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INTERNATIONAL ATOMIC ENERGY AGENCY

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GUATEMALA	NORWAY	
	PAKISTAN	
	PANAMA	

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

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5. Further information on the Agency’s activities can be obtained from the Division of Public Information and from the Agency’s Internet home page (<http://www.iaea.or.at>) on the World Wide Web.

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PREFACE

The Agency's approved 1996 programme was implemented for the most part as planned. Additionally, with the assistance of extrabudgetary funding, the Agency responded to unanticipated requirements such as the radiological assessments of nuclear test sites and the provision of advice on physical protection.

Progress was made in important areas including extension of the model project concept in technical co-operation, the introduction of measures for the strengthening of safeguards and the implementation of new procedures for the preparation and review of safety standards. Advances took place in the negotiation of new legal instruments relating to nuclear safety, the safety of spent fuel and waste management, liability and safeguards.

An Integrated Approach to Technical Co-operation

Recent initiatives such as model projects, country programme frameworks (CPFs) and thematic/sectoral planning became increasingly central to technical co-operation activities in 1996. An additional 36 model

projects were approved, many of them based on CPFs. The financial implementation of the technical co-operation programme remained at a high level, with a satisfactory balance of resources at the end of the year (equivalent to about two months of new obligations).

One of the largest ever technical co-operation projects, covering radiation and waste safety, progressed significantly during the year. This project will eventually cover some 50 developing countries and will help develop national legislation and practices in this area to an acceptable level by the year 2000 (*see Box 1*).

Nuclear Techniques and Water Resources Development

Isotope hydrology techniques, with unique capabilities for tracing and mapping water resources essential for sustainable development, were used in a recently completed project in the Moyale region in southern Ethiopia. Covering 45 000 km², this region, which has three million inhabitants and one of the largest cattle herds on the continent, depends entirely on scarce groundwater

Box 1

MODEL PROJECT ON UPGRADING RADIATION AND WASTE SAFETY INFRASTRUCTURES

The use of nuclear energy and the applications of radiation and radioactive substances have become a widespread and integral part of such diverse sectors as power generation, health care, industrial diagnostics and quality control, and research in the physical, chemical and agricultural sciences. The production, use, storage and disposal of radiation sources must be carried out in such a way that the risks to people and the environment are minimized and the appropriate national infrastructures need to be at an adequate level.

An interregional model project has adopted a new approach to upgrading radiation safety infrastructures in Member States. Action plans tailored to each Member State have been prepared, as have standardized draft texts which can serve as a basis for the formulation of national laws and regulations which are in accordance with the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (BSS). The plans include both generic and specific activities. Generic activities apply to all countries and as a first priority cover a system of notification, authorization and subsequent control of all radioactive sources, whatever their use, within the country. By the end of 1996, more than 90% of the participating countries had officially endorsed their action plans. The target is for most, if not all, participating countries to comply with the BSS by the year 2000.

resources. Isotope data were used to distinguish between renewable and non-renewable water resources, leading to better estimates of the total sustainable capacity for meeting water needs.

Eradication of the Tsetse Fly

Under a model project in Zanzibar, United Republic of Tanzania, to eradicate the tsetse fly, the last wild fly was captured in September with no detections since then. Improved techniques for the rearing of flies were passed on during the year to the tsetse production facility in Tanga, United Republic of Tanzania.

Therapeutic Applications of Radiopharmaceuticals

Priority continued to be given to the use of nuclear techniques and materials in treatment strategies against cancer. The Agency carried out a unique therapeutic clinical study to compare the use of phosphorus-32 and strontium-89 in the palliation treatment of bone pain from cancer metastases (*see Box 2*).

Moscow Summit

A Summit on Nuclear Safety and Security was held in Moscow in April. The participants — the G7 countries and the Russian Federation — stressed the importance of nuclear power as an energy source consistent with the goal of sustainable development, commitment to an international nuclear safety culture, strengthening of the Agency's safeguards system, and the need to combat trafficking in nuclear materials. The Agency provided background material for the meeting.

Nuclear Safety

The Agency's nuclear safety efforts are focused on establishing an international infrastructure with three main elements — basic binding conventions, recommended standards and advisory services, and technical assistance. Within the Secretariat, these activities became the charge of a separate Department. In addition, the various advisory groups in which Member State experts consider draft international safety standards and guides were strengthened and reorganized.

Box 2

PALLIATION OF CANCER BONE PAIN AT REDUCED COST

The primary aim of cancer treatment is to cure. This is not always achievable, especially when the disease is advanced. In such situations, the goal of treatment is to provide a certain measure of physical and mental comfort, promote self-reliance to the extent possible and preserve the dignity of the individual during the remaining period of life. Relieving pain therefore has an important place in the care of cancer patients, since pain is one of the most common symptoms in patients with advanced cancer.

Bone pain is the most usual form of pain in patients with cancer of the breast, prostate, lung, thyroid and colon which has invaded the bone. The cause is expanding lesions in the bone. Of the available treatments designed to shrink the cancer deposits in bones and relieve pain, such as chemotherapy, X ray irradiation and radiopharmaceutical administration, the last alternative is the one widely accepted as being the most effective and least toxic, especially in cases where the pain sites are numerous and widespread.

There are only a few radiopharmaceuticals which are suitable and available for clinical applications. Phosphorus-32 has been in use for some time, but strontium-89, a recent arrival on the clinical practice scene, has received wide publicity. However, it is also four to six times more expensive than phosphorus-32. This is significant, since cost is a serious obstacle to the widespread use of radiopharmaceuticals for alleviating bone pain in cancer patients, especially in developing countries.

Following an Advisory Group meeting, the Agency initiated a CRP with the specific aim of comparing the efficacy and toxicity of phosphorus-32 with that of strontium-89 in the treatment of cancer induced bone pain. This CRP, designed as a multicentre, randomized and controlled investigation, was the first therapeutic clinical study co-ordinated by the Agency and is the only one of its kind known in the world. Five countries — Austria, India, Indonesia, Slovenia and Peru — participated in this project, which involved 110 patients. The study was completed in 1996 and the results will be known in April 1997 when the final Research Co-ordination meeting is held.

Box 3**INTERNATIONAL CONFERENCE ON THE CONSEQUENCES OF THE CHERNOBYL ACCIDENT**

On the tenth anniversary of the Chernobyl accident the Agency, the European Commission and WHO co-sponsored an international conference chaired by Minister Angela Merkel of Germany to 'sum up' the results of the various assessments made and the specialized meetings held on the consequences of the accident. It attracted the participation of over 800 experts from some 70 countries. There was a consensus on the early health effects clinically attributable to radiation exposure as a result of the accident. It was also confirmed that:

- There was a significant increase in the incidence of thyroid cancer among children;
- There was no increase in the incidence of any other malignancies or hereditary effects that could be attributed to the accident;
- In the population affected by the accident there was a high incidence of psychological disorders which could not, however, be related to radiation exposure and were difficult to distinguish from effects associated with the economic and social hardship being experienced in the regions;
- No sustained severe impacts on ecosystems had so far been observed.

Officials from the affected countries reported to the conference on the severe economic, social and institutional consequences of the accident. At the technical level it was agreed that renewed attention must be paid to the 'sarcophagus' around the destroyed reactor.

Nuclear Liability Convention

The Standing Committee on Liability for Nuclear Damage reached the final stage of preparatory work on a draft protocol to amend the 1963 Vienna Convention and a draft convention on supplementary funding. At its session in October, the full texts of the two instruments were prepared and the Committee agreed to refer the texts to governments for detailed scrutiny.

Conventions on Safety

The Convention on Nuclear Safety entered into force on 24 October. While recognizing that national authorities have responsibility for the safety of nuclear power plants, the Convention lays down a number of fundamental safety principles. It also establishes a procedure under which the parties are obliged to submit reports on the safety of nuclear power plants on their territory and accept review of these reports at meetings of the Contracting Parties.

Negotiations on a convention covering the safety of spent fuel and waste management continued to make progress. The sixth session of the open ended group of legal and technical experts was held in November in Pilansberg at the invitation of the South African Government.

Operational Safety Services

The deterioration of spent fuel from research reactors is a new area of concern. In this context, a team consisting of technical experts from the Agency, France, the Russian Federation and the USA visited the Vinèa reactor near Belgrade. Two specific problems were identified that warranted prompt remedial action; a report was transmitted to the authorities concerned.

Consequences of the Chernobyl Accident

On the tenth anniversary of the Chernobyl accident the Agency, the European Commission and WHO co-sponsored an international conference to consolidate the various technical and scientific assessments that have been made over the years (*see Box 3*).

Radiological Assessments of Nuclear Test Sites

An assessment of the Semipalatinsk nuclear test site in Kazakstan provided assurance that radiation levels in villages around the site are very low. However, it was also concluded that lengthy human occupation of the test site itself would lead to unacceptably high radiation doses and the authorities of Kazakstan have been advised to take steps to clean up the site or prevent access to it. A report will be published in 1997.

Box 4**NUCLEAR SEAWATER DESALINATION**

In the 'Options Identification Programme', which was requested by a resolution of the 38th session of the General Conference and was completed in 1996, the list of available reactors was reviewed in order to identify practical options for the demonstration of seawater desalination using nuclear energy. Consideration was also given to the desalination technologies suitable for coupling to a nuclear reactor. The scheduling, infrastructure and investment requirements were taken into account.

As a result of the screening process, three options were identified as practical candidates that could be recommended for demonstration. (The details were published in IAEA-TECDOC-898, *Options Identification Programme for Demonstration of Nuclear Desalination*.) These options use well proven water cooled reactors and desalination technologies.

Option 1: Reverse osmosis (RO) desalination in combination with a medium size nuclear power reactor of a type now being constructed or at the advanced design stage.

Option 2: Reverse osmosis desalination in combination with a currently operating (preferably medium size) reactor (some minor design modifications may be required to the periphery of the existing nuclear system).

Option 3: Multi-effect distillation (MED) desalination in combination with a small reactor for capacities of up to 80 000 m³/d.

It was concluded that these demonstration options could be implemented if there is interest from investors. The investment required would be in the order of \$25–50 million for the RO options and \$200–300 million for the MED option, the latter including the cost of the reactor.

An assessment was carried out of the radiological situation on Bikini Atoll in the Marshall Islands. A final report is being prepared. Another study of conditions at the Mururoa and Fangataufa Atolls in French Polynesia was initiated. Specifically, a sampling expedition was carried out to study the spatial distribution of radionuclides; the water, biota and sediment samples taken are currently being analysed. The radioactive materials remaining in the deep geological structure and their possible transfer to the biosphere are also being studied.

Nuclear Power and Fuel Cycle

Experts from Member States and international nuclear organizations commenced preparation of key issue papers for the symposium on Nuclear Fuel Cycle and Reactor Strategy: Adjusting to New Realities, to be held in June 1997. The papers will provide background for discussions on the different options for development of the fuel cycle, the management of spent fuel and plutonium and the disposal of radioactive wastes.

Producing Potable Water Economically

The availability of potable water is an emerging issue in many Member States. A two year programme, with the aim of selecting a set of practical options for demonstration projects in seawater desalination using nuclear energy, was completed (*see Box 4*).

Demonstration of Predisposal Waste Management

Agreements were finalized for the establishment of a reference centre for demonstration of predisposal waste management methods and procedures at the Çekmece Nuclear Research and Training Centre in Turkey, and a first demonstration took place in early 1996. Participants from Albania, Greece, the Syrian Arab Republic and Turkey attended this exercise, which dealt with the collection, segregation and treatment of liquid waste, the conditioning of solid low level waste and spent sealed sources, and interim storage. A reference centre for Latin America was also established at a nuclear research establishment in Chile.

Co-operation in Radioactive Waste Management

A Contact Expert Group was formally established in 1996 under Agency auspices to harmonize and follow up on co-operative activities between the Russian Federation and other States in the field of radioactive waste management. The Group currently numbers 11 full members and 3 observers. A list of co-operative projects being implemented or planned was prepared.

Nuclear-Weapon-Free Zones

Two new treaties were signed in 1996 with a view to establishing nuclear-weapon-free zones (NWFZs) in Africa and South East Asia. Both treaties entrust the Agency with the task of verifying compliance with the peaceful use undertakings of the signatories. The Pelindaba Treaty, signed in Cairo in April, goes further than earlier NWFZ accords and the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in that it addresses issues such as prohibition of armed attack on nuclear installations and the possibility of hitherto undeclared nuclear explosive devices. In meeting the specific interests of the region, the South East Asian NWFZ treaty, signed in Bangkok in December, requires the Parties to comply not only with their non-proliferation obligations, but also with commitments in such areas as nuclear trade, nuclear safety and radioactive waste management.

Verification and Disarmament

In the USA, the Agency has been engaged since 1994 in the verification of nuclear material removed from weapon programmes. This material includes separated plutonium and high enriched uranium. At a trilateral meeting of the Russian Minister of Atomic Energy, the US Secretary of Energy and the Director General in September, it was agreed to explore the technical, legal and financial issues connected with the verification of such material in both the USA and the Russian Federation.

Comprehensive Test Ban Treaty

In September, the Comprehensive Test Ban Treaty (CTBT) was adopted by the General Assembly of the United Nations. The Preparatory Commission of the CTBT Organization (CTBTO), responsible for the verification of compliance by States Parties to the Treaty, held its first session in November in New York. Preliminary discussions took place about possible future co-operation between the Agency and the Provisional Secretariat for the CTBTO.

Strengthening of Safeguards

Progress was made in the introduction of measures to strengthen the effectiveness and increase the efficiency

Box 5

REMOTE MONITORING FOR SAFEGUARDS

One element of the Agency's continuing efforts to strengthen and improve the efficiency of the safeguards system is the introduction of new procedures and technologies to reduce the frequency of on-site inspections. In this regard, the use of remote monitoring technologies is expected to provide a significant opportunity for Agency safeguards to provide the required level of assurance with less intrusion on facility operators.

A variety of advanced unattended systems for remote monitoring and transmission are being examined. These include digital surveillance cameras, electronic seals and radiation detectors which can transmit their information directly by satellite and telephone lines to the Agency. To expedite the early implementation of these technologies, a systematic evaluation of commercially available systems was initiated in 1996 in collaboration with a number of Member States. Other related activities include:

- A field trial of a remote monitoring system installed in a mixed oxide fuel storage vault in Switzerland, which showed that the system was effective in monitoring events of safeguards relevance in near real time. The system is competitive from a cost standpoint with current methods and is suitable for use at other facilities under safeguards.
- Installation and testing of remote monitoring system components at an HEU storage vault in the USA.
- Preparatory work on establishing a remote monitoring system at an HEU storage vault in South Africa.

of Agency safeguards (programme '93+2', Part 1). In February, the 'Clean Laboratory' at the Agency's Safeguards Analytical Laboratory in Seibersdorf was commissioned and work on introducing environmental sampling as a standard safeguards measure was started. Baseline environmental samples from enrichment plants and hot cells were collected in a large number of States.

Additional information required for the measures relating to States' systems of accounting for and control of nuclear material, decommissioned and closed down facilities, and fuel cycles was received and analysed. In a related area, a plan for the introduction of remote monitoring was developed (*see Box 5*).

Further strengthening measures, requiring supplementary legal authority (93+2, 'Part 2'), were considered by a committee of the Board of Governors in July and October. Following discussions, the Chairman prepared a "Rolling Text of the Draft Protocol" to provide the necessary legal authority. The text will be considered by the Board in 1997.

The nearly 180 non-nuclear-weapon States now party to the NPT have committed themselves to concluding comprehensive safeguards agreements with the Agency. Nevertheless, over 60 of these States — most of which have no nuclear activities — have yet to do so.

Iraq

The Agency's ongoing monitoring and verification system, which has been in place since August 1994, remained the principal means to deter any effort by Iraq to reconstitute a nuclear weapon oriented programme, and to provide early warning in the event that the nuclear knowledge and know-how still existing in Iraq were to be used for proscribed activities. In parallel with its field work, the Agency's UNSC 687 Action Team continued the analysis of the vast number of Iraqi documents which were obtained in August 1995 and the assessment of the so-called 'Full, Final and Complete Declaration' — a detailed description of Iraq's past covert nuclear programme — provided by the Iraqi authorities in September.

Democratic People's Republic of Korea

The Agency remained unable to verify the initial declaration of nuclear material made by the Democratic People's Republic of Korea (DPRK). The DPRK was still not in compliance with its safeguards agreement.

The sixth round of technical discussions with the DPRK took place in Vienna in September. No progress was made on important issues, including the preservation of information to enable the Agency to verify in the future the correctness and completeness of the DPRK's initial declaration under its safeguards agreement. The Agency informed the Security Council of the United Nations and the Board of Governors that it cannot provide any assurance that the information required is actually being preserved.

The canning of spent fuel from the 5 MW Experimental Reactor, which began in April, was discontinued at the beginning of November, when about 50% of the fuel rods had been canned.

Trafficking in Nuclear Materials

The database on illicit trafficking incidents, established to provide accurate and timely information to three audiences — Member States, the public and the Agency — became fully functioning and recognized as an authoritative list of incidents verified by Member States. The International Physical Protection Advisory Service (IPPAS) was established to give advice to Member States on improving national nuclear security systems. IPPAS missions were conducted to Bulgaria and Slovenia.

Staffing

In 1981, when the first resolution on the 'Staffing of the Secretariat' was under discussion, a number of Member States proposed that a target of 33% be set for the representation of developing countries among Professional staff. At the end of 1996, 32.9% of the Agency's staff came from developing countries. However, the number of women in the Professional category, even though it had doubled since 1981, stood at only 17.3%.

Efficiency and Management

Despite the limitations on resources, the Agency's programme has expanded over the years to take on new activities. The resources for these new activities have become available both through the phasing out of some programmes and through gains in efficiency. This process continued in 1996 and included systematic, routine evaluations of programme performance to increase efficiency.

NUCLEAR POWER

Regular Budget expenditure: \$6 209 599

Expenditure by subprogramme

<i>Nuclear power planning and implementation</i>	\$1 413 513
<i>Assessment and improvement of nuclear power plant performance</i>	\$1 888 302
<i>Advanced reactor developments and applications</i>	\$2 187 588
<i>Nuclear fusion</i>	\$720 196

Extrabudgetary programme resources utilized (not included in chart): \$357 404

The emphasis in the nuclear power programme in 1996 was on information exchange and assistance to Member States. The Agency continued to give advice in the field of nuclear power plant planning and implementation, with technical assistance supplied to 17 Member States. The Power Reactor Information System (PRIS) database was made available on the Internet, providing easier access to this information resource for the statistical analysis of nuclear power plant performance indicators. Results from an 'Options Identification Programme' — a study on seawater desalination using nuclear energy, undertaken in response to a General Conference resolution — were published. The Agency's 16th Fusion Energy conference, held in Montreal, Canada, provided the opportunity for a review of the status of research and of recent progress in relation to the various fusion reactor concepts.

Nuclear Power Planning and Implementation

In 1996, assistance was provided to Belarus, Brazil, Colombia, Pakistan, Peru, Poland and Romania to assess the role of nuclear power in the future expansion of electricity supply systems, with due account being taken of technical, economic and environmental issues. In addition, assistance was given to Albania, Armenia, Estonia,

the Islamic Republic of Iran, Latvia, Lithuania, The Former Yugoslav Republic of Macedonia, Moldova, Slovakia and Viet Nam in defining a framework for technical co-operation projects in energy, electricity and nuclear power planning. Technical support also continued to be provided to Indonesia in nuclear power feasibility studies, financial analysis of electricity system expansion programmes and the economic evaluation of bids for nuclear power plants.

In support of its technical assistance activities, the Agency has developed a number of computer models which can be used as tools for an integrated approach to energy, electricity and nuclear power planning. Efforts continued to improve and update these models in the light of feedback from users and to provide recipients of the models with the latest versions. Expert advice from consultants was used to incorporate improvements in the Agency's BIDEVAL software on the economic evaluation of bids for nuclear power plants, taking into account methodological and software advances over the last ten years.

A technical report entitled *Policy Issues for a Nuclear Power Programme* was prepared to assist decision makers in developing Member States who wish to consider, or who have decided to implement, a nuclear

power programme. The report highlights areas where policy decisions are required, the options which are available and the context in which they should be considered.

Distribution of Agency computer models

	Number of releases of planning model or package			
	MAED	WASP	VALORAGUA	ENPEP
Member States	45	90	36	42
International organizations	5	12	2	5
<i>Totals</i>	50	102	38	47

ENPEP: Energy and Power Evaluation Package; **MAED:** Model for Analysis of Energy Demand; **VALORAGUA:** 'Valor Agua' (value of water); **WASP:** Wien Automatic System Planning Package.

Support continued to be provided to Member States on upgrading and maintaining nuclear power personnel qualifications and competence through the application of the systematic approach to training (SAT). Two technical documents, the *IAEA World Survey on Nuclear Power Plant Personnel Training* and the *IAEA Handbook for the Development, Conduct and Evaluation of IAEA Training Activities Related to Nuclear Power* were prepared during 1996. The world survey, covering 23 Member States, provides information on: training systems, organizations, programmes and facilities; the role of management and the resources provided for training; training facilities and programmes which could be made available to other Member States; and contact persons in Member States.

Assessment and Improvement of Nuclear Power Plant Performance

While the extent of application of formal quality assurance principles to the activities of regulatory organizations varies widely among Member States, increasing attention is being paid to this area in many parts of the world. In response, the Agency produced a technical document identifying typical problems in the performance of regulatory activities and the benefits and

constraints associated with the application of quality assurance principles to these activities.

Computerized operator support systems using fast, 'intelligent' data processing capabilities are used in nuclear power plants to improve productivity, reliability and operational safety. The first version of a database on operator support systems (OSSDB) was completed in 1996 and distributed to nuclear power plants, design organizations and other interested national institutions. The system has adequate flexibility to satisfy the needs of a wide spectrum of users.

The first version of a software package for the International Database on Reactor Pressure Vessel (RPV) Materials was completed and distributed to the eight participating Member States. The first set of inputs include about 1500 items of data on RPV material properties. This software is a part of the International Database on Nuclear Power Plant Life Management. The data will be helpful in the analysis and characterization of changes in RPV material properties during reactor operation in order to assess RPV integrity.

A CRP initiated in 1989 on life management of the RPV primary nozzle was completed. The work programme included a pilot study on the implementation of the existing methodology for life management and was carried out in two phases. Phase I reviewed the current understanding of the ageing process for four selected components, methods for monitoring the process, measures to mitigate its consequences, identification of gaps in knowledge and technology and formulation of follow-up work for the next phase. Phase II dealt with the life management of the RPV primary nozzle. These studies have made it easier to identify different factors affecting primary nozzle performance which are also applicable to other nozzles with similar design features. This is of interest to designers, researchers and regulators.

A new version of the Agency's PRIS database, called PRIS-PC, which was made available on-line in 1995 for direct access through the public telephone network, also became accessible on the Internet. Micro-PRIS, a subset of the PRIS database, is also distributed through the Agency's Home Page on the Internet. The number of PRIS users in 54 Member States and 8 international organizations has increased to 280, representing a growth of 25% over the previous year. A database and a technical document covering country data on the energy and economic situation, a forecast of nuclear energy

utilization and the main organizations and institutions related to the nuclear industry, were prepared and will be published in 1997.

Distribution of Agency computer software

Name of software	Member States	International organizations
Micro-PRIS	8	—
OSSDB	30	1
IDRPVM	54	8
IAEA-SAT	26	—

Advanced Reactor Developments and Applications

The main activities dealing with small and medium size reactors (SMRs) in 1996 included a second Advisory Group meeting on the status and introduction of SMRs in developing countries, held in Tunis, in September. The meeting reviewed the design and development status of SMRs, the lessons learned from their introduction in developing countries, and their market potential. It was emphasized that a strong technical and organizational infrastructure, with qualified personnel, industrial support and financial resources, is one of the most important requirements for the introduction of nuclear power. A review of the market potential of SMRs led to the conclusion that they will be deployed primarily in countries which have already started nuclear projects, in particular in countries which have developed SMR designs themselves. The overall market is estimated at about 70–80 units to be implemented up to the year 2015. About one-third of the SMRs are expected to supply heat or electricity or both to integrated seawater desalination plants.

To assist in training, software was developed to simulate the behaviour of current and advanced reactors, PWRs, BWRs and HWRs on a personal computer. This software and a technical document, comprising the training and user manuals, will be available in early 1997.

The Agency continued to play a role as an international forum for the exchange of scientific and technical information on advances in LWRs and HWRs. In 1996, a

status report on advanced LWR designs was prepared. Under a CRP, a database of thermophysical properties for a broad spectrum of LWR and HWR materials over a wide range of temperatures was developed. In another CRP, the Agency is establishing a consistent set of relationships which can be used to analyse the thermo-hydraulic performance of advanced water cooled reactors, since accurate information is required for reactor design and performance studies.

Highlights of liquid metal cooled fast reactor (LMFR) development in 1996 were: stable operation at a power of ~1000 MW(e) of Superphénix, the first large demonstration fast reactor in France; 16 years of commercial operation of the 600 MW(e) BN-600 in the Russian Federation; operation of the BN-350 in Kazakstan to generate nuclear heat for seawater desalination and electricity production; and the successful continuation of fast reactor programmes in China, India and the Republic of Korea.

