaining in the programme, namely the generic safety issues and the safety issues affecting the older reactors — 'small series' WWER-1000 plants and RBMKs of the first and second generation. Work is also under way to ensure that tasks which will not be completed in 1998 are transferred to regular budget projects of the Agency, including those of the Technical Co-operation programme, or to national, bilateral or other international programmes.

Discussions were also under way in 1997 on the establishment of an extrabudgetary programme on nuclear safety for the countries of south-east Asia, the Pacific and the Far East. The objective of the programme is to strengthen nuclear safety in the countries of the region, and in particular to enhance the capabilities of national regulatory authorities and technical support organizations. A 'kickoff' meeting in October was attended by 21 representatives of 13 Member States, and agreed on action plans for the programme. The programme will involve two phases, and will follow the pattern specified in the Agency's Integrated Strategy for Assisting Member States in Establishing and Strengthening their Nuclear Safety Infrastructure (see above). Phase 1 (1997–1998) will include national and regional training, and the development of country profiles and national action plans; these actions plans will then be implemented in Phase 2 (1999–2000). The Japanese Government has committed funds to finance implementation of the 1998 programme, and other States have indicated their willingness to provide financial contributions and cost free experts, and to host training activities. A notable and novel feature of this programme is that, unlike the programme in eastern Europe aimed at improving safety in a long established industry, it would in a number of cases be providing assistance to States as they consider developing nuclear power programmes.

Information Exchange

The Agency fosters the international exchange of safety related information by producing a wide range of publications aimed at different audiences, by organizing meetings, conferences and workshops and, increasingly, through electronic information systems. Full lists of safety related publications issued, and events organized by the Agency in 1997 are given in the Annual Report.

A number of Agency-sponsored meetings and conferences warrant special mention. The International Conference on Low Doses of Ionizing Radiation: Biological Effects and Regulatory Control — held in Seville, Spain in November — attracted over 500 participants from 65 countries and 5 international organizations. Other international conferences and symposia organized by the Agency included an International Conference on Physical Protection of Nuclear Materials: Experience in Regulation, Implementation and Operations (10–14 November) and a Symposium on Upgrading the Fire Safety of Operating Nuclear

Power Plants (17-21 November), both held in Vienna. The Agency also supported an International Conference on The Radiological Accident in Goiânia — Ten Years Later, organized by the Brazilian Nuclear Energy Commission and held in Goiânia in October.

The Agency is increasingly using electronic means of disseminating information. In 1997 the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (Safety Series No. 115) were issued on diskette as a Windows-based PC application. The program gives users access to the complete text of the Standards, enhanced with menu, search, index and cross-referencing functions. Two major new areas were added to the IAEA's Worldatom web site in 1997, providing information on the Agency's work in nuclear safety (http://www.iaea.or.at/ns/nusafe/) and radiation and waste safety (http://www.iaea.or.at/ns/rasanet/).

The Incident Reporting System (IRS), operated jointly by the IAEA and the NEA/OECD, provides a valuable tool in the exchange of information on safety significant events, their causes and lessons learned. Participants at the annual meeting of IRS co-ordinators in May 1997 noted that about one-third of the events being reported were recurrent events, and that this suggested that feedback of operational safety experience was not as effective as might be hoped. They therefore proposed that more attention be given to monitoring how, and to what extent, lessons learned are being acted upon. Analysis of events in the IRS is also used to identify subjects for topical studies; three such reports were issued in 1997, on human factors analysis, foreign material intrusion, and corrosion, erosion and sedimentation.

The Incident Reporting System for Research Reactors (IRSRR) was launched in mid-1997, and all Member States operating research reactors were invited to participate. The IRSRR is similar in character to, and compatible with, the existing IRS for nuclear power plants. It is expected that the database established by the IRSRR will prove to be a valuable service to the research reactor community worldwide. By the end of 1997, 13 Member States had notified the Agency of their participation in the IRSRR: Argentina, Austria, Brazil, Canada, Chile, Egypt, Finland, France, Hungary, Pakistan, Slovenia, Tunisia and Turkey.

Education and Training

Education and training are essential elements in the safe use of radiation, radioactive materials and nuclear technology. Pursuant to General Conference resolution GC(XXXV)/RES/552, the Agency supports, through its Technical Co-operation programme, regional and interregional educational courses covering a broad range of nuclear, radiation and waste safety issues, and specialized training courses and workshops on more specific subjects. A full list of Agency-sponsored regional and interregional courses can be found in the Annual Report. In addition, the Agency also arranges local Training Courses and Workshops on specific subjects as part of its assistance and services to Member States.

Six interregional courses were held in 1997, on safe transport (held in the USA), emergency preparedness (USA), operational nuclear safety (USA), prevention and management of accidents in nuclear power plants (USA/Canada), management of reactor ageing (Canada/USA) and safety assessment for near surface repositories (Spain). The Post-Graduate Regional Training Course in Radiation Protection and Nuclear Safety (in Spanish), held in Buenos Aires, Argentina, from April to November 1997 was the 20th such course. Regional Basic Professional Training Courses in Radiation Protection were held in the Syrian Arab Republic — the first time that such a course has been held in Arabic — and in Germany (in English). A number of Regional Seminars were held on a range of basic safety infrastructure issues in connection with the Model Project on "Upgrading Radiation and Waste Safety Infrastructure" (see above), and a number of Regional Training Courses and Workshops on regulatory, inspection and licensing issues were held as part of the European Regional Project "Nuclear Safety Regulatory and Legislative Infrastructure".