Development programmes for gas cooled reactors continue in a number of Member States, with additional interest being focused on this technology as the result of its potential as a high temperature energy source for a wide range of process heat applications. In this context, Eskom, the state electric utility of South Africa, is evaluating the use of the high temperature reactor (HTR) for the generation of electricity through the application of a closed cycle gas turbine power conversion system. The National Atomic Energy Agency of Indonesia is investigating the HTR as an energy source for co-generation application in the development of gas and oil resources. The high temperature engineering test reactor (HTTR) and the HTR-10 are under construction in Japan and China, respectively, for testing the high temperature heat applications of nuclear power. In 1996, a technical co-operation programme was initiated with BATAN, in Indonesia, on the feasibility of the HTR for the production of methanol and fresh water.

In 1994, in response to the interest of Member States in a possible demonstration facility for seawater desalination using nuclear energy, the Agency initiated a new two year Options Identification Programme with the aim of selecting a limited set of practical options for demonstration projects. This programme has now been completed and a report was submitted to the 40th session of the General Conference. A few nuclear coupled desalination plants have been selected as practical candidates for demonstration projects. The two types of plants to be tested are: a reverse osmosis desalination process

coupled to an existing or newly built medium size water cooled reactor, and a multi-effect distillation process coupled to a small size reactor in the 20–50 MW(e) range. In accordance with a resolution of the General Conference, preparatory work for further study of this subject began.

Nuclear Fusion

The Agency's 16th Fusion Energy conference was held in October in Montreal, Canada. There was significant interest in the International Thermonuclear Experimental Reactor Engineering Design Activity (ITER EDA). New results included: confinement enhancement with the 'reversed shear mode' of tokamak operation; encouraging prospects for low aspect ratio tokamaks; and good progress in inertial fusion research, stellarators and other alternative fusion concepts.

Experts from Argentina, Brazil, China, the Czech Republic, Egypt, India, the Islamic Republic of Iran, Israel, the Republic of Korea, Pakistan and Poland met in Vienna to advise the Agency on ways to enhance the effectiveness of fusion related activities in Member States that do not have major fusion research programmes. Participants in this Advisory Group meeting discussed the current status of research in those countries and made recommendations for future work, including: efforts to increase the awareness of fusion research;

better interaction with larger laboratories; the establishment of a network of regional plasma centres; and more effective CRPs.

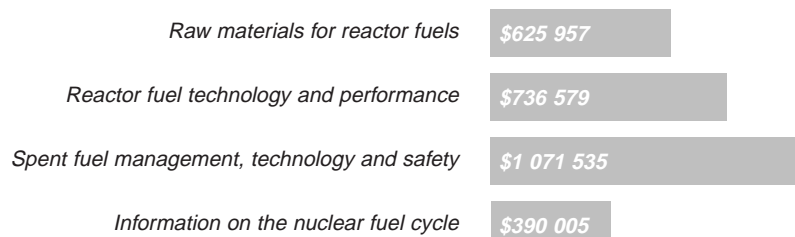
A new CRP on engineering, industrial and environmental applications of plasma physics and fusion technologies was initiated. The research topics include: plasma assisted surface engineering for surface property enhancement; plasma technologies for hazardous waste remediation; and studies to broaden the required experimental database. This CRP will benefit plasma research, strengthen co-operation between developed and developing Member States and help to commercialize plasma and fusion technologies in developing Member States.

The ITER EDA, conducted jointly by EURATOM and the Governments of Japan, the Russian Federation and the USA, under the auspices of the Agency, prepared a Detailed Design Report, which reflects progress made towards design integration at the system and plant levels, and the Non-Site-Specific Safety Report-1, containing the results of an environmental and safety assessment of the current ITER design. The safety report provides confidence that ITER can be constructed and operated safely, with a favourable environmental impact. The Agency provided atomic and molecular physics database information to the ITER project and published the ITER Monthly Newsletter as well as ITER administrative and technical documents.

NUCLEAR FUEL CYCLE

Regular Budget expenditure: \$2 824 076

Expenditure by subprogramme



Extrabudgetary programme resources utilized (not included in chart): \$654 338

Comprehensive studies were carried out during the year on: uranium supply and demand; the modelling of fuel under extended burnup; a quality assurance system for dry storage technologies; preparation of spent research reactor fuel for shipment back to its country of origin; the safe handling and storage of plutonium; and the corrosion of zirconium based alloys in nuclear power plants.

Raw Materials for Reactor Fuels

A guidebook to accompany the Agency map *World Distribution of Uranium Deposits* was published. Preparation of the map and the guidebook included development of a database containing detailed information on the location, reserves, grade of ore, geology and status of each deposit.

The IAEA–OECD/NEA report *Uranium 95 — Resources, Production and Demand* (the ‘Red Book’) was published in 1996. It is the first truly global edition of the Red Book, with information on 54 countries.

After falling nearly 50% from 1988 to 1994, world uranium production in 1995 was around 34 000 t U,

representing an increase of 8% over 1994 production — the first increase in production since 1988. Australia, Canada, France, Kazakstan, Namibia, Niger, the Russian Federation, South Africa, the USA and Uzbekistan each produced over 1000 t U and together accounted for 90% of world uranium production. Worldwide power reactor requirements are estimated to be about 62 000 t U per year, which is about 28 000 t U greater than world uranium production. While 55% of the demand is being met by current production, the balance is being filled by inventory drawdown. In the near future, as stockpiles become depleted, demand will be met by increased uranium production and blended down high enriched uranium from dismantled warheads.

At a Technical Committee meeting held in Vienna, experts from 30 countries discussed the application of geoscientific research to such problems as the high concentration of radioelements in some buildings and the rapid detection of isotopes resulting from nuclear power plant failures. They also underlined the importance of updated airborne and ground gamma spectrometry data in the early detection of environmental problems and recommended that a set of standardized units be adopted for expressing levels of radioactivity from various surveys.

Reactor Fuel Technology and Performance

The validity and predictive capabilities of fuel performance codes were compared and assessed in a CRP on Fuel Modelling under Extended Burnup (FUMEX), which involved a blind exercise with experimental data provided by the OECD Halden Reactor Project. Nineteen different codes were studied. As a consequence of FUMEX, elementary models and codes have been improved and validated. In addition to FUMEX, a 'mature' fuel modelling code (TRANSURANUS) has been transferred to developing Member States, together with guidance on application of the code to reactor operation and safety assessments. Compilation of a database of well defined experiments suitable for code validation was started in association with the OECD/NEA.

A CRP on the modelling of transport of radioactive substances in the primary circuit of water cooled reactors was initiated in 1996. The aim of the study is to improve computer codes designed for the modelling of radiation field growth, to understand the mechanisms involved and to determine appropriate countermeasures.

Design, materials performance and safety margins of fuel and pressure/coolant tubes were the topics discussed at a Technical Committee meeting held in Vienna on channel reactor fuel. Even though the design and characteristics of various channel type reactors differ considerably, specific common features, such as coolant boiling and on-power loading, were analysed. It was concluded that current operating conditions for both the fuel and fuel channels satisfy requirements. An analysis of data presented internationally for the first time on RBMK fuel and fuel channels led to recommendations for further R&D to improve fuel utilization and operational flexibility.

Under the terms of the 'Record of Decision on a Nuclear Weapons Non-Proliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel', published on 13 May 1996 by the US Department of Energy, the first shipments to the Savannah River of US origin foreign research reactor spent nuclear fuel have already begun. Since many of the Member States involved in the programme will be shipping back spent fuel for the first time, a guidelines document on the technical and administrative

preparations required for the shipment of research reactor spent fuel was prepared. It will be used in a training course on the same topic to be held at the Argonne National Laboratory in early 1997 and will be updated as experience with the shipments is accumulated.

As part of a CRP on irradiation enhanced degradation of materials in spent fuel storage facilities, a review of the durability of fuel cladding materials in wet storage was prepared. It concludes that zirconium based cladding materials perform very well in wet storage, while aluminium alloys only perform well in water of optimum quality. Stainless steel cladding can degrade as a result of intergranular stress corrosion cracking if it was previously sensitized in the reactor.

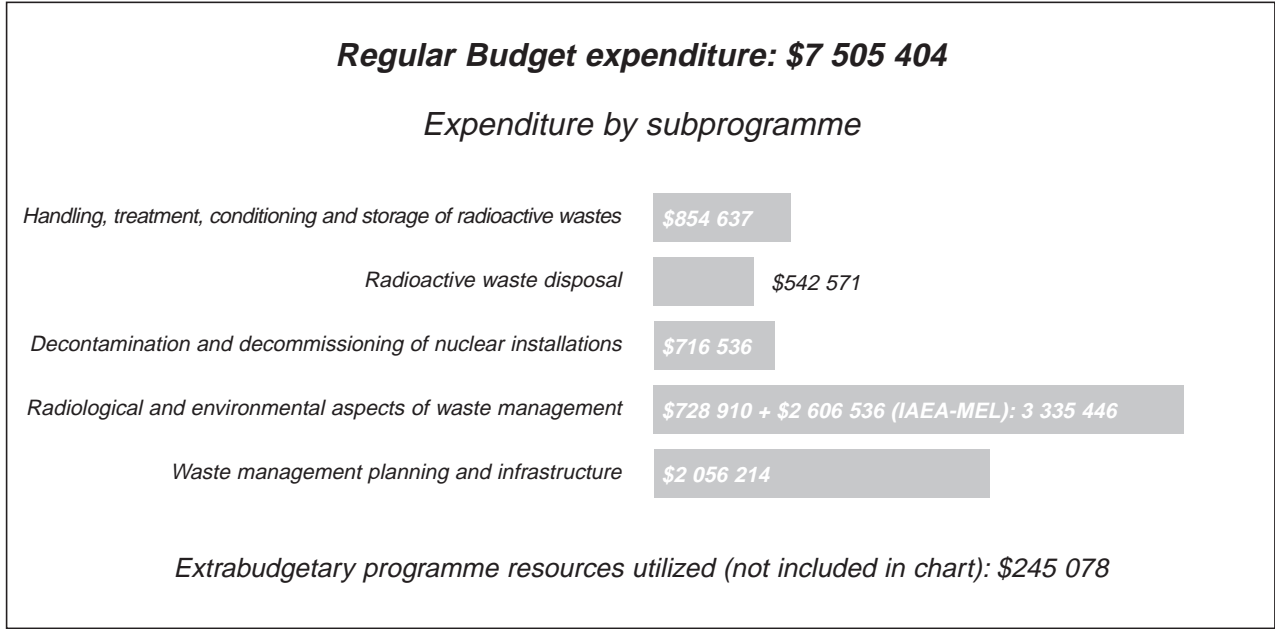
Information on the Nuclear Fuel Cycle

Worldwide interest in separated civil plutonium continues to grow as global inventories increase. Refined estimates of present and future separated plutonium inventories were published in the *IAEA Yearbook 1996*.

Important preparatory work was carried out for an international symposium entitled 'Nuclear Fuel Cycle and Reactor Strategy: Adjusting to New Realities', to be held in co-operation with the European Commission, the OECD/NEA and the Uranium Institute in June 1997. Six working groups were formed to cover all aspects of plutonium management and related fuel cycle and reactor strategies. As part of preparations for the symposium, a new generic model, which takes into account the recycling of uranium and plutonium from spent fuel in power reactors, was developed to calculate global fuel cycle requirements, spent fuel arisings and the production of plutonium in reactors up to the year 2050.

An updated guide on the Nuclear Fuel Cycle Information System (NFCIS) was published eight years after an earlier version. It is an international directory of civilian nuclear fuel cycle facilities that provides information on existing and planned facilities throughout the world. NFCIS is an important reference work for the nuclear industry and currently contains information on 422 civilian nuclear fuel cycle facilities in 46 countries.

RADIOACTIVE WASTE MANAGEMENT



The Agency's 1996 programme on radioactive waste management focused on: the establishment of international principles and standards for the safe management of wastes; preparations for the convention on the safe management of radioactive waste; development of infrastructures and tools for strengthening and solving waste management problems in developing Member States; and assessing waste management situations and needs as a consequence of past practices. New advisory committees were established to advise the Agency on its activities related to waste technology and safety. The International Radioactive Waste Technology Advisory Committee (WATAC) met for the first time in October to review the 1995-1998 Agency programme in these areas and to facilitate the exchange of information and experience between Member States represented on WATAC. The Waste Safety Standards Advisory Committee (WASSAC) was established to review waste safety documents intended for publication in the Safety Standards series.

Handling, Treatment, Conditioning and Storage of Radioactive Wastes

Progress was made in the preparation of guidance on waste minimization methods applicable at different nuclear

facilities. A report completed in 1996 provides a number of different options and technologies for the treatment of boric acid containing waste. These are aimed at the recovery of boric acid from waste streams and its possible reuse.

In co-operation with national authorities, the Agency implemented a training programme with the aim of providing technical expertise to developing Member States in various aspects of radioactive waste management. Incorporating the results of over 20 regional and interregional training courses held between 1991 and 1995, guidance material was prepared for use by Member States in conducting training courses on the management of low and intermediate level waste (LILW). The report covers the requirements for organizing courses, an annotated outline of such courses and a selection of practical exercises and demonstrations.

Two CRPs on fostering research in developing Member States in the field of waste processing technologies for LILW from nuclear applications were concluded in 1996. One CRP on treatment technologies for LILW was designed to help develop reliable, simple and low cost processes for specific institutional waste to be made

compatible with long lived radioactive waste forms. A number of new treatment technologies were developed and tested, and are in use in some of the countries that participated in the project. The other CRP dealt with inorganic sorbents that in many cases have been proved to be advantageous in the treatment and immobilization of liquid radioactive waste. Specific properties of synthetic and composite sorbents can be designed and controlled during their synthesis. This facilitates the preparation of a range of sorbents suitable for the treatment of specific waste streams. However, the variety of inorganic sorbents, both natural and synthetic, that are in use worldwide requires the setting up of standardized procedures for comparative evaluation. Several standard testing procedures and sets of reference waste streams were thus developed in the CRP.

Difficulties encountered in the short term in many Member States in the development of disposal facilities have led to more effort being devoted to the storage of radioactive wastes. A report was prepared to provide guidance on various technological aspects of radioactive waste package storage, and to place storage in the context of the entire waste management process. The report reviews current practices and experience in waste storage, summarizes the various actions required before, during and after interim storage and links various activities involving the storage of radioactive waste.

Radioactive Waste Disposal

At a symposium entitled 'Experience in the Planning and Operation of Low Level Waste Disposal Facilities', held in Vienna in July, it was demonstrated that the majority of the Agency's Member States, while not employing nuclear power, were utilizing nuclear technology in such areas as medicine, industry and research. These applications as a rule produce low level waste (LLW) which has to be managed and disposed of. The symposium showed that LLW disposal is based on proven technologies and the safety of disposal can be satisfactorily ensured over the time periods currently envisaged. It was also pointed out that while developing Member States are looking for adequate, affordable and safe solutions, in developed Member States there is a trend towards increasing technical sophistication.

Radiological and Environmental Aspects of Waste Management

For several years the Agency has organized an annual group forum for the discussion and resolution of outstanding issues related to the disposal of radioactive wastes, mainly the problem of assuring and demonstrating the long term safety of waste repositories. The second report of this group was issued in 1996 and contains discussions on interface issues between nuclear safeguards and radioactive waste management, aspects of the post-closure phase of a repository and the application of the concept of 'radiological optimization' to radioactive waste disposal.

A three year assessment study of the radiological impact of high level radioactive waste dumping in the Arctic seas (the International Arctic Seas Assessment Project (IASAP)) was completed. An executive summary of the study report was presented to the Contracting Parties to the Convention on the Prevention of Marine Pollution by Dumping Of Wastes and Other Matter (the London Convention, 1972). The study examined various aspects of radiological assessment, making use of the results obtained from several exploratory cruises to the affected area. In addition, three-dimensional hydrodynamic and compartmental modelling of dispersal from possible releases of radionuclides from dumped wastes to the open Kara Sea and the Arctic Ocean was carried out by IAEA-MEL. One of the study's conclusions was that the current radiological risks presented by the dumped wastes are negligible and that the future risks to population groups most likely to be exposed are also small. No justification was found on radiological grounds for instituting a programme of remedial action in relation to the wastes. However, a reassessment of the situation was recommended if the current military restrictions over the fjords of Novaya Zemlya, where much of the waste was dumped, are removed.

As a contribution to IASAP, IAEA-MEL verified laboratory experimental approaches to estimating radionuclide coefficients (K_{ds}) for Kara Sea sediments. Comparisons of field derived and radiotracer derived K_{ds} values showed that radiotracer techniques used with natural sediments can, under carefully controlled conditions in the laboratory, accurately predict K_{ds} coefficients that have been measured in far more costly field tests.

Closely related radioecological experiments have determined the potential usefulness of starfish, a common bottom species in the Arctic seas, as bioindicators of americium-241, caesium-137 and cobalt-60 contamination in these waters. Laboratory radiotracer food chain studies demonstrated that starfish can accumulate from

75 to 100% of the radionuclides ingested with their food and can retain them in their tissues for several months.

The analysis of sediment and seawater samples collected during the 1994 and 1995 Japan–Republic of Korea–Russian Federation expeditions to the Far Eastern seas has been completed and a final report issued. The analytical results did not show any effects from the dump sites. Dispersion modelling of possible releases of radionuclides from dumped wastes in the Far Eastern seas was also completed. The results have shown that the turnover time of water in the Far Eastern seas may be about 25 years, which is shorter than expected by a factor of 4. However, the simulated surface water concentrations of caesium-137 released from wastes may reach values an order of magnitude lower than the present environmental levels.

A sampling expedition to the Mururoa and Fangataufa Atolls in French Polynesia was carried out. A new progressive technique based on in situ gamma spectrometry of seabed sediments was used to study the spatial distribution of radionuclides in sediment and to optimize sediment sampling. Hundreds of water, biota and sediment samples were collected in both lagoons and are being analysed in seven Member State laboratories and at IAEA-MEL.

A Global Marine Radioactivity Database (GLOMARD) was established to provide Member States with information on radioactivity baselines and records for radiological assessments and international and national monitoring programmes. All available data on radionuclide concentrations in the Arctic seas have been included in GLOMARD to study the temporal and spatial distributions of radionuclides. The data show that in recent years the concentrations of strontium-90 and caesium-137 in the Kara and Barents Seas have been decreasing, the dominant contribution being from reprocessing plants and global fallout.

A CRP on the applications of tracer techniques in studies of processes and pollution in the Black Sea was completed. The project resulted in: a comprehensive and up to date assessment of radionuclide distributions, trends, inventories and sources in the Black Sea environment; an evaluation of doses delivered through marine exposure pathways to humans and biota; and the development of applications of radioactive and stable isotope tracers to understand the fate of pollutants in this particularly complex and stressed environment.

Bioassay tests have been designed to examine the possible enhancement of natural radioactivity in marine organisms living in the vicinity of non-nuclear industries. Initial experimental results indicate that polonium-210 in gypsum and other phosphatic wastes from the phosphoric acid industry is bioavailable to marine molluscs exposed to sea water containing such wastes.

Progress was made in 1996 to broaden the funding base for Agency projects focused on the application of nuclear techniques to understand oceanic processes. A subcontract was established under the European Union sponsored Aegean Sea Hydrothermal Fluxes project through which the Agency will use nuclear techniques to examine the potential environmental enhancement of natural radionuclides and trace elements emanating from shallow water hydrothermal vents off Milos Island. Such background data on geochemical sources are important in order to gauge the relative importance of industrial inputs of the same elements to enclosed seas such as the Mediterranean.

Waste Management Planning and Infrastructure

At the request of the French authorities, the Agency convened an international team of experts to review the short lived waste management programme and activities, both planned and implemented, at the Centre de l'Aube. On the basis of source material and a report provided by Andra (Agence nationale pour la gestion des déchets radioactifs, France), the team evaluated the programme and formulated recommendations in several areas such as verification, control and testing, and safety assessment.

A Contact Expert Group (CEG) was established by a number of countries interested in having an international forum for harmonizing and following up co-operation in the area of radioactive waste management in the Russian Federation. The first CEG meeting was held in March 1996 in Moscow. CEG Secretariat services are being provided by the Agency.

The first demonstration of predisposal waste management methods and procedures was held at the Çekmece Nuclear Research and Training Centre in Turkey. Participants from Albania, Greece, the Syrian Arab Republic and the host country attended this hands-on training session. A regional centre for Latin America has

also been established at the Lo Aguirre nuclear research centre in Chile.

A team of specialists from Brazil completed the conditioning of the national inventory of old radium sources in Uruguay. The conditioning, which was carried out with Agency staff in attendance, will ensure that these radium sources can be safely stored until deep geological repositories are available for disposal. This operation was the first in a series that will eventually remove spent radium sources from the list of highly dangerous radiation sources in Member States.

Proper assessment of the waste management situation in Member States is necessary in order to prepare adequate

work plans for technical co-operation activities. To support these activities, a waste management part in the Country Profile Database was established. This section will complement the corresponding database on radiation protection. Information on more than 20 countries has so far been included.

COMPARATIVE ASSESSMENT OF NUCLEAR POWER AND OTHER ENERGY SOURCES

Regular Budget expenditure: \$2 059 654

Extrabudgetary programme resources utilized: \$168 970

All fuel chains for electricity generation involve some health risks and lead to certain environmental impacts. Since many countries need to define sustainable energy programmes for the coming decades, interest has grown in the application of improved data, tools and techniques for the comparative assessment of different options and strategies for electricity supply. The Agency's activities in this area seek to merge health, environmental, technical and economic factors into planning and decision making for the electricity sector.

The Agency continued, within the framework of the interagency DECADES project, to develop and update databases and methodological tools. The Reference Technology Database (RTDB), which contains generic information on the technical, economic and environmental aspects of various components of different energy chains, was expanded to cover about 300 energy facilities.

In order to allow for more specific assessments to be undertaken in particular national situations, development continued of country specific databases (CSDBs), mainly by providing technical support to national experts from various Member States. In addition to updating some of the existing CSDBs, 9 new CSDBs were established, raising the total number to 24. Improvements were also made, as a result of user feedback, to the Agency's methodological software for comparative assessment studies (DECPAC) to permit assessments at the power plant, full energy chain and electricity supply system levels.

Work began on a reference book, on enhanced electricity system analysis for decision making, with the help of

experts from national and international organizations active in the field. The book will describe an overall framework and processes and state-of-the-art methods and techniques for carrying out comparative assessment studies.

A CRP on case studies to assess and compare the potential role of nuclear power and other energy options in reducing emissions and residuals from electricity generation was completed. Twenty-two country case studies were prepared, with technical support from the Agency. The range of issues covered: assessment of the potential role of nuclear power in reducing greenhouse gas emissions; the effects of carbon dioxide taxation and/or emission constraints on the future electricity generation mix; and the impact of privatization and deregulation of the electricity sector on system expansion strategies. The results showed that significant reductions of emissions and other environmental burdens can be obtained by improving the efficiency of facilities at different levels of the energy chains and by using better quality fuels, or by fuel switching. The rehabilitation of power plants, in particular by adding pollution control technologies, was found to be a cost effective measure in mitigating environmental impacts. In most of the studies where nuclear power was considered as a possible option for electricity system expansion, it was found to be cost effective for reducing emissions of sulphur dioxide, nitrous oxide, carbon dioxide and other greenhouse gases.

The Agency continued to contribute to the work of the Intergovernmental Panel on Climate Change (IPCC) and the Framework Convention on Climate Change (FCCC).

In particular, information was provided to an IPCC working group analysing climate change, and to the Subsidiary Body of the FCCC for Scientific and Technological Advice on the potential role of nuclear power in reducing global greenhouse gas emissions from the energy sector.

In this connection, the Agency held two Advisory Group meetings in 1996, one on greenhouse gas emissions from hydropower and the other on wind and solar technologies. The findings show that nuclear, wind and, in some cases hydropower, are generating options with the lowest full energy chain greenhouse gas emissions. The relevant emission factors, in g CO₂ equivalent/kW·h(e), are in the range of 0.4 to 3 for run of river hydropower, about 10 for nuclear power and for wind (without backup) at favourable sites, and 17 to 26 for hydropower plants with reservoirs. The corresponding figures for solar thermal plants and for photovoltaic systems (without backup) are in the ranges of 50 to 80 and 100 to 280, respectively.

Agency co-operation with the OECD/NEA and the International Energy Agency found expression in the

initiation of an update of comparative projected costs of generating electricity. The study will provide a reliable comparison of electricity generation costs for nuclear and fossil fuel fired base load power plants that can be expected to be commissioned within the next 10–15 years. The last such study was carried out in 1992.

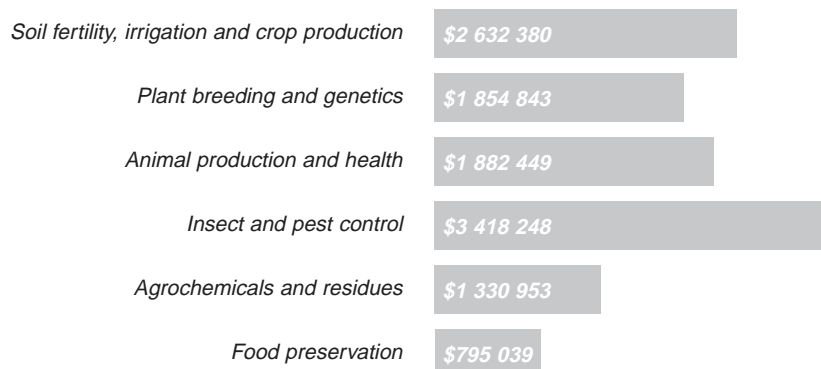
A document on general guidelines for the comparative assessment of the health and environmental impacts of electrical energy systems was completed. The document provides a framework for carrying out comparative risk assessments and identifies the major technical issues and uncertainties in the assessment process. It will be published in 1997.

The IAEA/UNEP/UNIDO/WHO project on risk management in large industrial areas was completed in 1996 and two documents were prepared. One is a manual for the classification and prioritization of risks as a result of major accidents in process and related industries. The other provides guidelines for integrated risk assessment and management in large industrial areas.

FOOD AND AGRICULTURE

Regular Budget expenditure: \$11 913 912

Expenditure by subprogramme



*Extrabudgetary programme resources utilized (not included in chart): \$2 917 102
(of which the sum of \$1 498 599 is from FAO)*

A feature of 1996 was the increasing extent to which techniques and technologies developed through the Agency's research contract programmes and at the FAO/IAEA Agriculture and Biotechnology Laboratory at Seibersdorf were applied through technical co-operation projects and other activities to improve food security and assist Member States in meeting international agricultural standards and undertakings. An example is the use of mutation breeding and biotechnology to support crop improvement and biodiversity under the Leipzig Declaration on Plant Genetic Resources. Other examples include the increasing use of FAO/IAEA developed diagnostic tests, the sterile insect technique (SIT) and food irradiation in assisting Member States to meet obligations with respect to sanitary and phytosanitary standards and technical barriers to trade under Uruguay Round agreements. Also noteworthy is the work on agrochemicals to assist in the implementation of the International Code of Conduct on the Distribution and Use of Pesticides.

Soil Fertility, Irrigation and Crop Production

A series of CRPs has been conducted over the years on enhancing the use of atmospheric nitrogen by plants through biological nitrogen fixation by the Rhizobium-legume symbiosis using the nitrogen-15 isotope dilution technique, and through the efforts of the FAO/IAEA Laboratory. In the latest CRP, a gene marker method for studying Rhizobium ecology was developed and tested. The new method was used for the identification and classification of Rhizobium strains and for studying strain competition for establishing symbiosis with the legume. Apart from being an important tool for research in Rhizobium ecology, this method, when combined with the dilution technique, will greatly enhance the selection of elite strains in nodulating legumes for use in biofertilizer production. The method has been transferred to microbiological laboratories in developing countries.

In Bangladesh, smallholder farmers have begun to realize higher crop yields and savings on chemical nitrogenous fertilizers from the use of legume biofertilizers developed from *Rhizobium* strains selected for their superiority in nitrogen fixation. Results from about 1500 demonstration trials conducted in farmers' fields showed that substantial increases in nitrogen fixation and yield can be obtained through the use of biofertilizer. The yield increases recorded in 1996 were over 95% for lentil, 70% for soybean and chickpea, 40% for groundnut and 25% for cowpea.

Progress was made in a CRP on optimizing fertilizer nitrogen application and irrigation water supply on wheat with reference to a CERES-wheat simulation model. This model will assist in refining nitrogen fertilizer management strategies. Using data generated through the nitrogen-15 isotope dilution technique and neutron moisture probes, it was found that the model is able to provide a realistic estimate of nutrient uptake, water use and crop growth. After validation, the model will be a quick and simple tool to evaluate specific management practices that would otherwise require several years of costly field research.

The first phase of a CRP on irradiated sewage sludge, which includes studies to quantify the availability of nitrogen to crops and to assess increases in crop yields from the applied sewage sludge, was completed. The results from 14 countries indicated the positive effect of irradiated sludge on yield and crop quality and a decrease in soil contamination by pathogenic organisms compared with the use of non-irradiated sludge.

Progress was made in a technical co-operation project on international quality assurance for nitrogen-15 analysis using emission spectrometers by laboratories in Member States co-ordinated by the FAO/IAEA Laboratory. The aim of the project is to determine whether results generated from Agency supported laboratories are accurate and reliable, and to recommend or take corrective measures where problems exist. About three quarters of the laboratories were found to produce reliable data, while the remaining produced data outside the acceptable limits of accuracy. Measures have been taken to assist the latter in correcting the situation.

Plant Breeding and Genetics

Promising results for the improvement of cassava, yam, sweet potato, plantain, sorghum and African rice were obtained through a recently completed CRP on improving

basic food crops in Africa through plant breeding including the use of induced mutations. Mutants of sorghum with long panicle length, improved grain quality and drought tolerance were obtained in Mali with the potential to yield 10–30% more grain than the parental variety. Presently, these mutants are being evaluated in multi-location field trials in Mali in co-operation with the International Crops Research Institute for the Semi-Arid Tropics. In the United Republic of Tanzania, mutants of upland rice (*Oryza sativa*) with increased yield, early flowering and short height were developed and are in advanced field trials.

A CRP on the application of DNA based marker mutations for the improvement of cereals and other sexually reproduced crop species concluded in 1996, laying the foundation for a better understanding of induced mutations at the molecular level. A comparison of the use of radioactive and non-radioactive markers showed that there is a place for both methods in the analysis of seed propagated species. Radioactive probes were used for the analysis of agronomically important traits in a number of species, including aluminium and drought tolerance in maize and resistance to barley yellow dwarf virus in wheat. Polymorphisms and selectable molecular differences were identified for blast resistance and salt tolerance in rice, and marker assisted selection has begun. The results achieved were facilitated by linking molecular biologists and plant breeders in developing and developed countries.

The use of linked DNA markers makes possible, for the first time, the large scale application of indirect selection for important agronomic traits. In order to implement these molecular technologies on a large scale in laboratories throughout the world, it is necessary to distribute DNA resources, including probes and primers. A CRP on radioactively labelled DNA probes for crop improvement helped to make available the necessary resources so that Member States can keep pace with developments in the fast changing world of marker assisted breeding. Major programmes in several developed countries are producing DNA resources for rice, wheat, barley, maize, sorghum, pearl millet, mungbean, cowpea and soybean. This CRP facilitates the distribution of DNA resources to laboratories in Member States. More than 210 requests for probes and primers have been fulfilled in 25 countries, with 40% of the requests coming from developing countries.

Techniques were developed at the FAO/IAEA Laboratory to regenerate ensete (*Ensete ventricosum*) through somatic embryogenesis and adventitious buds. This crop, which

is grown in Ethiopia and is an important starchy staple food crop, supports the diet of a quarter of the population. Owing to difficulty in germinating seed and the long vegetative period, the breeding of ensete is extremely difficult. No phenotypic variation was observed among the regenerants. Also, polyploids were induced in diploid banana and verified by flow cytometry. The polyploids were propagated for field testing in banana breeding programmes.

Animal Production and Health

To determine ways of increasing livestock productivity, radioimmunoassay laboratories for animal steroid hormone determinations have been established in over 60 countries. Using these resources, and through a CRP on the development of feed supplementation strategies for milk producing animals in tropical and subtropical environments using nuclear and related techniques, studies in Mexico showed the critical importance of supplementation feeding linked to innovative management. This finding led to an extension programme to improve dual purpose farming practices among 900 co-operating farmers in the region. The result was an increase in average milk production from 4.5 to 7.2 litres per cow per day (i.e. an increase of 63%), representing a rise in milk production of ten million litres per year.

Following similar studies supported under this programme in the Pucallpa region of Peru, a sustainable milk producing farming industry was created. The offspring produced 6–10 litres of milk per day without concentrates, generating a substantial increase of 60–80% in the daily income of farmers. The introduction of an artificial insemination scheme and an improved pasture production scheme amongst 80 farmers owning 2 to 15 cows each were key factors in this success.

In Sri Lanka, studies showed the advantage of grazing cattle on the natural herbage growing in coconut plantations. In grazed areas, coconut yields increased by 20%, with considerable improvements in soil fertility and water retention, while milk yields increased from four to ten times.

Brucellosis is a disease that affects both humans and cattle worldwide. In some countries, eradication has been possible through the slaughter of infected cattle, but this approach is difficult in many areas where vaccination is practised since it has not been possible to differentiate between infected and vaccinated animals.

Under a CRP, a new test that can show whether an animal is free from the disease, vaccinated or infected was developed, standardized and internationally validated. Based on a competitive enzyme linked immunosorbent assay (ELISA) and using a monoclonal antibody developed at the Animal Disease Research Institute in Nepean, Ontario, Canada, studies in five Latin American countries have clearly demonstrated the advantages of this new assay, which will now have a large role to play in future brucellosis control and eradication campaigns.

Under a regional technical co-operation model project in West Asia, support was provided for sero-monitoring and surveillance of rinderpest. As part of the intensive drive to eradicate this disease from the region, nine countries undertook national surveys in 1996 using FAO/IAEA ELISA kits. The surveys demonstrated a reasonable level of vaccination in most countries, but also highlighted problem areas where levels of immunity were too low to prevent disease. For example, in the Kurdish communities in northern Iraq it was shown that less than 30% of the cattle were vaccinated; an emergency vaccination campaign was consequently undertaken. The FAO/IAEA Laboratory provided over one million assay units to Member States in 1996.

Insect and Pest Control

In a model project applying SIT for the eradication of the tsetse fly from the island of Zanzibar, United Republic of Tanzania, persistent suppression of the target fly population below detectable levels was observed. The last wild fly was captured in September 1996 and there have been no detections of flies since that time. Also, trypanosomosis in cattle declined rapidly, reaching the lowest levels ever recorded since routine blood sampling was established. The third insectary at the Tanga mass rearing facility in the United Republic of Tanzania was inaugurated. The total number of flies in the colony reached almost a million females, allowing aerial releases of 100 000 sterile males per week over the whole island. Furthermore, in view of the self-sufficiency achieved by the Tanga facility, the backup mass rearing efforts at the FAO/IAEA Laboratory were discontinued.

In Argentina, advances were made in the streamlining and upgrading of Mediterranean fruit fly (medfly) SIT eradication activities over half a million hectares of deciduous fruit producing land in Mendoza and Patagonia provinces. These advances included improvements in quarantine legislation, infrastructure and operations to

protect the territories under fruit fly eradication from reinfestation. Also, the creation of the Mendoza Plant Protection Institute to provide this joint FAO/IAEA model project with more efficient and independent programme management resulted in important economic savings and the active participation of fruit growers and exporters in programme funding and management. For the first time a medfly genetic sexing strain (in which mostly sterile males are released and where the detection of the remaining wild female flies among the sterile and wild male population is the main objective) developed at the FAO/IAEA Laboratory was being mass reared and released on a large scale in an operational SIT eradication programme. As a result of these advances, and production of over 200 million sterile pupae per week, the medfly has now been eradicated from most of Mendoza Province.

In Madeira, Portugal, the medfly SIT project, financed jointly by the Agency, the European Union and the Government of Portugal, also made rapid progress. A modern medfly mass rearing facility with a capacity of 50 million sterile male flies per week was completed. Installation of mass rearing equipment is being completed and mass rearing of a genetic sexing strain provided by the FAO/IAEA Laboratory was initiated, reaching five million flies per week at the end of 1996.

A breakthrough was achieved through a CRP in the development and field testing of a very promising attractant for the female medfly. Unlike available medfly lures which attract mostly male flies, this new attractant is mainly female specific. The results of field tests of this new attractant in 12 countries confirm the effectiveness of the product, which will soon be available commercially. Its use in operational SIT projects will greatly facilitate the use of sexing strains.

Agrochemicals and Residues

A CRP aimed at finding ways to increase the stability of acaricides in livestock dips was completed. The effects of pH, sediment, microbial activity and recharging frequency on the persistence of active ingredients were studied using radiolabelled acaricides in model systems. It was found that some compounds break down more rapidly as the pH rises and that the addition of superphosphate fertilizer was a practical and inexpensive method of maintaining a low pH level. Adsorption by sediment reduced the performance of all compounds, but the addition of a surface active agent increased the

susceptibility of particles and thus extended the period during which animals receive an effective dose. Photo-degradation also proved to be significant, indicating that the siting of dipping baths in the shade is important. As expected, degradation by microorganisms is significant, but unfortunately this programme could not identify an effective bactericide. Information on increasing the stability of acaricides can, of course, also be applied to the problem of the disposal of spent solutions when decomposition rates should be maximized. Thus, raising the pH and dispersing the solution over a soil surface in a sunny location are recommended to minimize possible undesirable effects on the environment.

A major objective of an FAO/IAEA symposium on the use of nuclear and related techniques for studying the environmental behaviour of crop protection chemicals, held in Vienna in July, was to examine the extent to which information on the environmental behaviour of pesticides can be extrapolated from one climatic zone to another. It was agreed that standard laboratory physico-chemical data, together with information on pesticide metabolism and persistence obtained in temperate climates, could be used to provide a 'worst case' scenario for tropical countries. However, movement in the soil and losses by evaporation will almost always be underestimated, so additional climate specific data on these aspects is desirable. In addition, there is a need for information on the behaviour of these compounds in lateritic and volcanic soils, which are not common in temperate zones. There is also uncertainty over the validity of extra-polating toxicological data from temperate to tropical species and so appropriate studies are needed. There was strong support for the view that run-off and soil erosion play more important parts in the dissipation of pesticides in the tropics than elsewhere, so they should be taken into account in tropical environmental impact assessments. A final point of agreement was that information on impurities in pesticide formulations (products) is as important for environmental considerations as it is for human health.

The symposium also produced a number of conclusions and recommendations of interest to pesticide regulatory authorities and laboratories. The most important is that all such laboratories should now operate quality assurance and control procedures that comply with ISO Guide 25 and, where relevant, the OECD's *Principles of Good Laboratory Practice*, or equivalent standards. Only in this way will data be accepted internationally, something which is necessary if duplication is to be avoided.

Food Preservation

On the basis of results from a CRP on irradiation as a quarantine treatment of food and agricultural commodities which was concluded in 1990 and an evaluation by experts appointed by the International Consultative Group on Food Irradiation (ICGFI), the US Department of Agriculture issued a 'Notice of Policy' in May 1996. The policy recognizes the effectiveness of irradiation as a quarantine treatment of fresh fruits and vegetables against fruit fly infestation regardless of host commodities. The North American Plant Protection Organization (NAPPO), which consists of specialists on plant protection and quarantine from Canada, Mexico and the USA, issued a standard to this effect in October. Thus, the stage is set for the wider use of irradiation as a quarantine treatment of fresh fruits and vegetables against fruit flies, which should expand trade in these commodities significantly. In addition, research data generated by an ongoing CRP on irradiation as a quarantine treatment of mites, nematodes and insects other than fruit flies show that irradiation can make sterile thrips, mites and certain insects harboured in cut flowers (such as orchids, chrysanthemum, carnation and tulips), thus meeting quarantine requirements in importing countries.

A regional seminar on the use of irradiation to reduce food losses and foodborne diseases and to facilitate food trade was held in Rabat, Morocco. Co-sponsored by the Agency, FAO, the International Institute of Refrigeration,

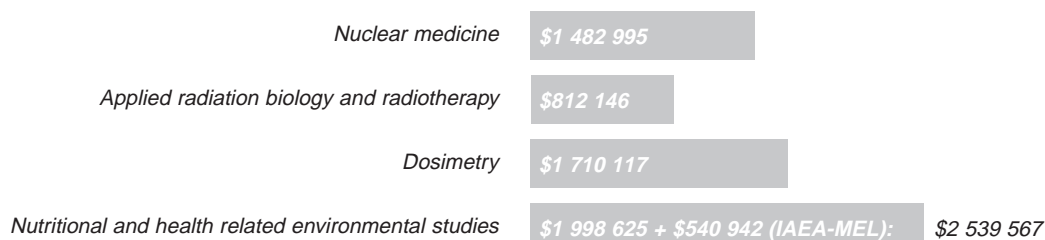
the International Trade Centre, WHO and the United Nations Economic Commission for Africa, it provided essential information on the technology and, in particular, the need to develop harmonized regulations on food irradiation in the African region. The seminar was followed by an AFRA II workshop on this subject in Ghana. This was attended by senior food control officials and food irradiation scientists who adopted a 'Model Regulation on Food Irradiation', which recognizes irradiation as a food process up to an overall average dose of 10 kGy, as recommended by the FAO/WHO Codex Alimentarius Commission.

As a follow-up to resolution GC(XXXVII)/RES/616, adopted by the General Conference in 1993, and the Action Plan described in GOV/2733, adopted by the Board of Governors in June 1994, the Agency assisted the authorities in Brazil, the Islamic Republic of Iran and the Philippines in conducting feasibility studies to establish commercial food irradiation facilities. The studies demonstrated the feasibility of establishing such irradiators in: São Paulo, Brazil; Rafsanjan, the Islamic Republic of Iran; and Manila, the Philippines. In all cases, public information seminars were organized to create an awareness of the safety and benefits of food irradiation among national authorities, the food industry and the media. In addition, a semi-commercial scale food irradiator, for which the Agency provided assistance as part of a model technical co-operation project, was commissioned in Beijing in early 1996.

HUMAN HEALTH

Regular Budget expenditure: \$6 544 825

Expenditure by subprogramme



Extrabudgetary programme resources utilized (not included in chart): \$2 045 493 (including IAEA-MEL)

Agency activities in the area of human health concentrated on applications of nuclear and radiation techniques, especially those suitable for the diagnosis and treatment of diseases prevalent in developing Member States. Increasing emphasis was also given to aspects of preventive medicine such as early detection of neonatal hypothyroidism, hepatitis and other communicable diseases, accurate evaluation of nutritional deficiencies in children and pregnant women, as well as opportune diagnosis of common genetic (hereditary) diseases. In dosimetry, the main emphasis was on the continuation and expansion of services to Member States (i.e. the SSDL network and dose quality audits) and educational programmes for hospital physicists. All activities in the programme are aimed at increasing the availability and quality of the applications through education at all levels, cost reduction in reagents and technology, and increased interaction between physicians, medical physicists and technologists.

Nuclear Medicine

Activities aimed at reducing the cost of nuclear medicine practices in developing countries continued. Field trials were carried out on more than 50 gamma camera-personal computer interface electronic cards developed by Cuba, India and Slovenia with Agency support.

These were designed to upgrade the performance and capability of gamma cameras, with feedback from the field laboratories. As a result of past CRPs, the quality control, care and maintenance of gamma cameras improved: the practice of acceptance testing has risen from 20 to 50% and routine quality control checks have increased from 40 to 70% during the past three years. A low cost single photon emission computed tomography system has been commercialized as a result of contacts between the Agency and the manufacturer.

Agency work on the use of in vitro radionuclide methods to diagnose diseases has yielded significant results: over 1.5 million newborn babies were screened for neonatal hypothyroidism in 14 Latin American countries; 650 babies were found to be suffering from the disease, enabling prompt and effective treatment to be provided. About 150 000 people in ten Asian countries, most belonging to high risk groups such as pregnant women and blood donors, were screened for hepatitis B infection and the incidence was found to be 5.75%. A universal antigen (consisting of four recombinant antigens) which reacts with all sera from patients with Chagas disease in Brazil has been developed. Field validation will now be initiated.

One hundred and eight patients were included in the first Agency sponsored multi-centre clinical trial to compare

the efficacy and toxicity of phosphorus-32 and strontium-89 for the palliative treatment of bone pain from cancer metastases, given that phosphorus is five times less expensive than strontium. The results of this unique trial, which was carried out in India, Indonesia, Peru and Slovenia, will be known in early 1997.

There are more than 3000 technicians working without formal training in nuclear medicine laboratories in developing countries. To address this situation, the Agency's first training course for nuclear medicine technologists was conducted in Cape Town, South Africa. The pilot phase of a distance education project for nuclear medicine technologists was completed in India, Indonesia, Malaysia and Sri Lanka. After final evaluation, the teaching material will be translated from English into other languages for the training of technologists in different countries. These activities are part of a concerted effort to improve the competence of nuclear medicine technologists in developing countries.

After conducting its second certifying examination in 1996, the Ibero-American Board of Nuclear Physicians, founded in 1992 under Agency sponsorship, certified 75 specialists in nuclear medicine from 14 countries.

Applied Radiation Biology and Radiotherapy

Co-ordinated Research Programmes and new regional projects focused on improving the cure rates of cancer of the cervix — the most common female cancer in Africa, South America and Asia and one that is curable even when diagnosed at a fairly advanced stage — while optimizing the limited equipment and personnel resources of these regions.

One of the main problems in cancer care in developing countries is the treatment of advanced and incurable tumours. To address this, efforts were focused on palliative treatment using radiotherapy. A new CRP was initiated utilizing hemibody irradiation for widespread metastasis and treatment of incurable oesophageal cancer with limited intraluminal irradiation.

Sound management principles enhance the efficacy of radiotherapy. The entire process from the selection of patients through optimized therapy to eventual assessment of treatment success was studied in a new CRP on quality assurance (QA). Initial tasks will be focused on Latin America. As this is an especially important problem in developing countries, clinical QA work will shortly be extended to other parts of the world.

Dosimetry

A comprehensive QA programme for the Agency's Dosimetry Laboratory at Seibersdorf began implementation. When completed, it will serve as a model for Secondary Standard Dosimetry Laboratories (SSDLs) to develop their own QA programmes. It is based on the recommendations of the ISO and specifically on 'Guide 25' (*General Requirements for the Competence of Calibration and Testing Laboratories*). The QA programme will result in a manual describing the operation of the Dosimetry Laboratory, supported by nine standard operating procedures.

The activities of the SSDLs in the IAEA/WHO network have been closely monitored, with only active participants remaining. The active members include 69 laboratories and 6 SSDL national organizations in 57 Member States; the network also has 19 affiliated members, mainly Primary Standard Dosimetry Laboratories (PSDLs), the International Commission for Radiation Units and Measurements, the Bureau International des Poids et Mesures, and other international organizations.

To establish a link to the International Measurement System, the Agency's Laboratories at Seibersdorf calibrated 18 reference ionization chambers and dosimeters for 12 laboratories. A total of 27 ionization chambers have been calibrated (96 calibration points at different radiation qualities). The quality audit system based on mailed thermoluminescence dosimeters (TLDs) has been applied to 65 SSDLs in order to verify their calibrations of cobalt-60 therapy units and medical accelerator radiation beams.

The IAEA/WHO TLD postal service distributed 294 dosimeters to radiotherapy centres in developing countries for dose quality audits of clinical beams from cobalt-60 treatment units and medical accelerators. New actions have been implemented to follow up on TLD results outside the limits.

The Agency carried out pilot studies at two SSDLs which had experience with postal TLDs. The objective was to allow the Agency to provide services elsewhere and to establish national services capable of rapidly providing results and local follow-up. Since the findings from these investigations were not satisfactory, additional studies have been added to an ongoing CRP on the development of a QA programme for radiation therapy dosimetry in developing countries.

The Agency continued to offer the International Dose Assurance Service (IDAS) at radiation processing dose levels using alanine dosimeters issued and measured at the Agency's Laboratories. An audited traceability chain was established to a PSDL. The fee for this service was waived for non-commercial laboratories, and direct contact between the Agency and users in Member States was established. This has resulted in a 65% increase in participation in the programme. The IDAS distributed dosimeter sets to 33 facilities in 30 Member States.

The impact of the new standards in PSDLs of absorbed dose to water on current procedures at the SSDLs and hospitals was analysed by a group of experts. Their findings were that the present air kerma based Agency Code of Practice uses theoretical methods for deriving absorbed dose that do not take into account individual variations within a particular type of chamber. Direct calibration in terms of absorbed dose to water will potentially remove much of the variation and it was recommended that a new Code of Practice be prepared.

Nutritional and Health Related Environmental Studies

Micronutrient malnutrition (sometimes referred to as 'hidden hunger') continues to affect hundreds of millions of people, particularly — but not only — in the developing world. Efforts to eliminate undernourishment focus on vitamin A, iron and iodine deficiencies because they are known to occur commonly in developing countries; moreover, because treatment methods exist progress can be measured unambiguously. The Agency has greatly expanded its work in this area, with attention directed to the use of isotopic techniques — mainly with stable isotopes — to identify populations at risk, and to monitor and improve the effectiveness of dietary intervention programmes. A new CRP in Latin America is using isotopes to measure the breast milk intake of infants, and to study the impact of breast milk volume and composition on growth. Isotope methods for measuring deuterium kinetics will be used in place of conventional measurements of breast milk intake, and other isotopic tracers will be used to evaluate nutritional reserves of vitamin A, iron and zinc.

Through the Agency's programmes and under the IAEA/UNEP/IOC Tripartite Memorandum of Understanding, one intercomparison exercise was completed (trace organic contaminants in IAEA-142, Mussel Homogenate) and two were ongoing (trace metals and trace organic contaminants in Sea Plant Homogenate

IAEA-140/TM and IAEA-140/OC, respectively). The current list of participants includes over 450 laboratories worldwide.

In an interagency collaborative effort, emergency assistance was provided in the Seychelles, where there was a large fish kill accident. Careful screening of the problem revealed that this was due to the high concentration of endsosulfan, a pesticide used in local agriculture.

In collaboration with UNDP, a pilot monitoring assessment within the Black Sea region was performed. The results indicated that the levels of oil, sewage and DDT contamination are generally comparable with those reported for the Mediterranean Sea and other regions of the world. Some 'hot spots' were, however, identified and substantial sewage contamination was recorded in some areas. For some compounds, such as combustion derived PAHs and industrial PCBs, levels in the Black Sea appear to be very low. Contamination by heavy metals also does not appear to be a basin-wide problem.

Together with Warwick University in the United Kingdom, a contaminant screening project on sediments and surface microlayers of water samples was conducted off the Chagos area in the Indian Ocean. It has been shown that this area is not affected by heavy pollution, and the only source of contamination in this pristine oceanic region is the long range atmospheric deposition of PAHs, PCBs and organochlorine pesticides.