Review and Assessment Services

Safety Services for Nuclear Installations

The Agency has for many years offered a range of services related to the safety of nuclear installations, provided on request to Member States; a comprehensive list of the missions and seminars carried out in 1997 is given in the IAEA's Annual Report, and some examples are described below. In addition to the development of the Integrated Strategy on nuclear safety infrastructure (see above), actions are under way to improve the integration of the different services provided by the Agency: specifically the Operational Safety Review Team (OSART), Assessment of Safety Significant Events Team (ASSET) and Assessment of Safety Culture in Organizations Team (ASCOT) services. Attention is also being given to improving the co-ordination of the Agency's services with the work of other international organizations in similar areas, such as WANO's peer reviews.

An OSART mission visited Qinshan, China — a 300 MW(e) prototype PWR — in January 1997 at the request of the Chinese Government. Two OSART missions had visited Qinshan during construction of the reactor; this was the first during operation. The purpose of the mission — which included experts from nine Member States — was to review operating practices in the areas of management organization and administration, training and qualification, operations, maintenance, technical support, radiation protection, chemistry and emergency planning. The mission reported a commitment to improving operations, and specific recommendations were made in the areas of safety culture, communication, training, equipment maintenance and configuration management. Other OSART missions in 1997 visited Laguna Verde, Mexico, Yong Gwang, Republic of Korea, and Embalse, Argentina. Preparatory visits for four future OSART missions were also carried out, and an OSART follow-up mission visited Ignalina, Lithuania.

At the request of the Bulgarian Government, an International Regulatory Review Team (IRRT), including experts from five Member States, visited Sofia, Bulgaria, in November 1997. The purpose of the mission was to review the effectiveness of the Committee for the Use of Atomic Energy for Peaceful Purposes and to exchange information concerning the role and responsibilities of the regulatory body, organization of the regulatory body, regulations and guides, the licensing process, requirements on applicants and licensees, review and assessment during the licensing process, regulatory inspection and enforcement, and radiation protection. As part of the mission, two members of the team visited Kozloduy nuclear power plant. Specific recommendations were made both on the regulation of operation and modernization at Kozloduy and on particular aspects of the Bulgarian regulatory regime in general. A pre-IRRT mission to Pakistan was also conducted during 1997.

In March 1997, a mission of the International Peer Review Service (IPERS) for probabilistic safety analysis (PSA) visited Taejon, Republic of Korea, to review the PSA for Ulchin Units 3 and 4. The PSA had been carried out by two Korean organizations, and a pre-review meeting had been held in October 1996 in Vienna to identify documentation requirements and to formulate preliminary lists of issues for the review proper. The main review was carried out in the form of a workshop involving participants from the Korean PSA team and the international mission team. The scope of the review included Level 1 and Level 2 PSAs and human reliability analysis but, because a separate review was addressing the treatment of external events, the IPERS review concentrated on the internal events PSA. Other IPERS missions concerned the HIFAR (High Flux Australian Reactor) at Lucas Heights, near Sydney, Australia — the first time IPERS has been applied to a research reactor PSA — and the nuclear power plants at Kozloduy (Units 3 and 4) in Bulgaria and Krško in Slovenia.

Other services provided in 1997 included four missions of the Integrated Safety Assessment of Research Reactors (INSARR) service, four ASSET peer review missions and seven ASSET training seminars on self assessment, one ASCOT seminar, and a total of 13 missions providing engineering safety review of site, structural and seismic safety issues: ten to reactor sites and three to other nuclear installations.

Radiological Assessments

The Agency has in recent years carried out a number of radiological assessments of areas with radioactive residues from accidents and from past practices such as nuclear weapon testing and radioactive waste disposal.

The International Arctic Seas Assessment Project (IASAP) was initiated in 1993 to investigate concerns over the potential health and environmental impacts of radioactive waste dumped in shallow waters of the Kara and Barents Seas. The findings of this project were described in the previous Nuclear Safety Review, and were submitted to the Contracting Parties of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Convention 1972). The full report will be published in 1998.

In 1994, at the request of the Government of Kazakhstan, the Agency initiated a radiological assessment of the former nuclear test site near the city of Semipalatinsk. Following missions to the site and surrounding area, the expert group assembled by the Agency has prepared a report on the current radiological situation which was submitted to the Kazakh Government in 1997 and will be published in 1998. The group concluded that further radiological assessment of the area surrounding the test site should not be regarded as a priority, although they recommended a hydrological study to investigate the future possibility of radionuclides from underground explosions appearing in drinking water supplies. Within the test site, the group concluded that most areas have little or no residual activity from the nuclear tests. However, two areas — the 'Ground Zero' and Lake Balapan areas — are heavily contaminated, and an assessment of the exposure of a critical group of site inhabitants who visit these areas on a daily basis indicates annual exposures of about 14 mSv, predominantly from external radiation. There are currently no permanent settlements within these areas; if permanent settlements were established there in the future, the estimated annual exposures would be an order of magnitude higher. Action is therefore considered necessary for the immediate areas around 'Ground Zero' and Lake Balapan, and restriction of public access to these areas is recommended as the most feasible and effective protective action.

In 1995, the Agency — at the request of the Government of the Marshall Islands — convened an expert group to review the radiological situation and prospects for resettlement at Bikini Atoll, which was used by the USA for atmospheric testing of nuclear weapons. The group concluded that there were feasible remedial measures that would allow Bikini to be reinhabited, and recommended a preferred strategy: removal of the soil from living areas, and treatment of the remaining soil with potassium based fertilizers to reduce the uptake by crops of radioactive isotopes of caesium. The group's report was presented to the Marshall Islands Government. At the request of the Government, and to provide further assurance to the Bikini people, an Agency mission visited the island in May 1997 and carried out independent monitoring of the environment and foodstuffs. The results obtained by the IAEA team were generally consistent with those from previous monitoring programmes that were used as a basis for the advisory group's assessment.

At the request of the French Government, the Agency initiated in 1996 an international assessment of the radiological situation at Mururoa and Fangataufa Atolls, the site of French nuclear weapon testing in the South Pacific. The studies were completed during 1997, and a report of the assessment is being prepared for publication in 1998. A summary of the principal findings can be found in GC(42)/INF/3.

Safety Related Research and Development

The Agency encourages research and development by supporting research contracts and agreements on a wide range of safety related subjects; at the end of 1997, there were almost 300 such contracts and agreements active, granted mostly under one of 24 Co-ordinated

Research Projects (CRPs) on particular aspects of nuclear, radiation and waste safety. A complete list of the active CRPs is given in the IAEA's Annual Report.

PART III

NUCLEAR, RADIATION AND WASTE SAFETY IN MEMBER STATES

Information on significant achievements, developments and issues related to nuclear, radiation and waste safety was requested from Member States in November 1997. This review, prepared by the Agency Secretariat, summarizes a selection of the information provided by 27 Member States, namely Australia, Belarus, Belgium, Bulgaria, China, Finland, France, Germany, Greece, India, Indonesia, Ireland, Jordan, Malaysia, Norway, Peru, the Philippines, the Russian Federation, Slovakia, Slovenia, Spain, Sweden, The Former Yugoslav Republic of Macedonia, Tunisia, Turkey, the United Kingdom and the United States of America.

SAFETY LEGISLATION

Several Member States reported progress on the development of fundamental national legislation governing the use of atomic energy, radiation sources and radioactive materials, to reflect current international standards:

- In Belarus, the Chamber of Representatives of the National Assembly adopted a law on "the national safety of the population", the scope of which includes safety regulation by the State, action to be taken in the event of a radiation accident, the responsibility of users of radiation sources for the consequences of their use, and the obligations and rights of citizens with regard to medical exposure and exposure to radon. A draft law on "the use of atomic energy and radiation protection" has been submitted to the Chamber of Representatives for consideration, and the Ministry of Health is close to completing a set of standards for nuclear safety.
- Germany reported that it is preparing extensive amendments to the Radiation Protection Ordinance to include the 1996 Euratom Basic Safety Standards. European Union Member States have until May 2000 to incorporate the Standards into national legislation.
- The Indonesian Government passed a new nuclear energy Act which, inter alia, ensures the independence of the regulatory body from bodies promoting nuclear energy and provides more detail than previous legislation in the areas of radioactive waste management and nuclear liability.
- A new Law on Peaceful Uses of Nuclear Energy was endorsed by the Government of Slovakia, and has been submitted to the Slovak Parliament. New regulations on the transport of nuclear material and radioactive waste, emergency planning and quality assurance are being prepared.

- A 'working version' of a law on protection from ionizing radiation and on nuclear safety has been prepared in The Former Yugoslav Republic of Macedonia. This will be submitted for comment to relevant institutions, and a draft law prepared.
- Tunisia's National Radiation Protection Centre (CNRP) reported on its work with the Ministry of Transport on the drafting of a law on the land transport of dangerous goods, including radioactive substances.

CONVENTIONS AND AGREEMENTS

Several Member States reported their involvement in the development of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

There was continued progress in Europe on a growing network of bilateral intergovernmental agreements on early notification of nuclear accidents, and on exchange of information and co-operation in the fields of nuclear safety and radiological protection. Finland reported that one such agreement, with Ukraine, was ratified by the Finnish Government in 1997.