Another contaminant screening programme was coordinated with the Regional Organization for the Protection of the Marine Environment (ROPME) in the Persian Gulf with the aim of pinpointing contamination hot spots in the coastal region. A report, issued in early 1996, played a key role in reorienting the ROPME regional monitoring programme for the next three years.

A Research Co-ordination meeting was held in Costa Rica as part of a project supported by Sweden on the distribution, fate and effects of pesticides on biota in the tropical marine environment using radiolabelled tracers. New information was presented on the degradation rates and bioaccumulation of chlorpyrifos, DDT and lindane, which was derived from the Agency's model ecosystem. This system comprises laboratory studies using radiotracers of these compounds under carefully controlled, simulated tropical conditions.

Biogeochemical cycling of mercury was studied in contaminated areas of the northern Adriatic Sea, where the

main source of inorganic mercury is through riverine inputs originating from a mercury mining area. It has been shown that the major source of methylmercury, the most toxic mercury compound, is from sediments due to sulphate reducing bacterial activity. These results represent a valuable contribution to the development of ecological modelling of mercury in contaminated sites.

In collaboration with an international team of scientists, the Agency's Laboratories at Seibersdorf played a leading role in a radiological study on marine and terrestrial samples collected at the atolls of Mururoa and Fangataufa in French Polynesia, where nuclear testing took place in 1995–1996. Measurements of samples were made both at the Agency's own laboratories and also by the Analytical Laboratories for Measuring Environmental Radioactivity (ALMERA), a network established by the Agency for this purpose.

A symposium was held in Hyderabad, India, in November on the harmonization of health related environmental measurements using nuclear and isotopic techniques. One strength of nuclear methods is in analytical quality assurance, including the validation of methods and the development of new reference materials. These methodologies are therefore helping to harmonize the data produced not only by nuclear techniques, but also by other non-nuclear methods of analysis. They are thus playing an important role in the application of newly emerging quality management and quality assurance standards (e.g. ISO-25 and ISO-9000). The meeting dealt with numerous applications of nuclear and related analytical techniques as used in the study of air particulates, solid waste products, sediments, food, water, human tissue and many other types of environmental samples. The Proceedings will be published in mid-1997.

INDUSTRY AND EARTH SCIENCES

Regular Budget expenditure: \$3 562 837

Expenditure by subprogramme

<i>Industrial applications</i>	\$830 739
<i>Development of water resources</i>	\$2 732 098

No extrabudgetary programme resources

Radioisotope production and its incorporation into a variety of labelled compounds, radiopharmaceuticals, tracers, gauges and special radiation sources for use in medicine, agriculture and industry constitute an important application of atomic energy. The Agency's programme on industrial applications focused on promoting the use of radiation technology, radiotracer techniques and nucleonic control systems, as well as non-destructive testing (NDT). With the growing demand in Member States for the use of isotope techniques in the development of water resources and for environmental investigations, greater efforts were undertaken to develop and apply these methods. The emphasis was on the search for water resources in arid and semi-arid regions, water pollution studies and other environmental issues, including soil erosion and siltation, atmospheric carbon dioxide and other greenhouse gases and the marine environment.

Industrial Applications

The sterilization of disposable medical products and devices by radiation is a well established industrial process aimed at improving the safety of health care services. Using the same methodology, the sterilization of pharmaceuticals such as drugs, herbal products and ointments is a promising new application which is attracting the increasing attention of industry. The services of consultants were used to examine the status of the implementation of radiation sterilization technology

in the pharmaceutical industry and to make recommendations on future Agency activities in this area.

The first Research Co-ordination meeting for a CRP on the irradiation treatment of water, wastewater and sludges was convened in Vienna. Three main target items — water intended for drinking, wastewater for irrigation or for disposal into ground or surface water reservoirs, and urban and rural sludges for agricultural applications — were considered. It was concluded that electron beam accelerators are best suited for a large throughput of water or wastewater, and recent improvements in the power conversion efficiency and power output of accelerators made decontamination and disinfection of wastewater and drinking water economically feasible.

An Advisory Group meeting was held in Guadeloupe, France, in November on radiation polymerization and modification of polymers. Discussions centred on the intrinsic advantages of using radiation in such applications as: cross-linking wires, cables and packaging materials; curing; grafting; synthesis and modification of polymers for biomedical applications; preparation of hydrogels; use of ion beams for the modification of polymers; preparation of composites; and reclaiming of polymer and rubber wastes, with emphasis on the treatment of plastic wastes.

A CRP that studied the use of nuclear methods in the monitoring of wear and corrosion in industry was

completed. A report on this research, issued in the IAEA-TECDOC series, provided information on the thin layer activation (TLA) technique, which permits remote monitoring of machine parts for wear and corrosion. This CRP contributed to: the development of new measurement methods; the collection of reliable data for TLA monitoring of various elements; the design of portable on-site wear measuring systems using NaI(Tl); and the measurement of corrosion in oil and gas pipelines.

The modification of materials by ion treatment for industrial applications is an area of interest for new material development. A CRP was initiated in 1996 and the first Research Co-ordination meeting was held in March. The main objective is to develop economically acceptable surface modification techniques that can produce 'thick' treated layers (i.e. a few micrometres) that will extend the lifetime of components under typical working conditions. Increasing the 'tribological performance' (i.e. wear, friction and lubrication) and preventing the corrosion of components are other goals of this CRP.

Residence time distribution (RTD) software for the data analysis of radiotracer experiments was completed under IAEA/RCA/UNDP activities. A manual and a software diskette were issued. The manual contains case studies that deal with problems in industry and the environment common to all countries. The software has been field tested and is being used in several Member States in experiment design and data analysis for a wide range of dynamic processes in industry, hydrology and the environment.

A CRP on the validation of protocols for the evaluation of corrosion and deposits in pipes by radiography was initiated. It incorporates quality assurance aspects of NDT measurements, including a round robin test and implementation of a quality plan. A quality management manual for a regional NDT project in Africa was developed.

Development of Water Resources

The final Research Co-ordination meeting on the application of tracer techniques in studies of processes and pollution in the Black Sea, conducted with IAEA-MEL, resulted in: a comprehensive and up-to-date assessment of radionuclide distributions, trends, inventories and sources in this environment; and an evaluation of doses delivered through marine exposure pathways to humans

and biota. The importance of applications of radioactive and stable isotope tracers to understand the fate of pollutants in this region was also demonstrated. Models were developed for predicting the impact of pollutants on various space and time-scales and these were fine tuned using radiotracer data.

Two new CRPs were initiated in 1996. One has the goal of improving the techniques of replenishment rate determination of groundwater systems through specific isotope and geochemical studies in the unsaturated zone. The second CRP focuses on the application of isotope techniques to problems associated with geothermal development. This CRP was designed to back up ongoing technical co-operation activities, including a three year regional project on the development of geothermal energy resources and environmental management through isotope techniques in East Asia and the Pacific, which was formulated at a regional workshop held in China in June.

To meet the need in Member States for studies of marine environmental problems, especially in areas of closed and partially closed seas such as the Mediterranean, Baltic and Black Seas, an international seminar on the use of isotope techniques in marine environmental studies was held in November in Athens. The seminar was jointly organized with IAEA-MEL and hosted by the Greek Atomic Energy Commission. The papers addressed both methodological aspects and advances related to the application of isotope and geochemical techniques in marine environment research, and topical problems of seawater pollution. The seminar offered specific proposals for strengthening collaboration between countries and for future Agency involvement in marine environment studies.

The steering committee of the Global Network for Isotopes in Precipitation (GNIP) was established in 1996 with the involvement of the Agency, WMO, the World Climate Research Programme and the International Geosphere-Biosphere Programme as represented by its core project PAGES (Past Global Change). This committee is expected to facilitate closer co-operation between the organizations in the provision of high quality data to scientific communities for hydrological and climatological applications. In this context, the development began of a database to meet the growing needs of Member States for basic isotope hydrology information for water resources assessment and environmental research.

On the basis of information from a model project in

Venezuela, 50 new wells were located and subsequently drilled, reducing the water supply deficit to Caracas by 25 million litres per day. A model project in El Salvador identified the best zones for production and reinjection in the Berlin and Ahuachapan geothermal fields.

Phase I of a model project for regional Africa seeks to identify palaeowater in Morocco, characterize the interaction between the Nile aquifer system and the adjacent Nubian sandstone aquifer (in Egypt), identify renewable and non-renewable resources in the Moyale area in Ethiopia, and collect isotope data to reassess groundwater resources around Dakar, Senegal, which is suffering a severe water shortage. The information obtained will help local authorities in these countries to develop and improve the management of their water resources.

A regional ARCAL XVIII project involving six countries (Brazil, Chile, Costa Rica, Cuba, Mexico and Venezuela) in the use of tracer techniques to study dam leakage was completed. The reservoirs selected are used for drinking water supply, irrigation and electric power generation. In a few cases where a link was found between the suspected leakage and the reservoir, corrective measures were suggested to the local authorities in charge of reservoir management and maintenance. In no case was the dam structure endangered by the leakages. Savings of \$6 million resulted from the successful implementation of this project.

A second three week research/training cruise in August–September 1996 on the Caspian Sea was carried out as

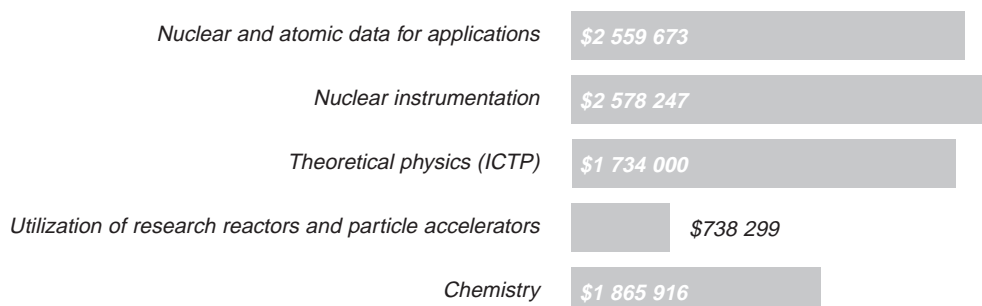
part of a technical co-operation project study of Caspian Sea water level fluctuations. The cruise combined training activities on board an Azerbaijani research vessel with oceanographic field work at 19 stations of the Caspian Sea. The combination of training and research activities has led to greater collaboration among specialists of all the riparian countries, and contributed to the training of personnel in tackling environmental problems in the region. The experimental studies carried out so far have considerably refined and extended the oceanographic and isotope-geochemical database of the Caspian Sea. The reevaluation of existing data on water balance parameters of the Caspian Sea provided a strong argument that the river runoff fluctuation has a dominating influence on sea level variation. Thus, changes in the hydroclimatic conditions in the catchment area of the Caspian Sea appear to be the major causes of the sea level fluctuations.

In support of technical co-operation projects, research contracts and regional programmes, as well as to provide data for the IAEA/WMO GNIP, 3200 water samples were analysed by the Agency's Laboratories for deuterium, 3100 for oxygen-18, 1200 for tritium, 70 for carbon-14 and 210 for carbon-13. About 1400 chemical analyses were performed on some 160 water samples. Approximately 400 samples of stable isotope reference and intercomparison materials and ten sets of carbon-14 intercalibration materials were distributed to isotope hydrology laboratories in various Member States.

PHYSICAL AND CHEMICAL SCIENCES

Regular Budget expenditure: \$9 476 135

Expenditure by subprogramme



Extrabudgetary programme resources utilized (not included in chart): \$ 93 166

The Agency's activities in the physical and chemical sciences cover nuclear and atomic data, which are basic inputs for all nuclear applications; nuclear instrumentation, the tools for the measurement and quantification of nuclear radiation; the utilization of research reactors and low energy accelerators for a variety of applications; and radiochemical applications relevant to radioisotope production and use in nuclear medicine, industry and ultratrace analysis. During 1996, the availability of nuclear and atomic data libraries for users worldwide was enhanced through the introduction of a World Wide Web interface. Newly initiated CRPs in the area of nuclear instrumentation are concerned with the development of improved software for gamma spectrometry and computer assisted troubleshooting of instrument faults. Application of the X ray fluorescence (XRF) technique was expanded in several areas and efforts continued to be directed towards better utilization of existing research reactor and low energy accelerator facilities in Member States. The main focus of radiochemical applications was on the development of new and novel radiopharmaceuticals for the diagnosis of neurological disorders in patients and to further explore the field of therapeutic radiopharmaceuticals. The Agency's Analytical Quality

Control Service (AQCS) continued to try and improve the accuracy of analytical and radiometric measurements in Member State laboratories to ensure the international acceptance of such measurements.

Nuclear and Atomic Data for Applications

In response to rapid developments in electronic computer networks, Internet access to the nuclear and atomic databases of the Agency was improved through the introduction of a World Wide Web interface. The available databases provide the most accurate and up-to-date nuclear physics data files that are needed for all nuclear technology applications. The use of on-line data retrievals again increased by about 50%, benefiting several hundred end-users in a growing number of Member States. In addition to the extended on-line services, conventional services continued to institutes in more than 80 Member States.

In response to the needs of the International Thermo-nuclear Experimental Reactor in its Engineering Design Activities, a validated and tested fusion evaluated nuclear

data library (FENDL-1) was officially released. An improved database for particle-impact-induced erosion of fusion reactor materials was also completed.

Co-ordination of the International Data Network of Nuclear Data Centres resulted in the release of four major databases, two of them of interest applicable in materials analysis by gamma spectroscopy. A neutron metrology file was released for use in reactor neutron dosimetry.

A CRP was begun on photonuclear data. The aim is to produce a handbook and data library for improved dose rate predictions on photon radiotherapy using medical electron accelerators.

Nuclear Instrumentation

A CRP was initiated on specialized software utilities for gamma ray spectrometry. This research will help Member States improve their ability to analyse trace quantities of materials by means of computer assisted nuclide identification, quality assurance provisions and 'loss free' counting and air monitoring.

The Agency's Laboratories at Seibersdorf continued to help many Member States to improve nuclear analytical techniques and upgrade infrastructures for nuclear instrument repair and maintenance by providing technical advice, documentation, troubleshooting tools and kits. Upon request, the Laboratory also designed and built special instruments and training kits, such as a portable dosimeter, a portable XRF unit power supply, a UNOLAB timing single channel analyser, a counting instrument and a digital temperature controller for entomology research.

The Laboratories also promoted the use of the XRF technique for materials analysis by improving the steps in this analytical method, including sample preparation, measurement and data processing. Optimum sample preparation procedures for X ray microfluorescence were developed for geological, biological and environmental materials. A new total reflection XRF module was constructed and put into operation implemented for routine analysis. Several portable XRF units were developed to extend the applicability range of XRF for in situ measurements, including one based on a thermoelectrically cooled silicon detector.

An e-mail distribution service was established in Africa with the assistance of the Agency's Laboratories to facilitate regional co-operation in nuclear instrument

maintenance. The resulting improved links between Member States, the Agency and suppliers will speed up the provision of spare parts and technical documentation. Since infrastructure for training has improved considerably in the past year, the Laboratories can now offer unique, practically oriented and specialized training programmes for Fellows from developing Member States in the repair, servicing and design of nuclear instruments, computer interfacing, power conditioning, and methodology and applications of various XRF techniques.

Utilization of Research Reactors and Particle Accelerators

At a seminar on the enhancement of research reactor utilization, held in Mumbai, India, in March, the role of research reactors in providing services to Member States was highlighted. Some of the topics discussed were: radioisotope production; industrial irradiation; neutron activation analysis; neutron beam applications; reactor refurbishment; and reactor operations. The objectives of the seminar were to provide ideas for the better utilization of research reactors and foster contacts for greater international co-operation.

The first Research Co-ordination meeting for a CRP on the analysis of research reactor transients was held in Vienna. The goal of the CRP is to develop updated codes suitable for the small computers available at research reactor centres, as well as expertise, procedures and documentation for carrying out reactor transient calculations.

An agreement was signed between the Agency and the Rudjer Bošković Institute in Zagreb, Croatia, for utilization of the Agency beamline on the accelerator at that institute. This agreement extends the nuclear analytical capabilities of the Agency to incorporate the field of accelerator ion beam applications. The Agency beamline was utilized for the analysis of soil and plant samples, glass fibres, air filters and algae samples, which are candidate reference materials.

Chemistry

Technetium-99m ($^{99}\text{Tc}^m$) continues to dominate diagnostic nuclear medicine and efforts continued to support the development of $^{99}\text{Tc}^m$ radiopharmaceuticals for new applications, with the focus on early detection of various diseases. Receptor binding molecules labelled with $^{99}\text{Tc}^m$,

such as peptides, are of particular interest in view of their potential role in the diagnosis of a variety of disorders, and possible therapeutic treatment by replacing $^{99}\text{Tc}^{\text{m}}$ with chemically analogous, beta emitting nuclides such as rhenium-188/186.

A CRP on $^{99}\text{Tc}^{\text{m}}$ labelled peptides for imaging peripheral receptors, particularly analogues of the neuropeptide somatostatin, was initiated. Many neuroendocrine tumours are rich in somatostatin receptors. $^{99}\text{Tc}^{\text{m}}$ labelled somatostatin analogues would be useful in imaging such tumours. This CRP focuses on $^{99}\text{Tc}^{\text{m}}$ labelling of appropriately derivatized analogues of somatostatin and the development of radiochemical and biological quality control methods for assessing their suitability for imaging. The first Research Co-ordination meeting was held in Portugal.

Another CRP on the development of agents for imaging central neural system (CNS) receptors based on $^{99}\text{Tc}^{\text{m}}$ was also initiated. The development of $^{99}\text{Tc}^{\text{m}}$ CNS receptor specific agents is expected to have a significant impact on the diagnosis and management of patients suffering from neurological disorders such as Parkinson's disease, Alzheimer's disease and schizophrenia, owing to the widespread availability of $^{99}\text{Tc}^{\text{m}}$. The CRP will focus in the first phase on the synthesis of neutral $^{99}\text{Tc}^{\text{m}}$ complexes that are able to cross cell membranes and can be derivatized to attach CNS receptor binding moieties. In the second phase, $^{99}\text{Tc}^{\text{m}}$ labelling of such chelate moieties and their evaluation using in vitro and in vivo models will be carried out.

Interest in targeted radiotherapy using radiopharmaceuticals has been growing in view of its potential advantages over conventional radiotherapy. At the second Research Co-ordination meeting, held in Brazil, for a CRP on optimizing the production of novel therapeutic radionuclides, promising results were reported for the palliation of metastatic bone pain using samarium-153 diphosphonates. The recent introduction of monoclonal antibodies and peptides for the specific targeting of radionuclides in vivo has highlighted the possible use of such biomolecules for targeted radiotherapy. An Advisory Group meeting on labelled biomolecules for such radiotherapy was held in the Netherlands to suggest future directions for research in this area. The meeting reviewed the present status of targeted radiotherapy and identified two prospective areas for further research, one on small molecules such as rhenium-186(V) DMSA and

the other on monoclonal antibodies and peptides labelled with yttrium-90 and samarium-153.

Fluorine-18 and iodine-123 are two cyclotron produced radioisotopes which can be used to label natural substrates, biomolecules and drugs for use as biochemical tracers in tomographic imaging. These tracers show great promise in the study of molecular medicine in vivo. A new CRP was initiated which focuses on the optimization of synthetic procedures, automation of production, development of quality control methods and biological assays for iodine-123 and fluorine-18 labelled peptides.

The Agency's AQCS, through its laboratories at Seibersdorf, initiates and supports improvements in the accuracy of analytical chemistry and radiometric measurements and their traceability to basic standards by, among other things, distributing reference materials. In order to harmonize quality requirements for the production of Agency reference materials and for certification procedures with international standards, the AQCS formulated good analytical practices for the certification of such materials. Work began on the certification of two proposed algae reference materials (as per ISO 'Guide 35') that will serve as models for the certification of future materials.

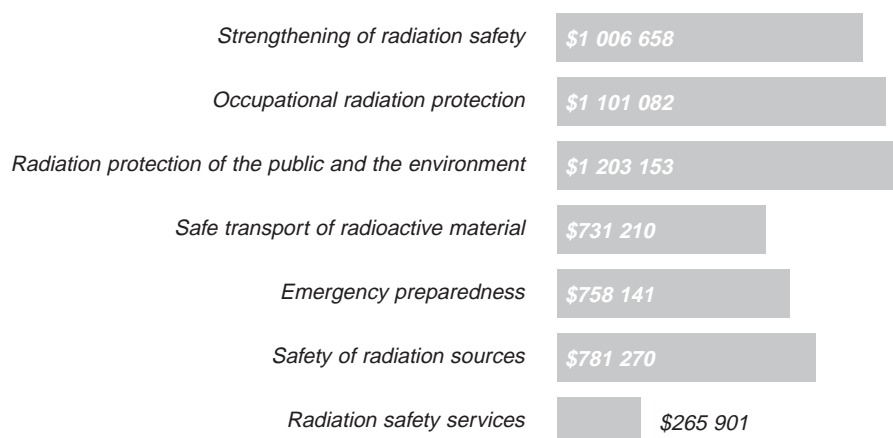
Trace element analysis of objects, especially ceramic materials, recovered in archaeological excavations are very useful for establishing chronologies. Of the various techniques available with sufficient sensitivity and precision to provide useful data in archaeological research, instrumental neutron activation analysis (INAA) is one of the most effective. In a new CRP archaeologists and experts in INAA from a number of Latin American countries will be brought together to apply INAA for archaeological investigations with the active collaboration of the Smithsonian Institution in the USA.

Nuclear analytical techniques (NATs) are useful in the precious and rare metal and mining industries for: determining the chemical composition of major, minor and trace elements; yield optimization of the separation process; quality control programmes; and the minimization of waste and pollution. A CRP on the development of NATs for precious and rare metals in mineral concentrates was initiated. This is expected to help realize the enormous potential of these techniques to improve raw material utilization in ore processing and lead to savings in energy and materials in these processes.

RADIATION SAFETY

Regular Budget expenditure: \$5 847 415

Expenditure by subprogramme



Extrabudgetary programme resources utilized (not included in chart): \$1 096 687

The work programme on radiation safety has as its major objectives the development of a unified set of consensus safety standards and provisions for their implementation in Member States. The main areas of work contributing to these objectives are: the development and harmonization of radiation safety standards, including regulations for the safe transport of radioactive material, and for the safety and security of radiation sources; provisions for the specification and implementation of emergency procedures; practical assistance services; and training and information exchange. Another important effort has been support for a technical co-operation model project on strengthening radiation and waste safety infrastructures in over 50 Member States.

Strengthening of Radiation Safety

Work focused on the preparation of a structure plan for documents for consideration by the Radiation Safety Standards Advisory Committee (RASSAC), which held

its first two meetings during the year. Considerable progress has been made in developing key documents within this structure which are supportive of the *International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Sources* (BSS) (jointly sponsored by the FAO, IAEA, ILO, OECD/NEA, PAHO and WHO) published in final form in 1996. A review of the documents was completed as a result of which a number of existing documents were found to be obsolete, others were found to be in need of revision for compliance with the BSS, and new documents were proposed. The structure plan was approved at the second meeting of RASSAC in July.

In order to strengthen radiation safety infrastructures in Member States and also support a technical co-operation model project, action plans was adopted. These plans cover: laws and regulations and the establishment of a regulatory authority, implementation of occupational and public dose controls, including environmental monitoring, medical dose control systems; emergency planning;

transport safety control systems; and support services and personnel development. Priority was given to the establishment of a system for notification and licensing. All of these areas are monitored to ensure consistency across the 53 States involved in the model project. In a separate but related initiative, information on the safety infrastructure status and needs of other countries continued to be maintained so that the situation in the 93 countries currently receiving or having received radiation safety related assistance is known.

The open ended group of legal and technical experts set up to develop a draft convention on the safety of radioactive waste management met three times during the year. The convention is modelled on the Convention on Nuclear Safety and is also on an 'incentive' basis. It contains a reporting requirement to a meeting of Contracting Parties and relies for its implementation on a peer review process. The convention is intended to apply to all radioactive wastes and implements the rules set out in Safety Fundamentals No. 111-F, *The Principles of Radioactive Waste Management*. It also includes the provisions of the Agency's *Code of Practice on the International Transboundary Movement of Radioactive Waste* (INFCIRC/386). Areas of difficulty in the development of the convention have included the extent to which it should apply to the safety of spent fuel management, the arrangements by which wastes from military and defence activities should be brought under the scope of the convention and the provisions to be applied to discharges of radioactive materials to the environment.

Occupational Radiation Protection

Meetings were convened during the year to arrive at a technical consensus on material to be incorporated in three interrelated Safety Guides, one covering occupational radiation protection and the other two specific to protection against external radiation or incorporated radionuclides. The Agency's co-sponsorship with the OECD/NEA of the Information System on Occupational Exposure continued; by the end of the year nuclear power plants from eight Member States not members of the OECD and regulatory authorities from four of these States were participating in this system.

Several CRPs were initiated on occupational dose monitoring and assessment methods covering: external and internal exposure to radiation; intercomparisons for individual monitoring for external exposure to photons;

calculational intercomparisons of internal dose assessment methods; and intercomparison of in vivo counting systems using a reference Asian phantom. Guidance on measures and procedures for handling accidents resulting in radionuclide contamination of individuals, issued in 1986 and 1988, was revised. Some Member States have developed schemes to compensate workers who may have cancer as a result of exposure to radiation during their work. Information on techniques for making quantitative estimates of the probability of causation of cancer as a function of occupational radiation exposure was compiled and issued as a technical document. Since post-mortem measurements of long lived radionuclide content in human tissues can provide valuable information on the biokinetics of actinide elements, guidance on the establishment and use of related registries was prepared.