STRUCTURAL AND ORGANIZATIONAL DEVELOPMENTS

Some Member States described structural or organizational changes to operators and/or regulators that were considered to be significant for safety:

- The formation was announced in September 1997 of the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). The new Agency will be the regulatory body for all radiation and nuclear activities carried out by Australian Federal Government agencies, including the operation of the two research reactors of the Australian Nuclear Science and Technology Organisation and the land transport of Federally owned radioactive material. ARPANSA will also work with the States and Territories — which regulate other radiation and nuclear activities — to promote uniform policies and practices.
- Some sections of the 1994 Belgian law to create a Federal Nuclear Control Agency came into force in 1997, relating to the appointment of an administrative board and a Director General. The Agency will begin operation in 1998, its first task being to integrate the nuclear control services currently provided by different ministries.
- The decree on STUK (the Finnish Radiation and Nuclear Safety Authority) was revised to allow management changes.
- Responsibility for the safety of radioactive material shipments in France was transferred to the Directorate for the Safety of Nuclear Installations (DSIN).

- A Common Federal Programme for Nuclear and Radiation Safety in Russia is being developed by the Ministry for Atomic Energy and other federal bodies. This will be an amalgamation of all existing programmes on nuclear and radiation safety in the Russian Federation.
- The former Yugoslav Republic of Macedonia is proposing to strengthen the role of the Sanitary and Health Inspectorate of the Department for Radiation Protection at the Republic Institute for Health Protection, Skopje, to act as the national regulatory body for radiation protection. A register of radiation sources is being prepared by this Inspectorate.

SAFETY ASSESSMENT

India reported on its use of computer codes to estimate the safety margins provided by BWR containment made of reinforced and prestressed concrete under a range of loads.

Level 1, level 2 and shutdown PSAs (probabilistic safety analyses) for the Krško NPP in Slovenia have been carried out at the request of the regulatory body, the first two performed by an IAEA IPERS mission and the third by an independent technical support organization. Measures are being taken to address issues identified by the analyses, particularly to address the risks associated with fire.

The Safety Analysis Report for the TR-2 research reactor at Cekmece in Turkey was reviewed and revised by the Turkish Atomic Energy Authority, in the light of current international standards and guidance.

The United States Nuclear Regulatory Commission (NRC) finalized guidance on the use of risk information from PSA in making changes to the design or operation of plants.

OPERATION — SAFETY REVIEWS AND UPGRADES

Safety reviews and upgrades were being carried out at nuclear facilities in several countries:

- The BR2 reactor, operated by the Belgian nuclear research organization CEN·SCK, was restarted after a two-year refurbishment programme which included upgrading of the protection system and inspection of the reactor vessel.
- A short term programme of measures to improve the safety of Kozloduy Units 1–4 in Bulgaria has been completed. Proposals for a longer term programme of measures to ensure the safety of these units for the rest of their operational lives have been submitted to the regulatory authority. Safety improvements were also made to Units 5 and 6.
- France reported on generic safety issues in EDF's series of 900 MW(e) and 1300 MW(e) PWRs. The problem with the 900 MW(e) stations — thermal cracking of auxiliary piping in the primary circuits — is being addressed by strict control

programmes to ensure any cracking is detected quickly, and EDF now seems able to deal well with the problems in the 1300 MW(e) plants, namely anomalies in the operation of control rod clusters. A number of human related operational incidents were also reported.

- Following recent problems in other countries with BWR core shrouds cracking, India reported that examination of the core shroud at Tarapur NPP had indicated that there were no cracks. Nevertheless, a detailed analysis had been carried out to ensure that the safety margins were sufficient to cope adequately should cracks develop.
- A safety upgrading programme for Bohunice Units 1 and 2 in Slovakia is continuing. A short term safety improvement programme at Units 3 and 4 — requested by the regulatory body following a comprehensive review in 1995 — is about one-third complete. The most important category of safety upgrading measures at the Mochovce NPP is expected to be completed in time to allow fuel loading in mid-1998.
- Replacement steam generators for the Krško NPP in Slovenia are currently being manufactured, and evaluation of the safety aspects of the replacement operation has started.
- A programme to replace the steam generators at Almaraz and Ascó NPPs in Spain was completed. A two-year programme "Analysis of Operating Experience and Systems", to detect and correct possible design deficiencies in the Trillo NPP, was also completed in 1997.
- The Swedish spent fuel storage facility CLAB became the first non-reactor facility in Sweden to undergo an As Operated Safety Assessment Review (due after ten years of operation). The Swedish nuclear regulators SKI have indicated to licensees that they will require improvements in safety levels at NPPs if they are to license prolonged operation.
- Periodic Safety Reviews were conducted by the United Kingdom Nuclear Installations Inspectorate (NII) on four NPPs. The Magnox NPPs at Calder Hall and Chapelcross have been operating for approximately 40 years, and the Advanced Gas-cooled Reactors (AGRs) at Hinkley Point B and Hunterston B were approaching 20 years of operation. In each case, the NII was satisfied that operation could continue for the next ten years; in the case of the older reactors, however, this is subject to annual review of pressure circuit integrity and the results of routine regulatory inspections.
- The United States Nuclear Regulatory Commission (NRC) has reviewed 74 individual plant examinations (IPEs) related to reactor safety and plant performance. The NRC will determine the necessary follow-up actions at the plants concerned, and a report of the findings will be published in 1998.