Radiation Protection of the Public and the Environment

In April 1996, an international conference entitled 'One Decade after Chernobyl: Summing up the Consequences of the Accident', co-sponsored by the European Commission and WHO, was held in Vienna. The conference was organized in co-operation with the United Nations, UNESCO, UNSCEAR, FAO and the OECD/NEA. It was presided over by Germany's Federal Minister for the Environment, Nature Conservation and Nuclear Safety and attended by officials and members of government, notably from Belarus, Ukraine and the Russian Federation. The conclusions of the conference provide an authoritative assessment of the consequences as they are now understood. They have been disseminated widely, especially through public information booklets.

A major area of work concerned the assessment of the radiological situation and the need for remedial action in locations contaminated as a result of nuclear weapons testing. Two assessments, at Semipalatinsk in Kazakstan and at Bikini Atoll in the Marshall Islands, were completed during the year.

The radiological legacy of the French nuclear weapon testing programme at the Mururoa and Fangataufa Atolls is the subject of a study begun in 1996 by the Agency at the request of the Government of France. The goal is to assess the present and potential future radiological situation at the atolls and the involved areas. France has offered to provide information and the data needed to carry out the assessments. An International Advisory Committee (IAC) comprising experts from ten

Member States and from the European Commission, the South Pacific Forum, UNSCEAR and WHO provided scientific guidance to the Agency. Two Task Groups supported by a number of Working Groups are carrying out the scientific assessments. The IAC met in Vienna in April, in Suva, Fiji, in December at the headquarters of the South Pacific Forum and, subsequently, in Papeete, French Polynesia.

This assessment also makes use of the large amount of data collected over many years by France on the levels of radioactive material in the environment of that region. Since this very comprehensive database must be validated, an independent sampling and surveillance campaign coordinated by the Agency's Laboratories at Seibersdorf and IAEA-MEL was carried out at the atolls during July and samples were given to an international network of laboratories for analysis. Furthermore, an independent estimate of the inventory of residual radioactive material in the cavities, and of the distribution of nuclides between the lava and rubble within each cavity, was completed in 1996.

Safe Transport of Radioactive Material

As part of the reorganization of the safety standards preparation and approval process, the Standing Advisory Group for the Safe Transport of Radioactive Material was replaced by the Transport Safety Standards Advisory Committee (TRANSSAC), which met in February. Its first task was to approve the revised *Regulations for the Safe Transport of Radioactive Material*. These were subsequently endorsed by the Advisory Commission on Safety Standards (ACSS) and approved by the Board of Governors in September, and published as the first title in the new Safety Standards series. In parallel, work proceeded on the revision of the accompanying explanatory and advisory material, which has been combined in a single document intended for issue as a Safety Guide.

Emergency Preparedness

Considerable streamlining and combining of documents on emergency planning and technical response has taken

place with the agreement of RASSAC. A review of the Emergency Response Unit was completed with evaluations of the effectiveness of the new procedures during two major international exercises, one held in May in Austria ('Viribus Unitis') and the other in November in Switzerland ('INEX-2 SWISS'). The resulting revised internal procedures and improved means of communication will significantly enhance the Agency's ability to fulfil its obligations under the Conventions on Early Notification of a Nuclear Accident and on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

Safety of Radiation Sources

Publications on accidents with major radiation sources involving injuries or deaths continue to add to knowledge on how to avoid such accidents in the future. During 1996, reports on accidents at Nezvizh (Israel) and Hanoi (Viet Nam) were published and those on accidents in Estonia and at the facility at Tomsk-7 in the Russian Federation were completed. To synthesize and make the conclusions more generally applicable, three reports on 'lessons learned' from accidents at different types of facilities are being prepared. One such report on accidents in industrial irradiation facilities was published in 1996. A major aspect of this work is the contribution to improving the safety of sources in Member States, especially through the technical co-operation model project on strengthening radiation and waste safety infrastructures. Practical procedures for inspecting and carrying out safety assessments on all types of sources were prepared and a number of training materials developed.

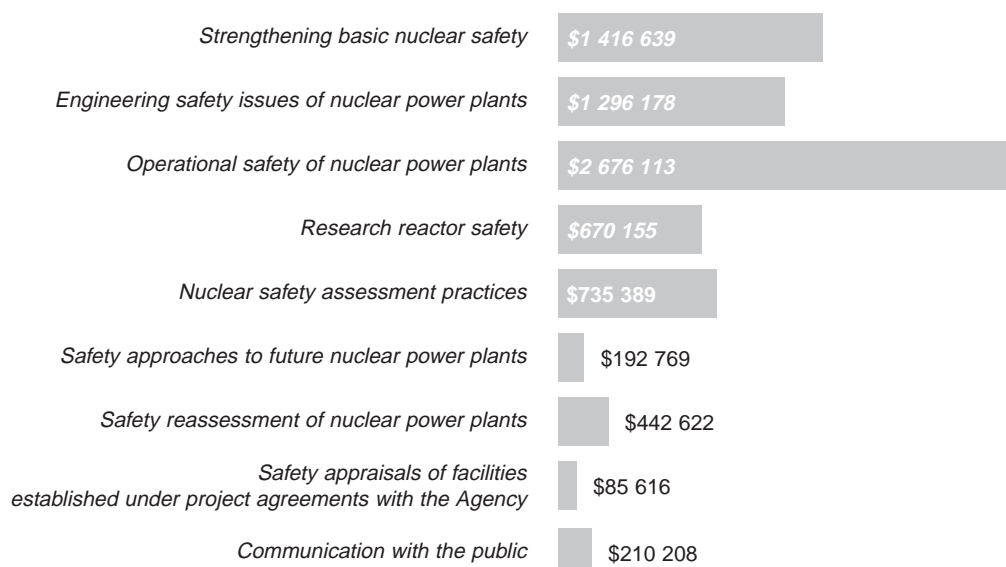
Radiation Safety Services

Personnel monitoring and other services, including in-house training, continued to be provided to Agency staff involved in safeguards activities, to other Agency personnel and to field experts. One mission to Armenia was undertaken to investigate a possible case of over-exposure and another went to the Vinča research reactor near Belgrade to evaluate the safety of the spent fuel pool.

SAFETY OF NUCLEAR INSTALLATIONS

Regular Budget expenditure: \$7 725 689

Expenditure by subprogramme



Extrabudgetary programme resources utilized (not included in chart): \$3 060 791

Agency activities in nuclear safety concentrated on supporting intergovernmental efforts to strengthen nuclear safety worldwide. The focus was on preparing for the implementation of the Convention on Nuclear Safety, fostering the exchange of information on safety issues, developing common safety standards, providing a variety of expert services and supporting co-ordinated research work in Member States.

Strengthening Basic Nuclear Safety

The Convention on Nuclear Safety entered into force on 24 October 1996. In June, a third informal meeting of representatives of signatories and other interested States completed draft rules of procedure, financial rules for meetings of the Contracting Parties, and draft guidelines

regarding the form and structure of national reports and on the review process under the Convention for consideration at the Preparatory Meeting of Contracting Parties in 1997. By the end of 1996, 65 countries had signed the convention and 32 countries had deposited instruments of ratification, acceptance or approval.

With the assistance of experts from regulatory, operating and engineering organizations, a report was prepared supplementing information issued earlier (in INSAG-4) by describing practices that have proved to be of value in establishing and maintaining a sound safety culture. It expands on the development and improvement of safety culture as a dynamic, progressive process, detailing three stages of development: safety based on rules and regulations; good safety performance becoming an organizational goal; and steady improvement of safety

performance. Practices are divided into general practices pertaining to certain values needed for continuous evolution of improved safety performance, and specific practices covering a wide range of activities including analysis of events, the regulatory approach, employee participation and safety performance measures. Recommendations emphasize the importance of consistent commitment to improving safety, the learning process and the role of the regulatory body.

Safety is a topical issue in the development of fusion reactors. Recent developments in fusion safety were reviewed and discussed at a meeting in Naka, Japan. The topics addressed were safety activities within national and international fusion programmes, including selected experimental studies, safety analysis and assessment methods, and considerations relating to magnet and seismic safety, recycling of activated materials and disposal of radioactive waste. Although fusion safety studies have been under way for over two decades, continuing research efforts are required on the optimization of protection as fusion technology develops. Exploration of specific aspects, such as the generation of radioactive dust in fusion reactors, are gaining importance.

In order to advise on the revision of all of the Agency's nuclear safety standards, the Nuclear Safety Standards Advisory Committee (NUSSAC) held its first two meetings in 1996. In the revision process, documents dealing with operational safety will receive the highest priority. A plan for the revision of documents dealing with design and siting was agreed upon. As quality assurance and governmental organization were considered important for nuclear, radiation and waste safety, and not just for nuclear installations, the Agency's Advisory Commission on Safety Standards (ACSS) initiated work on the revision of the existing Code on governmental organization to broaden its scope and cover all areas of safety.

As a result of the fourth series of peer discussions of senior regulators from 23 Member States on regulatory practices, a report was prepared on measures needed to assess the safety of existing nuclear power plants and the effectiveness of regulations and regulatory actions. The discussions addressed the merits of both the 'prescriptive' and the 'performance based' regulatory approaches. A combination of the two was found to be desirable, with a trend towards the performance based approach, which focuses on results obtained through the operating organization's activities to demonstrate compliance with regulations. The peer discussions also yielded a number of good safety practices.

Assistance through a technical co-operation model project to the nuclear regulatory authority of Slovakia (SNRA) in the areas of emergency preparedness, radioactive waste control, quality assurance, site inspection, periodic safety assessment and training had a substantial impact on the ability of SNRA to become an independent regulatory body. The experience acquired was used in providing assistance to the nuclear regulatory bodies of the Czech Republic and Hungary, and in drafting programmes of assistance to the regulatory bodies of Armenia and Ukraine.

Upon request, the Agency has been providing assistance and a wide range of services aimed at establishing and enhancing nuclear safety in Member States. Reviews revealed that all organizations involved in nuclear safety have become increasingly aware of the need to consider and implement corrective measures to meet general safety objectives, and to take account of current trends towards plant life extension and decommissioning. To improve the implementation of nuclear safety assistance programmes and services, a new strategy for providing assistance to Member States was developed, incorporating greater integration of safety related activities. Following an initial approach from a Member State for nuclear safety assistance, a review of the actual situation in the Member State will be carried out against a pre-defined and accepted international 'reference situation'. The comparison will be in the form of an overview to identify general areas where the Agency could provide the maximum benefit to Member States such as establishing and strengthening regulatory bodies, training personnel, providing safety review missions and endorsing assessment capabilities.

Engineering Safety Issues of Nuclear Power Plants

Engineering safety activities continued to focus on ageing, fire and seismic safety, and on the safety of plants built to earlier standards. A CRP on the management of ageing of concrete containment buildings concluded with the preparation of a report presenting information on potential degradation mechanisms, areas susceptible to degradation and methods for detecting and mitigating the effect of ageing. This information provides a technical basis for implementing plant specific ageing management programmes. Instrumentation and control and power cables are critical nuclear power plant components from both the safety and plant life perspectives. Work under phase I of a CRP on the management of ageing of in-containment instrumentation and control cables was completed, resulting in recommendations for ongoing qualification and condition

monitoring methods in nuclear power plants. Phase II of this CRP, focusing on the development and validation of the most promising condition monitoring techniques, was started.

A safety report on the assessment of the overall fire safety arrangements of nuclear power plants was issued and two reports, one on fire safety during the operation of nuclear power plants and the other on the preparation of fire hazard analyses for such plants, were completed. A fire safety mission visited the Temelin nuclear power plant in the Czech Republic.

Within the scope of a CRP on benchmark studies for the seismic analysis and testing of WWER type nuclear power plants, a second full scale dynamic test was conducted for the reactor building of Unit 5 of the Kozloduy nuclear power plant (WWER-1000). Experts are involved in the prediction of test results using state-of-the-art analytical methods and simplified procedures. A detailed comparison of their findings will be completed in 1997. Assessments of the seismic input for many WWER plants have been completed and certain upgrades have already been implemented in these plants. Delays were experienced in the work schedule for structural upgrades, which require substantial effort and financial resources. As a result, expert missions to review these upgrades were also facing delays. Nevertheless, a total of nine reviews were conducted for WWER or other types of plants in relation to siting and external hazards under the Agency's Engineering Safety Review Services.

The final report of a regional project on evaluation of the safety aspects of WWER-440 model 213 nuclear power plants was published. The project, initiated in 1991 at the request of the Atomic Energy Commission of the former Czechoslovakia, was designed to co-ordinate assistance in studying selected aspects of the safety of WWER-440/213 plants. It integrated the results of national activities carried out in the Czech Republic, Hungary, Slovakia and Ukraine. The report includes a comprehensive description of assessments. General conclusions in the report centre on the safety of plants based on the WWER-440 model 213, particularly of the Bohunice V2 reference plant. Detailed responses to the comments of an international peer review relating to design and beyond design basis accident analysis and management are also included in the report.

MELSIM, a severe accident simulation training system comprising a workstation with a personal computer and networking developed by the Agency for the Czech Dukovany and Chinese Qinshan nuclear power plants, was

demonstrated during the General Conference. The simulation is based on the US Nuclear Regulatory Commission's severe accident analysis computer code MELCOR.

Operational Safety of Nuclear Power Plants

Operational Safety Review Team (OSART) missions, which are comprehensive on-site operational safety reviews, continued to be conducted at the request of Member States. Follow-up visits, routinely conducted 12 to 18 months after an OSART mission, indicated a high rate of completion or satisfactory progress on recommendations and suggestions made by the OSART mission. The OSMIR database includes the results of 32 OSART missions and 15 follow-up visits conducted during the last five years; by the end of 1996, 93 copies of OSMIR had been disseminated to the nuclear industry.

Peer reviews of self-assessments continued. In 1996, Assessment of Safety Significant Events Teams (ASSETs) performed four such peer reviews, conducted seven training seminars to familiarize plant staff with ASSET guidance for plant self-assessment of operational safety performance, and organized a regional training course on operational safety assessment techniques in Madrid, Spain.

In order to assist countries in making the best and most effective use of the Incident Reporting System (IRS), a joint IAEA-OECD/NEA Advisory Committee (IRRS-AC) was constituted. At its first meeting in March in Vienna, this Committee made recommendations on the operation, maintenance and improvement of the IRS.

A report summarizing national practices on the use of unusual events in operational experience feedback was issued to supplement earlier information. The full text and image database, known as AIRS (Advanced Incident Reporting System), containing approximately 2500 national reports, underwent trial use by participating Member States of the IRS. Several topical studies were performed in the framework of IRS activities: events connected with vendor/contractor activities, events during low power and shutdown modes and single human failures resulting in significant degradation of safety equipment.

The second mission of a new module of safety services, peer review of the national operational experience feedback processes, was organized in November in Ukraine. Important events and generic problems reported to the

IRS were summarized in the *IRS Highlights 1995–1996*. National presentations at two IRS meetings in 1996 (the Joint Meeting to Exchange Information on Recent Events in Nuclear Power Plants and the Annual Meeting of the IRS National Co-ordinators) revealed that recent events at nuclear power plants occurred as a result of problems with batteries, valves, fuel and control rods, pressure tubes and signal systems, and that foreign material intrusion and corrosion phenomena continue to be a source of concern.

Research Reactor Safety

Over 270 research reactors are currently operating around the world. To promote the exchange of experience on the safety of these reactors, preparations were made to launch an Incident Reporting System for Research Reactors (IRSARR), including the development of a computerized data storage system with an associated user's guide, and the compilation of initial data selected from reported incidents. Safety related advisory missions visited research reactors in five Member States (Colombia, Egypt, the Syrian Arab Republic, Thailand and Zaire). A special meeting of research reactor managers and regulators from nine Member States holding project facility agreements with the Agency convened in Vienna to discuss their experience with such missions and to suggest improvements. The need to share information on the major findings of all individual missions was expressed. Information on good practices identified and recommendations made for the further improvement of research reactor safety could be shared through a comprehensive electronic database.

Nuclear Safety Assessment Practices

International Peer Review Service (IPERS) missions visited two nuclear power plants in 1996: Temelin in the Czech Republic and Atucha I in Argentina. In addition, a pre-review for the probabilistic safety assessment (PSA) of Ulchin Units 3 and 4 in the Republic of Korea was carried out.

One of the IPERS missions included a review of the Level 2 PSA, which considers accident progression within the plant and assesses the characteristics of potential releases of radioactive material to the environment during severe accidents. It was found that specific features of the particular containment design can significantly influence the course of events during severe accidents. The review showed that the information and

results from a Level 2 PSA are increasingly used for studying severe accident management measures and features that are intended to terminate or mitigate severe accidents.

A CRP on methodologies for the optimization of surveillance testing and maintenance of safety related equipment at nuclear power plants was launched. The overall objectives are to develop strategies and exchange experience with regard to: the improvement and optimization of the maintenance and test programmes for safety related systems and equipment; techniques for safety specific optimization of maintenance and surveillance testing; definition of acceptance criteria; and regulatory acceptance of the optimization process. Another activity was the completion of a report on regulatory oversights of safety related maintenance activities at nuclear power plants.

Safety Reassessment of Nuclear Power Plants

Member States operating WWER and RBMK reactors requested a review of the completeness of proposed safety improvements for these reactors. It was found that the programmes of safety modifications developed by countries operating such plants are generally structured in response to deficiencies identified through Agency activities. Guidance was also provided for the resolution of the generic safety issues that were identified. The technical findings were compiled in a database which includes all identified safety issues. In addition, the plant specific status of the implementation of safety upgrades has been linked to the database on assistance projects established by the G24 Nuclear Safety Assistance Co-ordination secretariat in Brussels.

Guidelines were developed for accident analysis on the basis of the conservative approach normally used for licensing new plants. Studies were carried out on the use of best estimate methods to determine success criteria in PSAs and develop emergency operating actions. The goal is to ensure that plant specific accident analysis will be performed for each installation, including safety related hardware and software modifications.

The integrity of WWER reactor pressure vessels (RPVs), particularly in WWER-440/230 plants, remains a matter of concern. In addition to uncertainties in the vessel material properties, and delays in implementation of related necessary plant modifications, deficiencies were

found in the pressurized thermal shock analysis (PTS) for RPV integrity assessment. Consequently, the demonstration of RPV integrity may not be conservative and the emergency operating procedures may not be adequate to guide the operator in the case of a PTS event. Guidelines on PTS analysis for WWER reactors were therefore developed and a CRP to provide a basis for judgement on the reliability of material properties data was established.

Communication with the Public

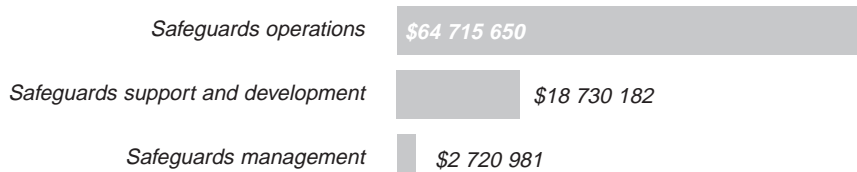
The International Nuclear Event Scale (INES) facilitates the communication and understanding of nuclear and

other radiation incidents to the public. In 1996, 59 countries provided information on 66 events. Three incidents were classified as serious incidents (Level 3): one involved a spread of contamination in a nuclear power plant and two concerned radiation exposure over the dose limit in non-reactor installations. Ten Level 2 incidents were reported, the majority of which involved some degradation of provisions for defence in depth. Work was undertaken on simplifying the INES procedure for rating the severity of defence in depth degradations, developing a computerized INES rating procedure and gaining a better understanding of the use of INES at the national level.

SAFEGUARDS

Regular Budget expenditure: \$86 166 183

Expenditure by subprogramme



Extrabudgetary programme resources utilized (not included in chart): \$14 503 508

Note: An amount of \$1 941 316 for implementation of United Nations Security Council Resolution 687 on Iraq is included in the extrabudgetary figure

Safeguards Statement

In fulfilling the safeguards obligations of the Agency in 1996, the Secretariat did not find any indication that nuclear material which had been declared and placed under safeguards was diverted for any military purpose or for purposes unknown, or that safeguarded facilities, equipment or non-nuclear material were misused. All the information available to the Agency supports the conclusion that the nuclear material and other items which had been declared and placed under Agency safeguards remained in peaceful nuclear activities or were otherwise adequately accounted for.

The Agency is still unable to verify the correctness and completeness of the initial declaration of nuclear material made by the Democratic People's Republic of Korea (DPRK) and the Agency is therefore still unable to conclude that there has been no diversion of nuclear material in the DPRK. The safeguards agreement between the DPRK and the Agency remains in force, and the Agency is continuing to implement safeguards measures in the DPRK under this agreement, including the monitoring of the "freeze" on the DPRK's graphite moderated reactors and related facilities, as requested by the United Nations Security Council and as foreseen

in the "Agreed Framework" of October 1994 between the DPRK and the United States of America

The Agency has continued its endeavour to strengthen the effectiveness and to improve the efficiency of the safeguards system. This includes efforts to strengthen the capability for detecting undeclared nuclear material, facilities and activities. A number of measures endorsed by the Board have been implemented. Progress has been made on the development of a model protocol additional to safeguards agreements to provide the necessary authority to implement complementary measures.

As of 31 December 1996, 214 safeguards agreements were in force with 131 States (and with Taiwan, China), compared with 207 agreements with 125 States (and with Taiwan, China) at the end of 1995.

Safeguards agreements pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) entered into force with Dominica and St. Kitts and Nevis in May and with Monaco in June. A safeguards agreement pursuant to NPT and the Treaty of Tlatelolco entered into force with Grenada in July, with Barbados in August and with Antigua and Barbuda in September.

A project agreement with Nigeria covering the supply of a research reactor and enriched uranium entered into force in August.

The Board of Governors approved draft safeguards agreements with Algeria and with the Czech Republic pursuant to NPT. These agreements had not entered into force at the end of 1996.

As of 31 December 1996, safeguards agreements were in force with 115 States pursuant to NPT. Austria acceded to the safeguards agreement between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency, which entered into force for Austria on 31 July. An agreement through an exchange of letters took place between Chile and the Agency in September confirming that the safeguards agreement concluded with Chile pursuant to the Treaty of Tlatelolco satisfies the obligations of Chile under Article III of the NPT.

For 64 non-nuclear-weapon States party to NPT there is no safeguards agreement in force pursuant to the Treaty. As far as the Agency is aware, five of these States have significant nuclear activities. Out of these five, safeguards were being applied in three States (Argentina, Colombia and Ukraine) pursuant to comprehensive safeguards agreements and in one State (Algeria) pursuant to INFCIRC/66/Rev.2-type safeguards agreements; preparatory work for the application of safeguards is under way in the other State (Georgia).

NPT safeguards agreements are in force with all 11 signatories of the South Pacific Nuclear Free Zone Treaty (Rarotonga Treaty); safeguards were applied in one of these States (Australia) pursuant to such an agreement. Twenty-four of the 31 States party to the Treaty of Tlatelolco have concluded safeguards agreements with the Agency pursuant to that Treaty and at the end of 1996 safeguards agreements pursuant to the Treaty of Tlatelolco were in force with 23 States. An agreement through an exchange of letters entered into force between St. Lucia and the Agency in June confirming that the safeguards agreement concluded with St. Lucia pursuant to the NPT satisfies the obligations of St. Lucia under Article 13 of the Treaty of Tlatelolco to conclude a safeguards agreement with the Agency.

Safeguards agreements pursuant to Additional Protocol I of the Treaty of Tlatelolco are in force with two of the four States outside Latin America which have jurisdiction over territories in the zone of application of the Treaty (Netherlands and the USA). A similar agreement with a third State (United

Kingdom) has been approved by the Board of Governors but has not yet entered into force.

The Secretary of Energy of the USA, the Minister of Atomic Energy of the Russian Federation and the Director General launched a trilateral initiative in September. This related to practical measures to fulfil statements made by the Presidents of the two countries about Agency verification of fissile material from nuclear weapons. It was stressed that such verification would not undermine the two States' obligations under Article I of the NPT. A trilateral group was formed to address the technical, legal and financial issues related to this verification. In November, a trilateral visit took place to sites in the USA at which fissile material excess to US defence requirements is under Agency safeguards.

On the basis of the decision of the Board of Governors following the request of the United Nations Security Council, the Agency has maintained a continuous presence of inspectors in the Nyongbyon area in the Democratic People's Republic of Korea (DPRK) since May 1994. The Agency has also continued to monitor the freeze on the DPRK's graphite moderated reactors and related facilities. By the end of 1996, half of the spent fuel rods from the shutdown 5 MW(e) graphite reactor had been loaded into canisters for long term storage. The canning operations were temporarily suspended at the beginning of November, but resumed in mid-January 1997. Three technical meetings between the DPRK and the Agency were held during the year, one of them in Vienna. Little progress was made on the issue of preservation by the DPRK of information relevant to the history of the DPRK's nuclear programme as required by the Agency for the eventual verification of the completeness and correctness of the DPRK's initial declaration. Also, the DPRK has still not enabled the Agency to implement certain inspection measures, such as measurements of the plutonium content of the spent fuel rods from the 5 MW(e) reactor and monitoring of the nuclear liquid waste at the reprocessing plant (Radiochemical Laboratory).

The Agency's safeguards obligations in Iraq continued to be subsumed under the mandate assigned to the Agency by resolutions of the United Nations Security Council. The Agency continued with the implementation of its plan for the monitoring and verification of Iraq's compliance with the relevant Security Council resolutions through the resident inspectors of the Nuclear Monitoring Group, with the assistance and co-operation of the United Nations Special Commission. The implementation of this plan

does not foreclose the exercise by the Agency of its right to investigate further any aspects of Iraq's former nuclear weapons programme, in particular as regards any further information that Iraq may still be withholding from the Agency. The Iraqi counterpart has continued to co-operate with the Agency in a productive way. During 1996, resident inspectors of the Agency conducted 354 inspections at some 107 facilities, 34 of which were inspected for the first time. No instances of activities, equipment or materials proscribed by the relevant Security Council resolutions have been detected. On 7 September, Iraq submitted what it declared was the final version of the "Full, Final, and Complete Declaration" called for in Security Council Resolution 707 (1991). The Agency is undertaking an in-depth appraisal of this document aimed at assessing its correctness and completeness and focusing, in particular, on those areas where, in the opinion of the Agency, Iraq's achievements may have been understated. It can be expected that the assessment of this declaration will require several months to complete.

Safeguards Operations

Following endorsement by the Board of Governors in June 1995 of the Director General's plan to implement at an early date measures to strengthen the effectiveness and improve the efficiency of the safeguards system (described in Part 1 of programme '93+2'), the Agency began implementation of specific measures related, in particular, to broader access to information, increased physical access and optimal use of the present system. Specifically,

- Baseline samples were collected at 6 enrichment facilities in 4 States and at 34 hot cell facilities in 22 States.
- Responses were received from 32 States to a questionnaire sent to all States with comprehensive safeguards agreements relating to their specific State's system of accounting for and control of nuclear material (SSAC). The Agency is developing methodology for the analysis of this information. In addition, responses were received from 23 States regarding information on certain closed down or decommissioned facilities and locations.
- As part of the process of developing in-house procedures for the evaluation of information, a committee was established for the comprehensive review and evaluation of information available to the Agency. The review process will ensure that the extensive knowledge, experience and information available are adequately brought to bear upon and

integrated into safeguards conclusions and the *Safeguards Implementation Report*.

The Agency verified material recovered by the operator from plutonium hold-up inventories in two MOX facilities. The recovered material was characterized and homogenized before destructive analysis (DA) samples were taken.

Safeguards application commenced in one State on irradiated fuel stored in casks. In another State, a different design of dry store under construction necessitated the development of unattended mode safeguards monitoring equipment.

Agency officials visited facilities in Argentina and Brazil as a continuation of the assessment of the completeness and correctness of the initial reports pursuant to the safeguards agreement between Argentina, Brazil, the ABACC and the Agency.

Considerable safeguards work continued to be carried out in the newly independent States (NIS) of the former USSR, in particular:

- Initial inventory verifications were started in Uzbekistan and were completed in Armenia. The initial inventory verifications in Belarus, Ukraine and Kazakstan were continued.
- Installation and upgrading of surveillance systems were completed in most of the nuclear power plants in Ukraine. Two unattended monitoring systems were installed at Chernobyl and the field test was successfully completed.
- A technical visit was carried out in Estonia to prepare for the implementation of safeguards.

Progress was made in the negotiation of Subsidiary Arrangements: two new and three revised General Parts of Subsidiary Arrangements (one new and six revised in 1995) and 17 (9 new and 8 revised) facility attachments (16 in 1995) entered into force.

Pursuant to the decision made by the President of the USA in September 1993, the US Government submitted nuclear material deemed excess to requirements for the US nuclear deterrent to Agency safeguards. The Agency carried out monthly inspections of such material at one site containing HEU and at two sites containing plutonium. The initial inventory verification of plutonium at one site started in December 1995 and was completed in June. The initial verification of the quantity of high enriched

Verification activities in 1996

	1994	1995	1996
Inspections performed	2 349	2 285	2 476
Person-days of inspection	9 152	10 167	10 831
Seals applied to nuclear material or safeguards equipment detached and subsequently verified (including seals applied jointly with a group of States)	21 746	23 877	27 029
Optical surveillance films reviewed	2 408	2 638	2 173
Video tapes reviewed	2 937	3 807	4 045
Nuclear material samples analysed	1 590	1 246	937
Nuclear material analytical results reported	2 579	2 559	2 200
Environmental samples analysed	—	—	278
Environmental sample results reported	—	—	4 200
Nuclear material under safeguards (in tonnes):			
Unirradiated plutonium outside reactor cores	40.5	45.0	53.6
Plutonium contained in irradiated fuel	452	512	533
High enriched uranium	19.4	20.5	20.7
Low enriched uranium	41 069	47 260	48 620
Source material (in tonnes)	93 907	104 395	105 395

uranium (HEU) to be blended down to low enriched uranium (LEU) at one facility was carried out. The blending down operation has been deferred until 1997. The safeguards requirements were defined during a stabilization and repackaging process for the plutonium currently subject to Agency safeguards. The safeguards aspects of different options for the disposition of plutonium were evaluated. The feasibility of applying Agency safeguards to the down-blending of HEU using a part of a large uranium enrichment facility was assessed.

Safeguards Support and Development

A report on measures for strengthening safeguards requiring additional legal authority (programme 93+2, Part 2) was submitted to the Board of Governors

for consideration in June. The Board endorsed the Secretariat's recommendation that further progress toward providing the Agency with the additional legal authority, namely a Protocol additional to comprehensive safeguards agreements necessary to implement Part 2 measures, required negotiations among States. A Committee of the Board, open to all Member States and all States with a comprehensive safeguards agreement with the Agency, was established. The Committee met twice in the course of the year. It is expected that a consensus text of the Protocol will be available for Board approval in the first half of 1997.

To implement the recently approved measures for strengthening the safeguards system (programme 93+2, Part 1), field trials of an unannounced inspection scheme were carried out from December 1995 to June 1996 at an LEU conversion and fuel fabrication plant in Sweden (with the co-operation of the Swedish Support Programme) and at large research reactors in South Africa and Canada. The results of these field trials demonstrated the feasibility of the inspection scheme at LEU conversion and fabrication plants, which can result in more cost effective safeguards. Training was provided to inspectors for the collection and handling of environmental samples, enhanced observation skills and nuclear fuel cycle proliferation indicators. Evaluation of a six month field trial of a remote monitoring system (RMS) installed in a MOX fuel storage vault in Switzerland has shown the system to be effective in monitoring events of safeguards relevance in near-real-time. RMS components were installed at an HEU storage vault in the USA and testing is under way, including transmission of data to the Agency. Work started on establishing an RMS at an HEU storage vault in South Africa.

During 1996, co-operation between EURATOM and the Agency within the framework of the New Partnership Approach in the area of support activities included: common purchasing of equipment; the holding of joint training courses for inspectors from both organizations; agreement on procedures covering on-site measurements of uranium samples in low enriched fuel fabrication plants and centrifuge enrichment facilities; and testing of new digital surveillance equipment.

Following accession as non-nuclear-weapon States to the NPT by most of the NIS of the former USSR, a number of donor States have extended considerable assistance at a bilateral level to set up appropriate SSAC, as well as physical protection and import/export control systems in the NIS. The Agency's role included prepa-

ration of co-ordinated technical support plans and help in identifying specific needs of individual States, and the appropriate donor support.

The Safeguards Analytical Laboratory (SAL) and the Network of Analytical Laboratories (NWAL) performed 1610 measurements for calibration and quality control of non-destructive analysis (NDA) techniques, certification of secondary reference samples, maintenance and improvement of off-site DA and testing procedures for on-site DA. A total of 2850 measurements were also provided by SAL and the NWAL for routine quality control of the analysis of inspection samples. SAL and the NWAL also assisted in the measurement of 85 samples taken in Iraq during inspections carried out pursuant to United Nations Security Council resolutions.

The 'Clean Laboratory' at Seibersdorf, inaugurated in December 1995, started operations in early 1996 with the installation of measurement instruments and the setting up of analytical procedures such as:

- Radiometric techniques for the initial screening of environmental samples, including low background gamma spectrometry and radioisotope excited X ray fluorescence spectrometry;
- Thermal ionization mass spectrometry for the measurement of uranium and plutonium isotopes and elemental content.

The initial work of the Clean Laboratory dealt with certifying the cleanliness level of the class-100 rooms and in measuring the blank level of uranium in all reagents and labware used for handling actual samples.

The NWAL was expanded to include specialized laboratories in three Member States to assist SAL in the analysis of environmental samples.

Acceptance tests on two new digital image surveillance systems (EMOSS and Gemini) were initiated. Some 30 units of each type were acquired and by the end of the year 17 EMOSS and 2 Gemini units had been installed in various facilities for extensive field testing. The remaining units will be installed in the first quarter of 1997 with a goal to complete the testing and evaluate the results by the third quarter of 1997.

With the assistance of a Member State support programme, a new miniature multichannel analyser was developed for use by the Agency and EURATOM. The device forms a multipurpose instrument platform covering most of the safeguards NDA verification methods requiring portable equipment and is commercially available.

Unique cadmium telluride detectors were developed for the Agency under contracts in four Member States. The performance of one detector type exceeds presently available detectors in detection efficiency by more than an order of magnitude. A second type has an energy resolution comparable to that of germanium detectors, but does not require liquid nitrogen cooling.

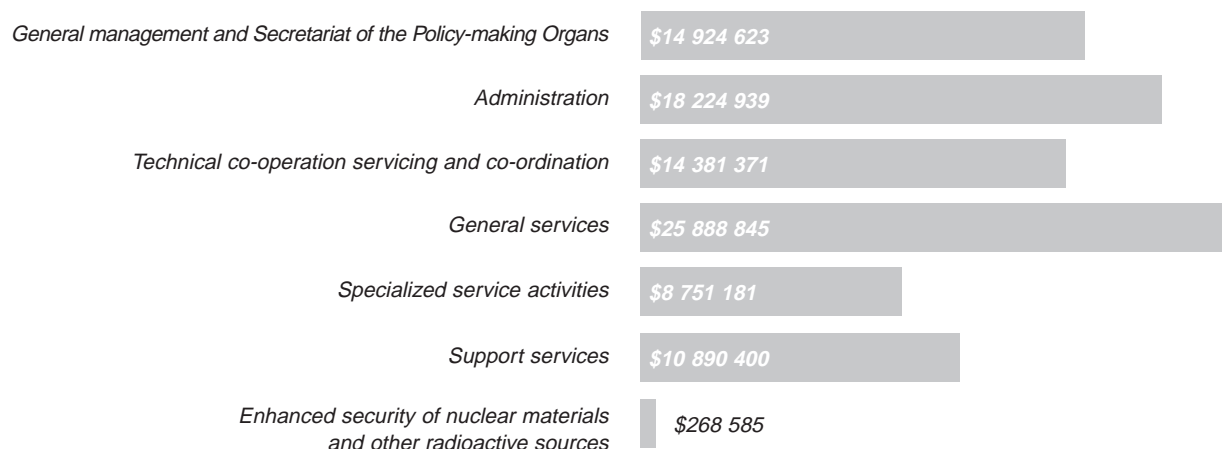
An Advisory Group meeting was held in Vienna in November to review the integrated safeguards instrumentation programme. Its major conclusion was that the principles of the programme, aimed at standardizing equipment and reducing support costs, should be adopted and implemented.

The Safeguards Traineeship Programme held an intensive ten month training programme for six trainees from developing countries. The programme is designed to increase the number of qualified candidates from these countries who would be available for filling Professional posts in the Agency and to enhance their technical skills and competence regarding safeguards implementation. Four trainees have been offered positions with the Agency.

DIRECTION AND SUPPORT

Regular Budget expenditure: \$93 329 944

Expenditure by subprogramme



Extrabudgetary programme resources utilized (not included in chart): \$3 304 571 (this includes a sum of \$ 1 033 599 for Enhanced Security of Nuclear Materials and Other Radioactive Sources, and a sum of \$1 251 625 for AGRIS)

Administration

A comprehensive review of the management and operation of official travel resulted in a number of changes to improve operating efficiency and reduce costs. First, the rules governing travel were revised, with the aim of introducing greater flexibility to permit the Agency to take advantage of the increasingly competitive travel market. Second, the review concluded that changes in the travel market required a change in the approach to the procurement and administration of business travel services. This led to a formal competitive tender process for a travel management company capable of providing global services and supporting policy implementation.

Personnel

A programme was implemented under which approximately 900 staff members (including those at IAEA-MEL) received training to improve their management or job related skills or to update their knowledge of Agency

policies and procedures. A Learning Resource Centre was established to provide Agency staff members and their spouses with self-directed programmes on: management and job skill development; career planning and personal development; and issues related to international mobility. Three Junior Professional Officers received on-the-job training in scientific/technical areas to enable them to apply for regular positions or use the experience gained in their home countries.

In accordance with the resolutions adopted by the General Conference, efforts were intensified to recruit more women, especially for scientific/technical positions, and more staff from developing, under-represented and non-represented countries. In this connection, the Director General created a 'Focal Point for Gender Concerns' with responsibility for promoting the establishment of a work environment in the Secretariat that supports the equal participation of men and women. It will also monitor implementation of the 'Platform for Action' approved at the United Nations Fourth World Conference on Women.

The percentage of women at the end of 1996 among the Professional staff was 17.3%. Developing countries provided 32.9% of the staff subject to geographical distribution.

A new Work Planning and Performance Review System was designed for implementation in 1997. Its purpose is to enhance accountability and organizational efficiency through planning, communication, evaluation and staff development.

Legal

The Standing Committee on Liability for Nuclear Damage met three times during which it resolved most of the outstanding issues regarding both the draft protocol to amend the Vienna Convention and the draft Supplementary Funding Convention. In particular, experts agreed on the: amounts of liability; definition of damage and related provisions; structure of supplementary funding; and phasing-in mechanisms which would allow a State to join the revised Vienna Convention and Supplementary Funding Convention with interim, lower amounts of liability. At its 16th session in October, the Standing Committee prepared the full texts of both draft instruments. Only a few provisions remained outstanding in the draft Supplementary Funding Convention. It was concluded that, as a package, each text reflected what was possible to achieve in the Committee without further guidance.

Technical Co-operation Servicing and Co-ordination

Two major activities dominated the Agency's technical co-operation programme during 1996: preparations for the new 1997–1998 programme and consolidation of recent initiatives.

In order to improve the overall efficiency and effectiveness of the Agency's technical co-operation programme, greater attention was paid to pre-project preparation. The Country Programme Framework (CPF) process has become the main mechanism for systematic pre-programme work at the country level, and the principal means for extending the model project approach to all Member States. During 1996, the Agency improved its internal guidelines for CPF in the light of the findings of a special evaluation carried out earlier in the year. Efforts to improve guidance and training in project planning and formulation continued, along with related

actions to automate and streamline project implementation in order to facilitate staff redeployment in support of pre-project activities.

The other major activity was preparation of the 1997–1998 technical co-operation programme, which was presented to the Technical Assistance and Co-operation Committee (TACC) in November and approved by the Board of Governors in December. The expanding base of CPFs, combined with extensive pre-project missions where CPFs did not exist, have led to an improvement in the quality of project designs. Thirty-six new model projects were approved, representing 18% of total core activities. By December, 58 model projects had been approved and 43% of the recipient Member States are now participating (or have participated) in the execution of a national model project.

The United Nations System-wide Special Initiative for Africa (UNSIDA) seeks to identify and develop practical proposals to maximize the support provided to African development, and to raise the priority given to Africa in the international agenda. Agency participation in the high level interagency meeting on UNSIDA in September, included reports on the CPF process and the experience gained in applying nuclear and isotope applications that produce quantifiable social and economic benefits. Subjects discussed included the Agency's support of activities to eradicate rinderpest in Africa and the tsetse fly in Ethiopia. The Agency will continue to monitor the development of UNSIDA, with the objective of linking technical co-operation projects to the implementation of the initiative for the benefit of African Member States.

Efforts continued during the year to quantify technical co-operation project results and highlight their impacts on end users. Promotional material was developed which seeks to raise awareness of the Agency's technical co-operation activities in developing countries. Eleven fact sheets on several model projects are now available and are being used in briefings to demonstrate the effectiveness and impact of the technical co-operation programme.

The Agency's efforts to streamline and simplify operations and improve management were aided by the introduction of newer information systems and technology. Two systems began operating — the Field Procurement Management System in August and the Training Course System in December. For the 1997–1998 programme, new planning software for project formulation was installed for processing project requests. This software facilitated the preparation of work plans for larger

projects. Such plans ensure that the details of project execution have been worked out in advance. Development of the Project Information System (PIMS) is proceeding in several phases. The first module will maintain work plans and establish linkages to the implementation systems. The module was developed in 1996 and testing began at the end of the year.

The level of resources and their implementation achieved in 1995 was sustained in 1996. On the resource side, the total of \$63.3 million compares with the almost identical sum of \$63.5 million for 1995. A sum of \$50.5 million was pledged to the Technical Co-operation Fund (TCF), which was 78.3% of the target - a modest increase over 1995 (77.5%). However, some pledges and payments from major donors came very late, which complicated the Secretariat's ability to plan with certainty. An additional concern was the number of Member States not pledging at all. This number increased to a total of 68 countries. On the implementation side, the overall rate was 75.4%, the second highest level ever attained. Although there was significant overprogramming during the year, at year end the TCF was underprogrammed by a very small amount (\$533 000). The unobligated balance for the Fund rose to \$15.5 million by the end of 1996 (\$13.8 million at the end of 1995), though this included \$3.8 million pledged but not yet paid. The useable part of the unobligated balance increased to \$6.9 million, or about seven weeks worth of obligations.

Specialized Service Activities

Public Information

In addition to regular media relations and publications activities, there were three events that required a significant public information response. The first was the European Union-IAEA-WHO conference in April, marking the tenth anniversary of the Chernobyl accident, which reviewed the current state of knowledge about the disaster and its consequences. The conference attracted over 200 journalists, including all of the major television networks in Vienna. The second was the ongoing efforts to strengthen the Agency's safeguards activities. In this context, Agency inspection activities in Iraq and the Democratic People's Republic of Korea were subjects featuring in information work both with the media and the public at large. The third event was the launching of the scientific study on the radiological situation at the Mururoa and Fangataufa Atolls in French Polynesia. A short documentary film was prepared and distributed to television stations on the work being undertaken.

The range of information available on the Agency's publicly accessible World Wide Web site, 'WorldAtom', was significantly expanded during the year with the addition of Information Circulars (INFCIRCs), the Agency's Publications Catalogue, new booklets on radiation safety, Agency activities in the field of nutrition, and status reports on international conventions and treaties.

International Nuclear Information System

Cyprus, the Former Yugoslav Republic of Macedonia, Singapore, Uganda and Yemen joined the International Nuclear Information System (INIS) in 1996. The number of participating Member States is therefore 99, together with 17 international organizations. A total of 80 516 records of published literature were added to the INIS database and announced in the abstracting journal *INIS Atomindex*, bringing the total number of records available in the database to 1 936 722. Work on the Microsoft Windows version of the FIBRE software for input preparation was finalized and distributed to 74 INIS members. FIBRE was used by 62 members to prepare input to the database. In addition, the database was sent on tape or cartridge to 15 INIS members and was used on-line by external users for a total connection time of about 200 hours.

The INIS Clearinghouse microfilmed the full texts of 4792 documents of non-conventional literature that contained 17 900 cited references (393 762 pages). To this were added 5886 other documents of non-conventional literature received in microfiche form from a Member State. Twenty-five Member States had standing orders for the full microfiche collection. The Clearinghouse produced and disseminated non-conventional literature on 162 094 microfiche containing 9.7 million images. By the end of 1996, the total collection of non-conventional literature on microfiche was almost 315 700 documents (i.e. 453 000 microfiche).

A study to develop an operational system for the electronic imaging and dissemination of the full texts of non-conventional literature on CD-ROM was completed. As a result of this study, and on the basis of a contract with a commercial firm, the INIS Clearinghouse will be in a position to produce such literature on CD-ROM in 1997.

Under a co-operative arrangement between the Agency and the OECD/NEA Data Bank, 497 computer codes were distributed to Agency Member States not members of the OECD. This figure represents a major increase

over the corresponding figure for 1995, when 216 codes were distributed.

Support Services

Library

The Vienna International Centre (VIC) Library undertook a user needs survey which identified the needs and priorities of the staff of all the VIC organizations and the affiliated Permanent Missions.

The Library answered 11 477 user queries, performed 1002 external database searches, acquired 3765 books and new journal titles, loaned 16 785 items, routed 19 754 journal issues to 1204 users and provided 4851 photocopies of requested materials. Forty audiovisual items were lent to Member States.

Data Processing

The Agency's Internet services were enhanced, with most areas of the Agency providing information through the Internet to Member States. The security of these services was improved by the addition of a 'firewall' to prevent unauthorized access to the network. At the same time, network management was enhanced to ensure reliable services, since most staff now depend on access to the electronic data network to carry out their duties.

The first official release of the Advanced Incident Reporting System, Version 1.0, was distributed on CD-ROM to over 30 Member States. The system provides the Agency and its Member States with a powerful information retrieval tool and should lead to improvements in the evaluation of safety significant events at nuclear power plants.

Publishing and Printing

More than 170 books, reports, journal issues and booklets were published in English during 1996. In addition, there were two publications in Chinese, eight in French, seven in Russian and seven in Spanish. Of particular note were:

- *Radiation Protection and the Safety of Radiation Sources (Safety Fundamentals)*
- *Safe Transport of Radioactive Material*
- *One Decade After Chernobyl: Summing up the Consequences of the Accident*

- *Lessons Learned From Accidents in Industrial Radiation Facilities*
- *The IAEA Yearbook 1996*
- *Isotopes in Water Resources Management*

Enhanced Security of Nuclear Materials and Other Radioactive Sources

The issue of trafficking in nuclear material was among those specifically addressed at a Nuclear Safety and Security Summit held in Moscow in April. In August, the Agency convened a second interagency meeting on the illicit cross-border movement of nuclear materials and other radioactive sources. Attending were representatives from the Agency and other international organizations — the European Commission, EURATOM, EUROPOL, the International Federation of Air Line Pilots Association, the International Road Transport Union, INTERPOL, the United Nations, the Universal Postal Union, and the World Customs Organization. The Agency's initiative was endorsed as a useful co-operative mechanism for participating agencies. The Agency's programme of technical guidance and training and operation of the illicit trafficking database was also endorsed. In October, the Agency circulated a first summary of trafficking incidents, containing 127 confirmed incidents, to all Member States and organizations in the interagency group.

A list of official State points of contact for matters involving illicit trafficking was established. By the end of 1996, 47 Member States had submitted the names of persons to act in these matters. Efforts are continuing to expand this listing.

The Agency increased its assistance to States in enhancing their national infrastructures for overseeing the physical protection of nuclear materials at facilities and during transport. This includes training, technical support, information exchange, and the provision of guidance and advice. Of particular note was the establishment of the International Physical Protection Advisory Service (IPPAS). A new international review service which will be conducted on request, IPPAS focuses on three basic aspects of the physical protection of nuclear facilities and material:

- Evaluation of the need to upgrade State regulatory systems in accordance with international recommendations and practices;
- Review of selected nuclear facilities to assess the effectiveness of the State regulatory programme; and

-
- Assistance to regulatory authorities, as appropriate, in developing national goals, objectives and regulations for physical protection.

Requests for an IPPAS mission were received from three countries in 1996; missions were carried out to Bulgaria and Slovenia.

SUMMARY AGENCY BUDGETARY AND STAFFING DATA

Budget

For 1996, the General Conference appropriated an amount of about \$219 million for the Agency's Regular Budget on the basis of an exchange rate of 12.70 Austrian Schillings to one United States dollar, of which \$213 million was related to Agency programmes. The latter amount was adjusted to \$249 million to account for the average United Nations exchange rate (10.51 Austrian Schillings to one US dollar) actually experienced during the year.

The Regular Budget for 1996, at an exchange rate of 10.51 Austrian Schillings to one US dollar, amounted to some \$256.4 million, of which \$246.2 million was to be financed from contributions by Member States on the basis of the 1996 scale of assessment, \$7.4 million from income from reimbursable work for others and \$2.8 million from other miscellaneous income.

The actual expenditures for the Agency's Regular Budget in 1996 amounted to some \$250 million, of which \$243 million was related to the Agency's programmes. The unused budget from the Agency's programmes amounted to \$5.9 million, while the total unused budget was \$6.5 million when account was taken of reimbursable work for others.

The target for voluntary contributions to the Technical Co-operation Fund for 1996 was established at \$64.5 million, of which \$50.5 million was pledged by Member States.

A total of about \$29.3 million in extrabudgetary funds was provided by Member States, the United Nations, other international organizations and other sources during 1996. Of this amount, \$7.6 million was in support of safeguards, \$6.3 million was for technical co-operation projects, \$3.2 million for projects in food and agriculture, \$2.8 million for nuclear safety and \$2.7 million for implementation of United Nations Security Council Resolution 687 on Iraq. An amount of \$1.7 million (supplemented by the Agency's contribution of \$3.1 million) was in support of IAEA-MEL. The remaining \$5 million was in support of various other projects implemented by the Agency.

The sum of \$0.43 million was provided in 1996 by Member States for technical co-operation activities as funds-in-trust. Furthermore, a total of \$0.7 million was administered on behalf of research institutions and \$2.4 million for the International Thermonuclear Experimental Reactor.