REGULATION

New or revised safety regulations and guides, on a range of subjects, were reported to have been published in several countries, for example:

- Bulgaria has issued a large number of regulations and guides, including basic rules and procedures for licensing and instructions for regulatory inspectors.
- China issued clearance levels for steel and aluminium, and standards for radioactive waste casks and for measuring radioactive waste and analysing leachate.
- Finland issued a number of new or revised regulatory guides on, inter alia, generators and electrical systems at NPPs and assessing dispersion of, and doses from, radioactive material released into the environment.
- Radiation safety regulations in Peru have been revised, bringing them into line with the ICRP's 1990 Recommendations and the International Basic Safety Standards.
- The Russian Federation's Ministry for Atomic Energy and Federal Nuclear and Radiation Safety Authority, along with other federal bodies, are preparing regulations on the safe transport of radioactive substances. Meanwhile, work is continuing to bring radiation safety standards in the Russian Federation into line with the International Basic Safety Standards.
- SKI, the Swedish nuclear regulatory body, issued draft regulations on Safety in Nuclear Facilities, containing requirements related to reactor safety, waste management, physical protection and on-site emergency management. SKI has also drafted a document defining the basis for future regulations on the disposal of spent fuel and nuclear waste. Both documents have been issued for review, with the intention that regulations will come into force at the beginning of 1999.
- The Turkish nuclear regulatory body TAEK has accelerated its preparation of regulations in the light of the Government's decision to proceed with a nuclear power programme. Three safety related Codes of Practice were issued in 1997, covering quality assurance and inspection, safe transport of radioactive materials, and the establishment of an Advisory Committee on Nuclear Safety, which will examine licence applications and proposed regulations and guidance.

Elsewhere, France reported a developing programme of inspector exchanges with counterparts in other countries, allowing inspectors to broaden their experience, and a new evaluation procedure to identify "experienced" inspectors for more delicate tasks. The Malaysian Atomic Energy Licensing Board has developed an interactive home page on the World Wide Web (http://www.jaring.my/aelb/) to enable users, including licensees, to communicate electronically with the Board. A final rule on licence renewal came into force in the USA in January 1997, and guidance for applicants is being developed by the NRC. The NRC is also working towards design certification for next-generation NPPs.

RADIATION EXPOSURE

Following expressions of concern in the media in France, the regulatory authorities requested information from the nuclear power plant operator EDF about the exposure of contract workers carrying out maintenance work on its plants. Investigations also continued into the question of whether the reprocessing plant operated by COGEMA at La Hague could be responsible for an increased incidence of leukaemia in the nearby north Cotentin area; a Government-appointed committee has divided into two sub-committees to examine the epidemiological and radioecological information.

The National Radiological Protection Institute of Ireland published the results of the second phase of its National Radon Survey, covering 14 counties (the final phase — a further seven counties — is due for completion in 1998). Mean annual indoor radon concentrations for the second phase ranged from 63 to 147 Bq/m^3, with some values above 1000 Bq/m^3 recorded.

The Philippines has introduced a new thermoluminscence dosimetry (TLD) system for personnel monitoring, replacing the existing film-based system.

Spain reported that all individual worker doses in 1997 were well below the existing limit of 50 mSv, and only 71 workers (0.09% of those monitored) received more than 20 mSv, indicating good progress towards complying with the 20 mSv dose limit in the Euratom Directive on basic safety standards, which comes into force in 2000.

WASTE MANAGEMENT AND DECOMMISSIONING SAFETY

Existing waste storage and disposal facilities continued to operate without significant radiological incident, although shipments of high level waste (HLW) to the Gorleben storage facility in Germany continued to attract large scale (sometimes violent) demonstrations. Meanwhile, work continued in a number of countries to develop new disposal facilities for radioactive waste. For example:

- Licensing of the Konrad repository for non-heat-generating waste in Lower Saxony, Germany, is in an advanced state; approval for construction to proceed was expected in late 1997 or early 1998. Meanwhile, investigations continue into the potential suitability of the Gorleben salt dome for a spent fuel/high level waste repository.
- A construction licence for a repository for low and intermediate level waste at Himdalen, Norway, has been granted. Construction will be completed in 1998.

In Belarus, the upgrading and certification of 69 'Chernobyl repositories' — the near surface facilities used for the disposal of waste generated in the post-Chernobyl cleanup operation — was completed. A project to improve the safety of the Novi Han repository in Bulgaria has begun, with IAEA assistance.

In Belgium, the Government programme framework act of December 1997 gave the national waste management organization ONDRAF·NIRAS the task of establishing an inventory of all nuclear facilities and all sites containing radioactive substances. This task also includes estimating the decommissioning and cleanup costs for each site and assessing the adequacy of existing provisions to meet these costs. The inventory will be updated every five years.

The construction of liquid waste treatment facilities in the north-western and far eastern regions of the Russian Federation (expected to be commissioned early in 1998) will allow the practice of discharging liquid waste into open water bodies to be stopped.

Spent fuel from the decommissioning of the A-1 NPP in Slovakia is being sent to the Russian Federation under a newly revised agreement. Some of the spent WWER fuel stored on the Bohunice site came from reactors now in the Czech Republic; this fuel has now been transferred to Dukovany. A new drainage system was installed at the Mochovce near surface disposal facility, as required by the regulatory body.

Tunisia reported the organization of two training courses — one national and one regional — on radioactive waste management in hospitals.

In the USA, the NRC adopted radiation protection standards for licence termination at decommissioned facilities (see Part I). The NRC reached agreement with the Department of Energy on a performance-based approach to resolving issues of greatest safety significance for the proposed Yucca Mountain repository for high level waste, and on a number of specific methodological issues related to the safety assessment.

EMERGENCY PLANNING AND PREPAREDNESS

Belgium reported on progress in the development of infrastructure for the national emergency plan. A study carried out by CEN·SCK and the nuclear inspection agency AIB Vinçotte Nucléaire has identified the priority areas for the coming years.

Bulgaria commissioned a nationwide network of 26 gamma monitoring stations providing continuous measurement of dose rates. A specially equipped mobile radiometry and gamma spectrometry laboratory for use in the event of radiation emergencies was also commissioned.

The Philippines has completed a revision of its National Radiological Emergency and Preparedness Plan (RADPLAN). The RADPLAN arrangements are designed to be applicable to any type of radiological accident or emergency, including events outside the Philippines having a potential impact on the Philippine population or environment.

Slovenia's early warning radiation monitoring system — started in 1991 and subsequently upgraded — fed its first results into the international data exchange EURDEP at the EC's Joint Research Centre at Ispra, Italy. Results are also displayed on the World Wide Web (http://www.sigov.si/cgi-bin/spl/ursjv/intranet/functiona.html).

PART IV

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. Many of the issues discussed in this section will be addressed further at an International Conference on Topical Issues in Nuclear, Radiation and Radioactive Waste Safety, to be held in Vienna from 31 August–4 September 1998.

CHRONIC EXPOSURES TO RADIATION

As reported in the previous Nuclear Safety Review, the pursuit of radiological criteria for the rehabilitation of areas affected by residual radioactivity from past practices, and for other chronic exposure situations, has raised a number of questions about the system of protection enshrined in the 1990 Recommendations of the International Commission on Radiological Protection (ICRP) and in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources. For example, the principles for intervening in the event of a nuclear accident are well established, but the criteria for determining when an intervention situation can be considered to have returned to 'normal' are less well developed. These latter situations can often, quite reasonably, be compared to those in areas of high natural background radiation, where quite different standards seem to be applied. Another area of confusion arises from the fact that the existing system of protection concentrates largely on the increment of dose added by a practice or averted by an intervention, with relatively little attention being given to the total dose.

An Agency discussion document entitled "Application of Radiation Protection Principles to the Cleanup of Contaminated Areas — Interim Report for Comment" will be published early in 1998 and, as noted in Part II, a number of reports on radiological assessments of such areas are also due to be published in 1998. The ICRP has established a Task Group that is preparing a document covering the whole range of chronic exposure situations. Clearly this is an area where the principles will continue to develop in the coming years.

REGULATING LOW DOSES OF RADIATION

This issue is a matter of perennial interest, but has been particularly prominent of late. At one level, there has been renewed debate as to whether the fundamental basis for the regulation of low doses — the linear–no threshold (LNT) hypothesis — is valid. At another, the practical issues of managing low dose activities within the existing radiation protection framework continued to cause much discussion.

The LNT hypothesis of radiation risk, on which modern radiation protection philosophy is based, has come under attack in the past few years from both sides of the argument. Many individuals and some organizations — notably the French National Academy of Science and the US Health Physics Society — have argued in favour of a threshold below which individual doses should not be considered for radiation protection purposes. Some have argued this as a matter of principle, claiming radiobiological and/or epidemiological evidence that there are no adverse health effects from low doses; others suggest it as a pragmatic approach in the absence of direct evidence for such effects. Meanwhile, some researchers have interpreted experimental results and epidemiological findings as providing evidence that low doses of radiation are much more harmful than the LNT hypothesis implies. A number of mechanisms have been proposed by which this might occur, a recent example being the phenomenon of genomic instability. The renewed debate on the subject was evidenced by the number of national and international conferences and symposia at which the matter was discussed, culminating in an international conference in Seville, Spain in November 1997, sponsored by the IAEA and the World Health Organization, in co-operation with the United Nations Scientific Committee on the Effects of Atomic Radiation. Among other things, the Conference highlighted areas of radiobiological and epidemiological research that are likely to provide important new information on the effects of low doses in the coming years; there was particular optimism concerning epidemiological studies of workers and members of the public in and around the Mayak facility in the Russian Federation. From the evidence available at the present time, however, the LNT hypothesis continues to seem the most radiobiologically defensible basis for radiation protection recommendations. It is also a workable hypothesis that can underpin systems of regulation which, when applied reasonably, provide sound and sensible management of the risks from radiation.