Staffing

At the end of 1996, the number of staff members in the Secretariat was 2202 — 906 in the Professional and higher categories and 1296 in the General Service category. These figures represent 1634 regular, 248 temporary assistance and 222 extrabudgetary staff, as well as 70 cost free experts and 28 consultants. Ninety nationalities were represented among the 633 staff members in posts subject to geographical distribution.

THE BOARD OF GOVERNORS AND THE GENERAL CONFERENCE

Georgia became a member of the Agency by depositing an instrument of acceptance of the Agency's Statute. The application by the Republic of Moldova for membership was approved by the General Conference but the instrument of acceptance has not yet been deposited with the Government of the USA in accordance with the Agency's Statute.

Board of Governors documents, which are normally of restricted distribution and intended for the 'official use only' of Member States, have now been released for general distribution two years after the date of issue. However, the Board decided that the annual *Safeguards Implementation Report*, documents relating to deliberations of the Board in closed session, documents for whose distribution there is a legal impediment and any other documents specified by the Board, including those of its committees, will continue to be of restricted distribution.

In November, the Secretariat began electronic distribution of documents to Permanent Missions and Member States through the Internet. The objective is to provide more rapid dissemination of documents for consideration by the Board of Governors. The service is for official use only and all users have to register individually with the Agency through their competent authorities.

The Board of Governors, at its June session, established a Committee on Strengthening the Effectiveness and Improving the Efficiency of the Safeguards System (Committee 24) charged with the task of drafting a model Additional Protocol to existing safeguards agreements. The Committee met in July and October and is expected to conclude its deliberations in the first half of 1997.

The Board, at the request of the General Conference, re-established an informal open-ended consultative group on Article VI of the Statute. The General Conference resolution requested that the group "submit a report on a finalized formula" for revision of Article VI to it at its 1997 regular session. The Board also re-established its open-ended informal working group on the criteria for designating members. In this connection, the General Conference, through a statement by the President, requested the Chairman of the Board of Governors to consult with Member States not yet listed in a regional area, as well as with other Member States and representatives of the regional areas, and submit for consideration a report on specific proposals for the inclusion of each Member State within the appropriate area to the General Conference in 1997.

Since the term of office of the current Director General will expire in 1997, the Board, following the proposals adopted in 1991 on the procedure for appointment of the Director General, called in October for nominations to the post from Member States. By the deadline date of 31 December 1996, candidates from Egypt, Italy, the Islamic Republic of Iran, Switzerland, Ukraine and Zambia were nominated for the position by their respective Governments. The appointment is expected to be made by the Board at its June 1997 session.

Since 1997 is the 40th anniversary of the entry into force of the Statute of the Agency, the Board at its December session established an open-ended informal working group to discuss the contributions of Member States and the Secretariat to the commemorative activities planned for 1997. The Group held its first meeting on 11 December.

The Board re-established its open-ended informal working group on the financing of technical assistance.

ANNEX

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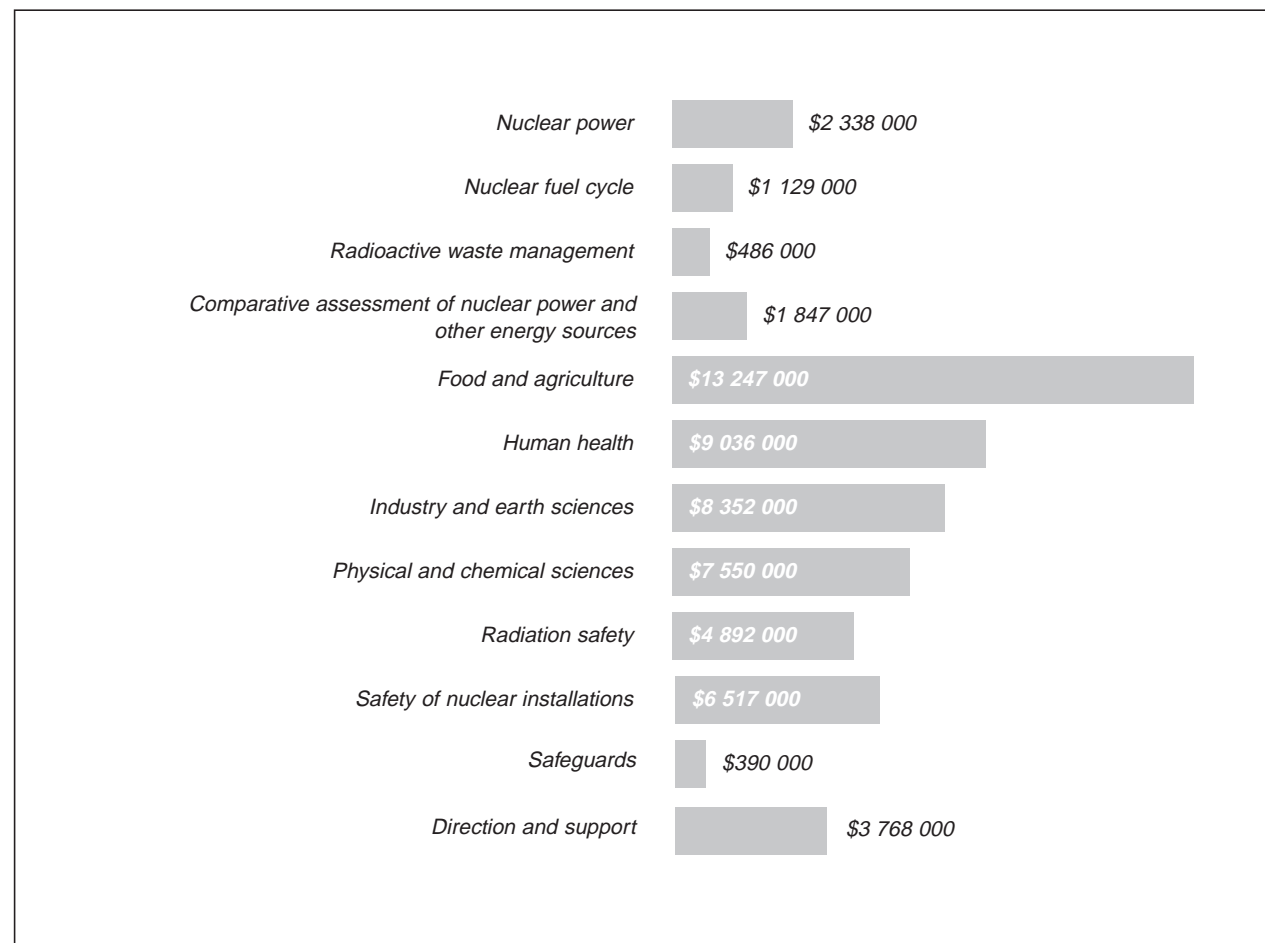
Summary of allocation and utilization of Agency regular budget resources by programme in 1996

Programme	Budget GC(XXXIX)/4 (at AS 12.70) ^a (1)	Adjusted budget (at AS 10.51) ^a (2)	Total expenditure (3)	Unused budget ^b (2)-(3) (4)
Nuclear Power	5 165 000	5 972 000	6 209 599	(237 599)
Nuclear Fuel Cycle	2 550 000	2 929 000	2 824 076	104 924
Radioactive Waste Management	6 627 000	7 674 000	7 505 404	168 596
Comparative Assessment of Nuclear Power and Other Energy Sources	2 052 000	2 359 000	2 059 654	299 346
<i>Subtotal</i>	16 394 000	18 934 000	18 598 733	335 267
Food and Agriculture	10 525 000	12 012 000	11 913 912	98 088
Human Health	5 991 000	6 833 000	6 544 825	288 175
Industry and Earth Sciences	3 563 000	4 052 000	3 562 837	489 163
Physical and Chemical Sciences	8 462 000	9 497 000	9 476 135	20 865
<i>Subtotal</i>	28 541 000	32 394 000	31 497 710	896 290
Radiation Safety	4 760 000	5 527 000	5 847 415	(320 415)
Safety of Nuclear Installations	6 723 000	7 844 000	7 725 689	118 311
<i>Subtotal</i>	11 483 000	13 371 000	13 573 104	(202 104)
Safeguards Operations	58 256 000	68 108 000	64 715 650	3 392 350
Safeguards Support and Development	14 098 000	16 639 000	18 730 182	(2 091 182)
Safeguards Management				
Planning, Direction, Co-ordination and Control ^c	[335 000]	[396 000]	[641 038]	[(245 038)]
Effectiveness Evaluation	1 036 000	1 231 000	1 183 049	47 951
Programme and Resources	1 335 000	1 588 000	1 537 932	50 068
<i>Subtotal</i>	74 725 000	87 566 000	86 166 813	1 399 187
General Management and Secretariat of the Policy-making Organs	12 656 000	15 330 208	14 924 623	405 585
Administration	16 656 000	19 631 000	18 224 939	1 406 061
Technical Co-operation Servicing and Co-ordination	12 304 000	14 582 000	14 381 371	200 629
General Services	22 451 000	26 527 792	25 888 845	638 947
Specialized Service Activities	7 948 000	9 359 000	8 751 181	607 819
Support Services	9 299 000	10 993 000	10 890 400	102 600
Enhanced Security of Nuclear Materials and Other Radioactive Sources	333 000	388 000	268 585	119 415
<i>Subtotal</i>	81 647 000	96 811 000	93 329 944	3 481 056
Total Agency programmes	212 790 000	249 076 000	243 166 304	5 909 696

^a AS: Austrian Schillings.

^b Unused (over-expended) budget.

^c Included in General Management and Secretariat of the Policy-making Organs.

Technical co-operation disbursements by Agency programme in 1996

Assessment of Safety Culture in Organizations Team (ASCOT) seminars in 1996

Location	Date
Budapest, Hungary	5–7 March
Laguna Verde, Mexico	25–26 April
Gentilly, Canada	28–29 October
Kiev, Ukraine	5–7 November

International Peer Review Service (IPERS) missions in 1996

Review type	Country	Nuclear power plant
Main review	Czech Republic	Temelin
Main review	Argentina	Atucha I
Pre-review	Republic of Korea	Ulchin 3 and 4

Assessment of Safety Significant Events Team (ASSET) services in 1996

Type	Country	Location/nuclear power plant
S	Slovakia	Bratislava
S	Russian Federation	Leningrad
S	Slovenia	Kr,ko
S	Switzerland	Mühlberg
S	Ukraine	Kiev
S	Finland	Olkiluoto
S	China	Daya Bay
T	Russian Federation	Leningrad
Z	Sweden	Forsmark
Z	Slovenia	Kr,ko
Z	Czech Republic	Dukovany

Type S: seminar; **Type T:** peer review of self-assessment of operational events (safety culture); **Type Z:** peer review of self-assessment of plant events (safety performance).

Operational Safety Review Team (OSART) missions in 1996

Type	Country	Location/nuclear power plant	Plant type
O	Slovakia	Bohunice 3 and 4	WWER 440 MW
O	China	Guangdong	PWR 980 MW
O	France	Dampierre	PWR 940 MW
FU	France	Flamanville	PWR 1380 MW
FU	Switzerland	Leibstadt	BWR 1050 MW
S	Bulgaria	Kozloduy	WWER 440 MW
S	Ukraine	South Ukraine	WWER 1000 MW
S	Slovakia	Bohunice1 and 2	WWER 440 MW
T	Pakistan	Chashma	PWR 300 MW
T	Ukraine	Kiev	
T	Mexico	Laguna Verde	BWR 675 MW

Type FU: OSART follow-up mission; **Type O:** OSART mission; **Type S:** safety review mission; **Type T:** technical exchange mission.

Engineering Safety Review Services (ESRS) related to site and external hazards

Country	Site/plant	Service
Armenia	Medzamor WWER-440/230	(1) Preparation of terms of reference for seismic upgrading (2) Review of seismic capacity
Hungary	Paks WWER-440/213	Review of final design basis seismic parameters
Indonesia	Muria	(1) Review of tectonic stability and volcanic hazard (2) Review of foundation safety
Korea, Rep. of	Generic	Review of seismic hazard methodology
Pakistan	Chashma PWR 300 MW (Chinese design)	Review of seismic design (in Shanghai)
Slovakia	Bohunice WWER-440/230-213	Preparation of terms of reference for seismic assessment and upgrading
Slovenia	Kr ,ko PWR	(1) Review of tectonic stability (2) Review of external event PSA

**Number of States having significant nuclear activities
at the end of 1994, 1995 and 1996**

	Number of States		
	1994	1995	1996
States with safeguards applied under NPT or NPT/Tlatelolco agreements	49 ^a	53 ^a	54 ^a
States with safeguards applied under Tlatelolco agreements	1	2	1
States with safeguards applied pursuant to other comprehensive safeguards agreements	2	3	3
States with safeguards applied under INFCIRC/66/Rev.2-type agreements ^b	6	5	5
Nuclear-weapon States with safeguards applied under voluntary-offer agreements	5	5	5
States without any safeguards agreement in force	5	1	1
Total number of States with significant nuclear activities^c	68	69	69

^a This excludes Iraq, where safeguards activities in 1996 continued to be subsumed under activities carried out pursuant to United Nations Security Council Resolution 687.

^b Some States with INFCIRC/66/Rev.2-type agreements under which the application of safeguards has not yet been suspended, although NPT or other comprehensive safeguards agreements have entered into force, are listed under NPT agreements only. Nuclear-weapon States with INFCIRC/66/Rev.2-type agreements in force are not included. Safeguards are also applied to nuclear installations in Taiwan, China.

^c According to information available to the Agency for the year in question.

Situation on 31 December 1996 with respect to the conclusion of safeguards agreements between the Agency and non-nuclear-weapon States in connection with NPT

Non-nuclear-weapon States which have signed, ratified, acceded to or succeeded to NPT ^a (1)	Date of ratification, accession or succession ^a (2)	Safeguards agreement with the Agency (3)	INFCIRC (4)
Afghanistan	4 February 1970	In force: 20 February 1978	257
Albania ^b	12 September 1990		
Algeria	12 January 1995	Signed: 30 March 1996	
Andorra	25 June 1996		
Angola	14 October 1996		
Antigua and Barbuda ^c	1 November 1981	In force: 9 September 1996	528
Argentina ^d	10 February 1995		
Armenia	15 July 1993	In force: 5 May 1994	455
Australia	23 January 1973	In force: 10 July 1974	217
Austria ^e	27 June 1969	Accession: 31 July 1996	193
Azerbaijan	22 September 1992		
Bahamas	10 July 1973		
Bahrain	3 November 1988		
Bangladesh	27 September 1979	In force: 11 June 1982	301
Barbados ^c	21 February 1980	In force: 14 August 1996	527
Belarus	22 July 1993	In force: 2 August 1995	495
Belgium	2 May 1975	In force: 21 February 1977	193
Belize	9 August 1985	Signed: 13 August 1992	
Benin	31 October 1972		
Bhutan	23 May 1985	In force: 24 October 1989	371
Bolivia ^c	26 May 1970	In force: 6 February 1995	465
Bosnia and Herzegovina	15 August 1994		
Botswana	28 April 1969		
Brunei Darussalam	25 March 1985	In force: 4 November 1987	365
Bulgaria	5 September 1969	In force: 29 February 1972	178
Burkina Faso	3 March 1970		
Burundi	19 March 1971		
Cambodia	2 June 1972		
Cameroon	8 January 1969	Signed: 21 May 1992	
Canada	8 January 1969	In force: 21 February 1972	164
Cape Verde	24 October 1979		
Central African Republic	25 October 1970		
Chad	10 March 1971		
Chile ^{f,g}	25 May 1995	In force: 9 September 1996	476/Mod.1
Colombia ^h	8 April 1986		
Comoros	4 October 1995		
Congo	23 October 1978		
Costa Rica ^c	3 March 1970	In force: 22 November 1979	278
Côte d'Ivoire	6 March 1973	In force: 8 September 1983	309
Croatia	29 June 1992	In force: 19 January 1995	463
Cyprus	10 February 1970	In force: 26 January 1973	189
Czech Republic ⁱ	1 January 1993	In force: 3 March 1972	173
Democratic People's Republic of Korea	12 December 1985	In force: 10 April 1992	403

Safeguards agreements (cont.)

Non-nuclear-weapon States which have signed, ratified, acceded to or succeeded to NPT ^a (1)	Date of ratification, accession or succession ^a (2)	Safeguards agreement with the Agency (3)	INFCIRC (4)
Denmark ^j	3 January 1969	In force: 21 February 1977	193
Djibouti	16 October 1996		
Dominica	10 August 1984	In force: 3 May 1996	513
Dominican Republic ^c	24 July 1971	In force: 11 October 1973	201
Ecuador ^c	7 March 1969	In force: 10 March 1975	231
Egypt	26 February 1981	In force: 30 June 1982	302
El Salvador ^c	11 July 1972	In force: 22 April 1975	232
Equatorial Guinea	1 November 1984	Approved by the Board, June 1986	
Eritrea	16 March 1995		
Estonia	31 January 1992	Approved by the Board, Feb. 1992	
Ethiopia	5 February 1970	In force: 2 December 1977	261
Fiji	14 July 1972	In force: 22 March 1973	192
Finland ^k	5 February 1969	Accession: 1 October 1995	193
Gabon	19 February 1974	Signed: 3 December 1979	
Gambia	12 May 1975	In force: 8 August 1978	277
Georgia	7 March 1994		
Germany ^l	2 May 1975	In force: 21 February 1977	193
Ghana	5 May 1970	In force: 17 February 1975	226
Greece ^m	11 March 1970	Accession: 17 December 1981	193
Grenada ^c	19 August 1974	In force: 23 July 1996	525
Guatemala ^c	22 September 1970	In force: 1 February 1982	299
Guinea	29 April 1985		
Guinea-Bissau	20 August 1976		
Guyana	19 October 1993		
Haiti ^c	2 June 1970	Signed: 6 January 1975	
Holy See	25 February 1971	In force: 1 August 1972	187
Honduras ^c	16 May 1973	In force: 18 April 1975	235
Hungary	27 May 1969	In force: 30 March 1972	174
Iceland	18 July 1969	In force: 16 October 1974	215
Indonesia	12 July 1979	In force: 14 July 1980	283
Iran, Islamic Republic of	2 February 1970	In force: 15 May 1974	214
Iraq	29 October 1969	In force: 29 February 1972	172
Ireland	1 July 1968	In force: 21 February 1977	193
Italy	2 May 1975	In force: 21 February 1977	193
Jamaica ^c	5 March 1970	In force: 6 November 1978	265
Japan	8 June 1976	In force: 2 December 1977	255
Jordan	11 February 1970	In force: 21 February 1978	258
Kazakhstan	14 February 1994	In force: 11 August 1995	504
Kenya	11 June 1970		
Kiribati	18 April 1985	In force: 19 December 1990	390

Situation on 31 December 1996 with respect to the conclusion of safeguards agreements between the Agency and non-nuclear-weapon States in connection with NPT (cont.)

Non-nuclear-weapon States which have signed, ratified, acceded to or succeeded to NPT ^a (1)	Date of ratification, accession or succession ^a (2)	Safeguards agreement with the Agency (3)	INFCIRC (4)
Korea, Republic of	23 April 1975	In force: 14 November 1975	236
Kuwait	17 November 1989		
Kyrgyzstan	5 July 1994		
Lao People's Democratic Republic	20 February 1970	Signed: 22 November 1991	
Latvia	31 January 1992	In force: 21 December 1993	434
Lebanon	15 July 1970	In force: 5 March 1973	191
Lesotho	20 May 1970	In force: 12 June 1973	199
Liberia	5 March 1970		
Libyan Arab Jamahiriya	26 May 1975	In force: 8 July 1980	282
Liechtenstein	20 April 1978	In force: 4 October 1979	275
Lithuania	23 September 1991	In force: 15 October 1992	413
Luxembourg	2 May 1975	In force: 21 February 1977	193
Madagascar	8 October 1970	In force: 14 June 1973	200
Malawi	18 February 1986	In force: 3 August 1992	409
Malaysia	5 March 1970	In force: 29 February 1972	182
Maldives	7 April 1970	In force: 2 October 1977	253
Mali	10 February 1970		
Malta	6 February 1970	In force: 13 November 1990	387
Marshall Islands	30 January 1995		
Mauritania	26 October 1993		
Mauritius	25 April 1969	In force: 31 January 1973	190
Mexico ^c	21 January 1969	In force: 14 September 1973	197
Micronesia, Federated States of	14 April 1995		
Moldova	11 October 1994	Signed: 14 June 1996	
Monaco	13 March 1995	In force: 13 June 1996	524
Mongolia	14 May 1969	In force: 5 September 1972	188
Morocco	27 November 1970	In force: 18 February 1975	228
Mozambique	4 September 1990		
Myanmar	2 December 1992	In force: 20 April 1995	477
Namibia	2 October 1992		
Nauru	7 June 1982	In force: 13 April 1984	317
Nepal	5 January 1970	In force: 22 June 1972	186
Netherlands ⁿ	2 May 1975	In force: 21 February 1977	193
New Zealand ^o	10 September 1969	In force: 29 February 1972	185
Nicaragua ^c	6 March 1973	In force: 29 December 1976	246
Niger	9 October 1992		
Nigeria	27 September 1968	In force: 29 February 1988	358
Norway	5 February 1969	In force: 1 March 1972	177
Palau, Federated State of	14 April 1995		
Panama ^{c:p}	13 January 1977	Signed : 22 December 1988	

Safeguards agreements (cont.)

Non-nuclear-weapon States which have signed, ratified, acceded to or succeeded to NPT ^a (1)	Date of ratification, accession or succession ^a (2)	Safeguards agreement with the Agency (3)	INFCIRC (4)
Papua New Guinea	25 January 1982	In force: 13 October 1983	312
Paraguay ^c	4 February 1970	In force: 20 March 1979	279
Peru ^c	3 March 1970	In force: 1 August 1979	273
Philippines	5 October 1972	In force: 16 October 1974	216
Poland	12 June 1969	In force: 11 October 1972	179
Portugal ^q	15 December 1977	Accession: 1 July 1986	193
Qatar	3 April 1989		
Romania	4 February 1970	In force: 27 October 1972	180
Rwanda	20 May 1975		
St. Kitts and Nevis	22 March 1993	In force: 7 May 1996	514
St. Lucia	28 December 1979	In force: 2 February 1990	379
St. Vincent and the Grenadines	6 November 1984	In force: 8 January 1992	400
Samoa	17 March 1975	In force: 22 January 1979	268
San Marino	10 August 1970	Approved by the Board, Feb. 1977	
São Tome and Principe	20 July 1983		
Saudi Arabia	3 October 1988		
Senegal	17 December 1970	In force: 14 January 1980	276
Seychelles	12 March 1985		
Sierra Leone	26 February 1975	Signed: 10 November 1977	
Singapore	10 March 1976	In force: 18 October 1977	259
Slovakia ^f	1 January 1993	In force: 3 March 1972	173
Slovenia ^s	7 April 1992	In force: 28 December 1973	204
Solomon Islands	17 June 1981	In force: 17 June 1993	420
Somalia	5 March 1970		
South Africa	10 July 1991	In force: 16 September 1991	394
Spain	5 November 1987	Accession: 5 April 1989	193
Sri Lanka	5 March 1979	In force: 6 August 1984	320
Sudan	31 October 1973	In force: 7 January 1977	245
Suriname ^c	30 June 1976	In force: 2 February 1979	269
Swaziland	11 December 1969	In force: 28 July 1975	227
Sweden ^t	9 January 1970	Accession: 1 June 1995	193
Switzerland	9 March 1977	In force: 6 September 1978	264
Syrian Arab Republic	24 September 1969	In force: 18 May 1992	407
Thailand	7 December 1972	In force: 16 May 1974	241
The Former Yugoslav Republic of Macedonia	12 April 1995		
Togo	26 February 1970	Signed: 29 November 1990	
Tonga	7 July 1971	In force: 18 November 1993	426
Trinidad and Tobago ^c	30 October 1986	In force: 4 November 1992	414
Tunisia	26 February 1970	In force: 13 March 1990	381
Turkey	17 April 1980	In force: 1 September 1981	295

Situation on 31 December 1996 with respect to the conclusion of safeguards agreements between the Agency and non-nuclear-weapon States in connection with NPT (cont.)

Non-nuclear-weapon States which have signed, ratified, acceded to or succeeded to NPT ^a (1)	Date of ratification, accession or succession ^a (2)	Safeguards agreement with the Agency (3)	INFCIRC (4)
Turkmenistan	29 September 1994		
Tuvalu	19 January 1979	In force: 15 March 1991	391
Uganda	20 October 1982		
Ukraine ^u	5 December 1994	Signed: 21 September 1995	
United Arab Emirates	26 September 1995		
United Republic of Tanzania	7 June 1991	Signed: 26 August 1992	
Uruguay ^c	31 August 1970	In force: 17 September 1976	157
Uzbekistan	7 May 1992	In force: 8 October 1994	508
Vanuatu	24 August 1995		
Venezuela ^c	26 September 1975	In force: 11 March 1982	300
Viet Nam	14 June 1982	In force: 23 February 1990	376
Yemen, Republic of	1 June 1979		
Yugoslavia (Serbia and Montenegro) ^v , Federal Republic of	3 March 1970	In force: 28 December 1973	204
Zaire	4 August 1970	In force: 9 November 1972	183
Zambia	15 May 1991	In force: 22 September 1994	456
Zimbabwe	26 September 1991	In force: 26 June 1995	483

^a The information in columns (1) and (2) was provided to the Agency by depositary governments of NPT, and an entry in column (1) does not imply the expression of any opinion on the part of the Secretariat concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers. The table does not contain information relating to the participation of Taiwan, China, in NPT.