A related issue, that of exclusion and exemption (along with the related concept of clearance) continued to attract much discussion, particularly in European Union countries, where the exemption levels specified in the Euratom Directive on Basic Safety Standards — which are numerically the same as those specified in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources — will soon become mandatory (Member States have until May 2000 to implement the Directive in national legislation). A series of incidents in which slightly radioactive materials were transported from one State to another showed the potential for controversy. An international Specialists' Meeting at the IAEA in May 1997 highlighted many of the issues that remain to be resolved, the question of terminology being among the most prominent. International agreement on these issues is very important, as the purpose of exemption and clearance is to allow the free use of materials that do not warrant regulation. This cannot happen if material considered exempt in one State is regarded as a significant radiological hazard in another.

MANAGEMENT OF SAFETY AT NUCLEAR INSTALLATIONS

A number of the main events related to nuclear safety in 1997 suggested a common theme of deficiencies in the management of operational safety, even in States with long established nuclear programmes. The specific problems and their direct causes differed from case to case, but the underlying causes seemed to be consistently linked to the absence of key elements of safety culture. Different possible reasons for this have been postulated — complacency bred by past successes, cost cutting in a competitive energy market and authoritarian management, among others — but whatever the reasons there is significant room for improvement.

The principles of safety are well known and widely implemented. To go beyond the present level of nuclear safety, management of safety and safety culture will be the means for achieving progress. This means a commitment to safety from the top management down, a working environment in which communication is encouraged, staff concerns are listened to, and warning signs are noticed and acted upon. It also means constant vigilance to ensure that good safety performance is maintained, and is not taken for granted. Peer reviews can help in this regard, as can a continuing programme of self assessment. Regulatory inspection and enforcement are, of course, essential elements for monitoring safety at nuclear installations, but the primary responsibility for safety rests with the operating organization.

SAFETY OF RADIATION SOURCES AND SECURITY OF RADIOACTIVE MATERIALS

The possibility of illicit trafficking in nuclear materials has attracted great interest. While the interest started because of reports of nuclear material smuggling, it is also recognized that more mundane failures in the security of radiation sources and radioactive materials represent a substantial risk to human health. Incidents involving lost, abandoned or stolen radiation sources continue to occur.

Numerous incidents have occurred in recent years — particularly since 1992 — involving the illegal procurement and movement across national borders of nuclear materials and other radioactive sources. The vast majority of cases detected involved very small quantities of radioactive material, but in some incidents highly active sources emitting dangerous radiation levels were found. A frequent problem of particular importance is contamination of scrap metal due to careless or fraudulent disposal of industrial or medical radiation sources. Concerns remains as to whether larger scale trafficking, perhaps even involving weapon grade materials, is a real possibility. Many European States have taken action to improve their ability to prevent or detect such actions, and to ensure that any incidents that occur are handled in such a way that staff involved — principally customs and law enforcement officers — and the public are not put at risk.

Meanwhile, incidents continue to occur around the world in which radiation sources being used for medical, industrial and military applications are lost, abandoned, damaged,

stolen, misused, etc; sometimes with serious or even fatal consequences. For example, Table II shows fatal radiation accidents — in nuclear facilities and non-nuclear industry, research and medicine — reported in the past ten years; the number of accidents involving significant radiation exposure is several times greater. Improvements recommended and implemented on an ad hoc basis — typically after an incident has occurred — are being supplemented by a more systematic programme of improvements to regulatory control systems for sources (see discussion on Model Project "Upgrading Radiation and Waste Safety Infrastructure" in Part II). Nevertheless, further improvements and continued vigilance are needed to minimize the number and severity of such incidents.

An International Conference on the Safety of Radiation Sources and the Security of Radioactive Materials — co-sponsored by the IAEA, the European Commission, Interpol and the World Customs Organization — will be held in Dijon, France, from 14–18 September 1998, and will cover both of the areas of 'security' discussed above.

TABLE II. RECENT FATAL RADIATION ACCIDENTS (1987–1997)[a]

			Fatalities caused by radiation exposure		
Year	**Location**	**Type of source**	**Workers**	**Public**	**Patients**
1987	Goiânia, Brazil	Removed teletherapy source		4	
1989	San Salvador, El Salvador	Industrial sterilizer	1		
1990	Zaragoza, Spain	Radiotherapy accelerator			several[b]
1990	Soreq, Israel	Industrial sterilizer	1		
1991	Nesvizh, Belarus	Industrial sterilizer	1		
1992	China	Lost ^{60}Co source		3	
1992	USA	Brachytherapy			1
1994	Tammiku, Estonia	Source removed from waste repository		1	
1996	San José, Costa Rica	Radiotherapy			several[b]
1997	Sarov, Russian Federation	Critical assembly	1		

[a] In nuclear facilities and non-nuclear industry, research and medicine.

[b] The individuals affected in these cases were patients receiving radiotherapy for cancer, and therefore the number of deaths attributable to overexposure is not known. The numbers of patients overexposed were 26 (Zaragoza) and 115 (San José). In each case, overexposure is considered likely to have been a direct or major cause of several deaths.

COMMUNICATING NUCLEAR, RADIATION AND WASTE SAFETY ISSUES

Proponents and opponents of the use of nuclear technologies both devote considerable attention to communicating with decision-makers, opinion-formers, the media and the general public in order to convey their 'message'. The communication challenge for regulatory authorities and their technical support organizations is somewhat less straightforward. They have a responsibility to communicate with a wide range of audiences in such a way that unfounded fears are allayed, but real risks, concerns or problems are not understated. Furthermore, this needs to be achieved both on a routine, day-to-day basis and in circumstances of a real or perceived crisis. This need to provide accurate and timely information on nuclear, radiation, transport and waste safety issues, in a form that the relevant

audience(s) can readily understand, applies to regulatory organizations in all States, not only those with nuclear power programmes.

To help authorities in this task, the Agency is preparing a document, provisionally entitled "Communication of Nuclear, Radiation, Transport and Waste Safety: A Practical Handbook". It is intended that this document will serve as both a practical guide for regulators and the basis for material on safety related communication in training courses. It may also be used as a basis for future documents in this topic area.

THE CONVENTION ON NUCLEAR SAFETY — NATIONAL REPORTS, INTERNATIONAL SCRUTINY

An Organizational Meeting of the Contracting Parties to the Convention on Nuclear Safety is scheduled for 29 September–2 October 1998 in Vienna. The starting date of this meeting is also the deadline for Contracting Parties to submit national reports for discussion at the first Review Meeting of the Convention, which will begin on 12 April 1999. The international scrutiny of these detailed national reports is a novel and important feature of the Convention. Each report will describe the measures taken by the Contracting Party to fulfil the nuclear safety obligations set out in the text of the Convention. The national reports will be circulated to all of the Contracting Parties, who then have the opportunity to submit comments and questions. At the Review Meeting, each report — along with comments and questions submitted in advance by other Contracting Parties — will be reviewed by one of five Country Groups, who will then report their conclusions back to a plenary session of the Meeting. The main tasks of the Organizational Meeting will include the establishment of these Country Groups — by a pseudo-random process designed to ensure that each Group has a mixture of nuclear experience — and the selection of co-ordinators, rapporteurs and working language for each Group.

Many of the Contracting Parties are known to already be in the process of preparing national reports, and some regional groups have emerged, exchanging views and experience on the preparation process.

The meeting of Contracting Parties to the Convention on Nuclear Safety will result in a degree of transparency in safety matters that will be substantially higher than has existed in the past. While the conclusion is likely to be that, in general, nuclear safety has improved worldwide, the Parties will probably focus on some areas that require further attention.

Contracting Parties are likely to address situations where the independence of regulatory authorities is in question or the authorities have not effectively discharged their licensing duties. Openness in the exchange of information on safety issues and operating events is also a likely area for discussion. Contracting Parties that have not been open to international reviews, will be faced with increased scepticism about the safety of their nuclear activities. Overall, an increase in international activities and transparency will be necessary if concerns about the level of safety actually being achieved are to be counteracted.

TRANSBOUNDARY MOVEMENT OF RADIOACTIVE MATERIALS

As was noted in Part I the transport of radioactive materials, and radioactive waste in particular, has attracted considerable attention. Shipments that had been operating routinely in the past have been increasingly highlighted by pressure groups, and have attracted increased expressions of concern from some States along the route. Some have raised their concerns at international forums, such as the International Maritime Organization, the Diplomatic Conference on the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, and the IAEA's General Conference and Board of Governors. Both the Diplomatic Conference and the IAEA General Conference adopted resolutions on the issue; the latter requested the Agency "to prepare ... a report on legally binding and non-binding international instruments and regulations concerning the safe transport of radioactive materials and their implementation". The IAEA Secretariat has begun work on such a report, and is also taking the lead — as part of an informal working group with the IMO and the United Nations Environment Programme (UNEP) — in carrying out a literature review on the potential consequences of severe maritime accident scenarios involving shipments of irradiated nuclear fuel, high level waste and plutonium.

Some States have raised questions of safety and emergency preparedness; for example, a Joint Declaration on the Transport of Radioactive Waste issued by the Governments of Argentina, Brazil, Chile and Uruguay (reproduced in the Attachment to INFCIRC/533) declared, inter alia, "their grave concern at the risks associated with the transit through the region [of the Cape Horn route] of ships transporting radioactive waste". However, the focus of concerns has often been more on issues such as prior notification of shipments and consent of transited States. The present indications are that these issues must be resolved internationally so that the rights of shipping States and transit States reach an appropriate balance.

ECONOMIC DEREGULATION OF ENERGY MARKETS

National energy markets are increasingly being opened up to competition between generators, bringing a greater degree of privatization of operating organizations. In some States, this is already a reality, and there are strong indications that it will spread to many others in the near future. This process imposes new pressures on operators to cut costs — and often, therefore, to cut staff numbers — and to find more efficient working practices. It is incumbent on regulators and operators alike to ensure that the measures through which nuclear operators strive to compete do not lead to safety being compromised. As indicated in Part I, regulators are increasingly aware that this is an issue that needs to be addressed, and that vigilance is needed to detect, and if necessary reverse, any negative trends in safety performance.