^b A sui generis comprehensive safeguards agreement with Albania entered into force on 25 March 1988 (INFCIRC/359).

^c The relevant safeguards agreement refers to both NPT and the Treaty of Tlatelolco.

^d The Board of Governors has concluded that the agreement between Argentina, Brazil, the ABACC and the Agency for the application of safeguards which entered into force on 4 March 1994 (INFCIRC/435) is compatible with the Treaty of Tlatelolco and the NPT.

^e The application of safeguards in Austria under the NPT safeguards agreement INFCIRC/156, in force since 23 July 1972, was suspended on 31 July 1996, on which date the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency, to which Austria had acceded, entered into force for Austria.

^f A comprehensive safeguards agreement with Chile concluded pursuant to the Treaty of Tlatelolco entered into force on 5 April 1995 (INFCIRC/476).

^g An agreement through an exchange of letters has taken place between this State and the Agency confirming that the safeguards agreement concluded with the State pursuant to the Treaty of Tlatelolco satisfies the requirements of the obligations of the State under Article III of the NPT to conclude a safeguards agreement with the Agency. This agreement entered into force on the date of approval by the Board of Governors.

^h A comprehensive safeguards agreement with Colombia concluded pursuant to the Treaty of Tlatelolco entered into force on 22 December 1982 (INFCIRC/306).

ⁱ The NPT safeguards agreement concluded with the Czechoslovak Socialist Republic (INFCIRC/173), which entered into force on 3 March 1972, continues to be applied in the Czech Republic to the extent relevant to the territory of the Czech Republic. A new NPT safeguards agreement concluded with the Czech Republic was approved by the Board of Governors on 9 September 1996.

- ^j The NPT safeguards agreement with Denmark (INFCIRC/176), in force since 1 March 1972, has been replaced by the agreement of 5 April 1973 between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency (INFCIRC/193) but still applies to the Faroe Islands. Upon Greenland's secession from EURATOM as of 31 January 1985, the Agreement between the Agency and Denmark (INFCIRC/176) re-entered into force as to Greenland.
- ^k The application of safeguards in Finland under the NPT safeguards agreement INFCIRC/155, in force since 9 February 1972, was suspended on 1 October 1995, on which date the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency, to which Finland had acceded, entered into force for Finland.
- ^l The NPT safeguards agreement of 7 March 1972 concluded with the German Democratic Republic (INFCIRC/181) is no longer in force with effect from 3 October 1990, on which date the German Democratic Republic acceded to the Federal Republic of Germany.
- ^m The application of safeguards in Greece under the NPT safeguards agreement INFCIRC/166, provisionally in force since 1 March 1972, was suspended on 17 December 1981, on which date Greece acceded to the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency.
- ⁿ An agreement had also been concluded in respect of the Netherlands Antilles (INFCIRC/229). This agreement entered into force on 5 June 1975.
- ^o The NPT safeguards agreement with New Zealand (INFCIRC/185) also applies to Cook Islands and Niue.
- ^p A comprehensive safeguards agreement with Panama concluded pursuant to the Treaty of Tlatelolco entered into force on 23 March 1984 (INFCIRC/316).
- ^q The application of safeguards in Portugal under the NPT safeguards agreement INFCIRC/272, in force since 14 June 1979, was suspended on 1 July 1986, on which date Portugal acceded to the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency.
- ^r The NPT safeguards agreement concluded with the Czechoslovak Socialist Republic (INFCIRC/173), which entered into force on 3 March 1972, continues to be applied in Slovakia to the extent relevant to the territory of Slovakia.
- ^s When Slovenia became an independent State, it succeeded to the safeguards agreement concluded with the Socialist Federal Republic of Yugoslavia (INFCIRC/204). A new NPT safeguards agreement concluded with Slovenia was approved by the Board of Governors on 8 June 1994.
- ^t The application of safeguards in Sweden under the NPT safeguards agreement INFCIRC/234, in force since 14 April 1975, was suspended on 1 June 1995, on which date the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency, to which Sweden had acceded, entered into force for Sweden.
- ^u A sui generis comprehensive safeguards agreement with Ukraine entered into force on 13 January 1995 (INFCIRC/462). This agreement will remain in force until superseded by a new safeguards agreement to be concluded pursuant to NPT.
- ^v The NPT safeguards agreement concluded with the Socialist Federal Republic of Yugoslavia (INFCIRC/204), which entered into force on 28 December 1973, continues to be applied in the Federal Republic of Yugoslavia (Serbia and Montenegro) to the extent relevant to the territory of the Federal Republic of Yugoslavia (Serbia and Montenegro).

Situation on 31 December 1996 with respect to the conclusion of safeguards agreements between the Agency and States party to the Treaty of Tlatelolco^a

States party to the Treaty of Tlatelolco (1)	Date of becoming a party to the Treaty of Tlatelolco (2)	Safeguards agreement with the Agency (3)	INFCIRC (4)
Antigua and Barbuda ^b	11 October 1983	In force: 9 September 1996	528
Argentina ^c	18 January 1994		
Bahamas	26 April 1977		
Barbados ^b	25 April 1969	In force: 14 August 1996	527
Belize ^d	4 November 1994		
Bolivia ^b	18 February 1969	In force: 6 February 1995	465
Brazil ^c	30 May 1994		
Chile	18 January 1994	In force: 5 April 1995	476
Colombia	6 September 1972	In force: 22 December 1982	306
Costa Rica ^b	25 August 1969	In force: 22 November 1979	278
Dominica ^e	25 August 1993		
Dominican Republic ^b	14 June 1968	In force: 11 October 1973	201
Ecuador ^b	11 February 1969	In force: 10 March 1975	231
El Salvador ^b	22 April 1968	In force: 22 April 1975	232
Grenada ^b	20 June 1975	In force: 23 July 1996	525
Guatemala ^b	6 February 1970	In force: 1 February 1982	299
Guyana	6 May 1996		
Haiti ^b	23 May 1969	Signed: 6 January 1975	
Honduras ^b	23 September 1968	In force: 18 April 1975	235
Jamaica ^b	26 June 1969	In force: 6 November 1978	265
Mexico ^{b,f}	20 September 1967	In force: 14 September 1973	197
Nicaragua ^b	24 October 1968	In force: 29 December 1976	246
Panama ^g	11 June 1971	In force: 23 March 1984	316
Paraguay ^b	19 March 1969	In force: 20 March 1979	279
Peru ^b	4 March 1969	In force: 1 August 1979	273
St. Lucia ^h	2 June 1995	In force: 12 June 1996	379/Mod.1
St. Vincent and the Grenadines ^e	11 May 1992		
Suriname ^b	10 June 1977	In force: 2 February 1979	269
Trinidad and Tobago ^b	27 June 1975	In force: 4 November 1992	414
Uruguay ^b	20 August 1968	In force: 17 September 1976	157
Venezuela ^b	23 March 1970	In force: 11 March 1982	300

In addition, there are the following safeguards agreements with States party to Additional Protocol I to the Treatyⁱ:

Netherlands ^b	In force: 5 June 1975	229
United Kingdom	Approved by the Board, Sep.1992	
United States of America	In force: 6 April 1989	366

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- ^a The information in columns (1) and (2) was provided by Mexico as depositary of the Treaty of Tlatelolco. In addition to the States listed in column (1), St. Kitts and Nevis signed the Treaty on 18 April 1995, but has not yet become party to the Treaty as it has not so far made the declaration provided for in Article 28 of the Treaty. Cuba signed the Treaty on 25 March 1995.
- ^b The relevant safeguards agreement refers to both the Treaty of Tlatelolco and NPT.
- ^c The Board of Governors has concluded that the agreement between Argentina, Brazil, the ABACC and the Agency for the application of safeguards (INFCIRC/435) is compatible with the Treaty of Tlatelolco.
- ^d A safeguards agreement pursuant to NPT has been concluded with this State; the agreement has not yet entered into force.
- ^e A safeguards agreement pursuant to NPT is in force with this State.
- ^f The application of safeguards under an agreement with Mexico in connection with the Treaty of Tlatelolco which entered into force on 6 September 1968 (INFCIRC/118) was suspended after the conclusion of an agreement with Mexico in connection with both the Treaty of Tlatelolco and NPT (INFCIRC/197).
- ^g A safeguards agreement pursuant to both the Treaty of Tlatelolco and NPT has been concluded with Panama; the agreement has not yet entered into force.
- ^h An agreement through an exchange of letters has taken place between this State and the Agency confirming that the NPT safeguards agreement concluded with the State satisfies the obligations of the State under Article 13 of the Treaty of Tlatelolco to conclude a safeguards agreement with the Agency. The agreement entered into force on the date of approval by the Board of Governors.
- ⁱ Additional Protocol I refers to States outside Latin America and the Caribbean which have de jure or de facto jurisdiction over territories which lie within the limits of the geographical zone established in the Treaty.

Agreements providing for safeguards, other than those in connection with NPT or the Treaty of Tlatelolco, approved by the Board as of 31 December 1996^a

Party(ies) ^b	Subject	Entry into force	INFCIRC
(While the Agency is a party to each of the following agreements, only the State(s) party to them is (are) listed.)			
(i) Project agreements			
Argentina	Siemens SUR-100	13 March 1970	143
	RAEP reactor ^c	2 December 1964	62
Chile ^d	Herald reactor	19 December 1969	137
Colombia ^d	Fuel for research reactor	17 June 1994	460
Finland ^e	FIR-1 reactor	30 December 1960	24
	FINN subcritical assembly	30 July 1963	53
Ghana ^e	Research reactor and fuel therefor	14 October 1994	468
Greece ^e	GRR-1 reactor	1 March 1972	163
Indonesia ^e	Additional core-load for TRIGA reactor	19 December 1969	136
	Supply of enriched uranium	15 January 1993	453
	Supply of enriched uranium	15 January 1993	454
Iran, Islamic Republic of ^e	UTRR reactor	10 May 1967	97
Jamaica ^e	Fuel for research reactor	25 January 1984	315
Japan ^e	JRR-3	24 March 1959	3
Malaysia ^e	TRIGA-II reactor	22 September 1980	287
Mexico ^e	TRIGA-III reactor	18 December 1963	52
	Siemens SUR-100	21 December 1971	162
	Laguna Verde Nuclear Power Plant	12 February 1974	203
Morocco ^e	Fuel for research reactor	2 December 1983	313
Nigeria ^e	Research reactor and fuel therefor	29 August 1996	526
Pakistan	PRR reactor	5 March 1962	34
	Booster rods for KANUPP	17 June 1968	116
Peru ^e	Research reactor and fuel therefor	9 May 1978	266
Philippines ^e	PRR-1 reactor	28 September 1966	88
Romania ^e	TRIGA reactor	30 March 1973	206
	Experimental fuel elements	1 July 1983	307
Slovenia ^e	TRIGA-II reactor	4 October 1961	32
	Krško Nuclear Power Plant	14 June 1974	213
Spain ^e	Coral-I reactor	23 June 1967	99
Syrian Arab Republic ^e	Miniature neutron source reactor and enriched uranium	18 May 1992	408
Thailand ^e	Fuel for research reactor	30 September 1986	342
Turkey ^e	Subcritical assembly	17 May 1974	212
Uruguay ^e	URR reactor	24 September 1965	67
Venezuela ^e	RV-1 reactor	7 November 1975	238
Viet Nam ^e	Fuel for research reactor	1 July 1983	308
Zaire ^e	TRICO reactor	27 June 1962	37
	Fuel for research reactor	20 September 1990	389

Safeguards agreements (cont.)

Party(ies) ^b	Subject	Entry into force	INFCIRC
(ii) Unilateral submissions			
Algeria	Nur research reactor	9 April 1990	361
	Es Salam research reactor	2 June 1992	401
Argentina	Atucha Power Reactor Facility ^f	3 October 1972	168
	Nuclear material ^f	23 October 1973	202
	Embalse Power Reactor Facility ^f	6 December 1974	224
	Equipment and nuclear material ^f	22 July 1977	250
	Nuclear material, material, equipment and facilities ^f	22 July 1977	251
	Atucha II Nuclear Power Plant ^f	15 July 1981	294
	Heavy water plant ^f	14 October 1981	296
	Heavy water ^f	14 October 1981	297
	Nuclear material ^f	8 July 1982	303
Chile	Nuclear material ^g	31 December 1974	256
	Nuclear material ^g	22 September 1982	304
	Nuclear material ^g	18 September 1987	350
Cuba	Nuclear power plant and nuclear material	5 May 1980	281
	Zero power nuclear reactor and fuel therefor	7 October 1983	311
Democratic People's Republic of Korea	Research reactor and nuclear material therefor ^h	20 July 1977	252
India	Nuclear material, material and facilities	17 November 1977	260
	Nuclear power station	27 September 1988	360
	Nuclear material	11 October 1989	374
	All nuclear material subject to safeguards under INFCIRC/154	1 March 1994	433*
Pakistan	Nuclear material	2 March 1977	248
	Miniature neutron source reactor	10 September 1991	393
	Nuclear power reactor	24 February 1993	418
Spain	Nuclear material ^h	18 June 1975	221
	Vandellos Nuclear Power Plant ^h	11 May 1981	292
	Specified nuclear facilities ^h	11 May 1981	291**
United Kingdom	Nuclear material	14 December 1972	175
Viet Nam	Research reactor and fuel therefor ^h	12 June 1981	293

* Amended in 1994 to cover nuclear material supplied for use in the Tarapur Atomic Power Station (TAPS) which material is required by the supplier to be subject to safeguards. The amendment entered into force on 12 September 1994 (INFCIRC/433/Mod.1).

** Amended in 1985 to cover specified nuclear facilities. The amendment entered into force on 8 November 1985 (INFCIRC/291/Mod.1/Corr.1).

Agreements providing for safeguards, other than those in connection with NPT or the Treaty of Tlatelolco, approved by the Board as of 31 December 1996^a (cont.)

Party(ies) ^b	Subject	Entry into force	INFCIRC
(iii) Agreements concluded with nuclear-weapon States on the basis of voluntary offers			
China	Nuclear material in facilities selected from list of facilities provided by China	18 September 1989	369
France	Nuclear material in facilities submitted to safeguards	12 September 1981	290
Russian Federation	Nuclear material in facilities selected from list of facilities provided by the Russian Federation	10 June 1985	327
United Kingdom	Nuclear material in facilities designated by the Agency	14 August 1978	263
United States of America	Nuclear material in facilities designated by the Agency	9 December 1980	288
(iv) Other comprehensive safeguards agreements			
Albania	All nuclear material and facilities	25 March 1988	359
Argentina/Brazil	All nuclear material in all nuclear activities	4 March 1994	435
Ukraine	All nuclear material in all peaceful nuclear activities	13 January 1995	462
(v) Other safeguards agreements			
Argentina/United States of America		25 July 1969	130
Austria ^h /United States of America		24 January 1970	152
Brazil/Germany ^h		26 February 1976	237
Brazil/United States of America		31 October 1968	110
Colombia/United States of America		9 December 1970	144
India/Canada ^h		30 September 1971	211
Iran, Islamic Republic of ^h /United States of America		20 August 1969	127
Israel/United States of America		4 April 1975	249
Japan ^h /Canada ^h		20 June 1966	85
Japan ^h /France		22 September 1972	171
Japan/United Kingdom		15 October 1968	125
Korea, Republic of/United States of America		5 January 1968	111

Safeguards agreements (cont.)

Party(ies) ^b	Subject	Entry into force	INFCIRC
Korea, Republic of ^h /France		22 September 1975	233
Pakistan/Canada		17 October 1969	135
Pakistan/France		18 March 1976	239
Philippines ^h /United States of America		19 July 1968	120
Portugal ^h /United States of America ⁱ		19 July 1969	131
South Africa/United States of America		26 July 1967	98
South Africa/France		5 January 1977	244
Spain/Germany ^h		29 September 1982	305
Spain ^h /United States of America ⁱ		9 December 1966	92
Spain/Canada ^h		10 February 1977	247
Sweden ^h /United States of America		1 March 1972	165
Switzerland ^h /United States of America ⁱ		28 February 1972	161
Turkey ^h /United States of America ⁱ		5 June 1969	123
Venezuela ^h /United States of America ⁱ		27 March 1968	122

(vi) The Agency also applies safeguards under two agreements (INFCIRC/133 and INFCIRC/158) to the nuclear facilities in Taiwan, China. Pursuant to the decision adopted by the Board of Governors on 9 December 1971 that the Government of the People's Republic of China is the only government which has the right to represent China in the Agency, the relations between the Agency and the authorities in Taiwan, China, are non-governmental. The agreements are implemented by the Agency on that basis.

^a Safeguards agreements pursuant to the South Pacific Nuclear Weapon Free Zone Treaty (Rarotonga Treaty) are not separately listed with this compilation since the Treaty requires that safeguards by the Agency will be applied pursuant to safeguards agreements equivalent in scope and effect to an agreement required in connection with the NPT on the basis of the material reproduced in INFCIRC/153 (Corrected). As of 31 December 1996, all 11 States Party to the Treaty (Australia, Cook Islands, Fiji, Kiribati, Nauru, New Zealand, Niue, Papua New Guinea, Solomon Islands, Tuvalu and Samoa) were covered by safeguards agreements concluded pursuant to NPT.

^b An entry in this column does not imply the expression of any opinion whatsoever on the part of the Agency concerning the legal status of any country or territory or of its authorities or concerning the delimitation of its frontiers.

^c Agency safeguards required by this project agreement are implemented pursuant to the comprehensive safeguards agreement concluded between Argentina, Brazil, the ABACC and the Agency (INFCIRC/435).

^d Agency safeguards required by this project agreement are implemented pursuant to a safeguards agreement in connection with the Treaty of Tlatelolco covering the State indicated.

^e Agency safeguards required by this (these) project agreement(s) are implemented pursuant to an agreement in connection with NPT covering the State indicated.

^f Application of Agency safeguards under this agreement has been suspended. Safeguards are applied pursuant to the comprehensive safeguards agreement concluded between Argentina, Brazil, the ABACC and the Agency (INFCIRC/435).

^g Application of Agency safeguards under this agreement has been suspended in the State indicated as the State has concluded an agreement in connection with the Treaty of Tlatelolco.

^h Application of Agency safeguards under this agreement has been suspended in the State indicated as the State has concluded an agreement in connection with NPT.

ⁱ Application of Agency safeguards under this agreement has been suspended in the United States of America in order to comply with a provision of INFCIRC/228.

Approximate quantities of material subject to Agency safeguards at the end of 1996

Type of material	Quantity of material (t)			
	Comprehensive safeguards agreements ^a	INFCIRC/66 ^b	Nuclear-weapon States	Quantity in SQs
Nuclear material				
Plutonium ^c contained in irradiated fuel	394.4	26.0	107.8	66 020
Separated plutonium outside reactor cores	12.2	3.9	37.6	6 703
Recycled plutonium in fuel elements in reactor cores	4.3	0.2	0	562
HEU (equal to or greater than 20% ²³⁵ U)	10.0	0.4	10.4	616
LEU (less than 20% ²³⁵ U)	38 213	2 434	7 973	13 533
Source material ^d (natural or depleted uranium and thorium)	71 229	4 019	30 183	6 832
Non-nuclear material^e				
Heavy water	0	572	0	29
<i>Total significant quantities</i>				94 294

^a Covering safeguards agreements pursuant to NPT and/or Treaty of Tlatelolco and other comprehensive safeguards statements.

^b Excluding installations in nuclear-weapon States; including installations in Taiwan, China.

^c The quantity includes an estimated 82 t (10 250 SQ) of plutonium in irradiated fuel, which is not yet reported to the Agency under the reporting procedures agreed to (the non-reported plutonium is contained in irradiated fuel assemblies to which item accountability and C/S measures are applied).

^d This table does not include material within the terms of subparagraphs 34(a) and (b) of INFCIRC/153 (Corrected).

^e Non-nuclear material subject to Agency safeguards under INFCIRC/66/Rev.2-type agreements.

Number of facilities under safeguards or containing safeguarded material on 31 December 1996

Facility type	Number of facilities (number of installations)			
	Comprehensive safeguards agreements ^a	INFCIRC/66 ^b	Nuclear-weapon States	Total
Power reactors	178 (215)	10 (13)	1 (1)	189 (229)
Research reactors and critical assemblies	151 (164)	11 (11)	1 (1)	163 (176)
Conversion plants	12 (12)	1 (1)	0 (0)	13 (13)
Fuel fabrication plants	36 (38)	4 (4)	0 (0)	40 (42)
Reprocessing plants	5 (5)	1 (1)	0 (0)	6 (6)
Enrichment plants	9 (9)	0 (0)	2 (2)	11 (11)
Separate storage facilities	52 (53)	2 (2)	7 (7)	61 (62)
Other facilities	73 (78)	1 (1)	1 (1)	75 (80)
<i>Subtotals</i>	516 (574)	30 (33)	12 (12)	558 (619)
Other locations	353 (437)	3 (22)	0 (0)	356 (459)
Non-nuclear installations	0 (0)	2 (2)	0 (0)	2 (2)
<i>Totals</i>	869 (1011)	35 (57)	12 (12)	916 (1080)

^a Covering safeguards agreements pursuant to NPT and/or Treaty of Tlatelolco and other comprehensive safeguards agreements; excludes locations in Iraq.

^b Excluding installations in nuclear-weapon States; including installations in Taiwan, China.

**Facilities under Agency safeguards or containing safeguarded material
on 31 December 1996**

Power reactors

State ^a	Abbreviated name of facility	Number of reactor units	Location	Subsidiary arrangements in force
Argentina	Atucha NPP	1	Lima	—
	Embalse NPP	1	Embalse	—
Armenia	Armenia NPP	2	Medzamor	—
Belgium	BR3-Mol	1	Mol	x
	DOEL-1	2	Doel	x
	DOEL-3	1	Doel	x
	DOEL-4	1	Doel	x
	Tihange-1	1	Tihange	x
	Tihange-2	1	Tihange	x
	Tihange-3	1	Tihange	x
Brazil	Admiral Alvaro Alberto	1	Angra dos Reis	—
Bulgaria	Kozloduy-I	2	Kozloduy	x
	Kozloduy-II	2	Kozloduy	x
	Kozloduy-III	2	Kozloduy	x
Canada	Bruce A	4	Tiverton	x
	Bruce B	4	Tiverton	x
	Darlington N.G.S.	4	Bowmanville	x
	Gentilly-2	1	Gentilly	x
	Pickering G.S.	8	Pickering	x
	Point Lepreau G.S.	1	Point Lepreau	x
China	QSNPP	1	Hai Yan	x
Cuba	Juragua	2	Juragua	x
Czech Republic	EDU-1	2	Dukovany	x
	EDU-2	2	Dukovany	x
Democratic People's Republic of Korea	Nyongbyon-1	1	Nyongbyon	—
Finland	Loviisa	2	Loviisa	—
	TVO-1	1	Olkiluoto	—
	TVO-2	1	Olkiluoto	—
Germany	AVR	1	Jülich	—
	KWG Grohnde	1	Grohnde	—
	GKN-2	1	Neckarwestheim	x
	RWE Biblis-A	1	Biblis	x
	RWE Biblis-B	1	Biblis	x
	KBR Brokdorf	1	Brokdorf	—
	KKB Brunsbüttel	1	Brunsbüttel	x
	KKE Emsland	1	Lingen	x
	KKG Grafenrheinfeld	1	Grafenrheinfeld	—
	KKI Isar-Ohu	1	Ohu bei Landshut	x
	KKI Isar-2	1	Essenbach	x
	KKK Krümmel	1	Geesthacht	x
	RWE Mühlheim-Kärlich	1	Mühlheim-Kärlich	x
	GKN Neckarwestheim	1	Neckarwestheim	x
	KWO Obrigheim	1	Obrigheim	x
	KKP Philippsburg-1	1	Philippsburg	x
KKP Philippsburg-2	1	Philippsburg	—	

Power reactors (cont.)

State ^a	Abbreviated name of facility	Number of reactor units	Location	Subsidiary arrangements in force
Germany (cont.)	KRB II Gundremmingen B	1	Gundremmingen	x
	KRB II Gundremmingen C	1	Gundremmingen	x
	KKS Stade	1	Stade	x
	KKU Unterweser	1	Unterweser	x
	KWW Würgassen	1	Würgassen	x
	HKG-THTR 300	1	Hamm	—
	KKW Greifswald 1	2	Lubmin	—
	KKW Greifswald 2	2	Lubmin	—
	KKW Greifswald 3	1	Lubmin	—
KKW Rheinsberg	1	Rheinsberg	x	
Hungary	PAKS-I	2	Paks	x
	PAKS-II	2	Paks	x
India	RAPS	2	Rajasthan	x
	TAPS	2	Tarapur	x
Italy	ENEL-Latina	1	Borgo-Sabatino	x
	ENEL-Caorso	1	Caorso	x
	ENEL-Trino	1	Trino-Vercellese	x
Japan	Fugen	1	Tsuruga-shi, Fukui-ken	x
	Fukushima Dai-Ichi-1	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ichi-2	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ichi-3	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ichi-4	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ichi-5	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ichi-6	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ni-1	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ni-2	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ni-3	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ni-4	1	Futaba-gun, Fukushima-ken	x
	Genkai-1	1	Higashimatsura-gun, Saga-ken	x
	Genkai-2	1	Higashimatsura-gun, Saga-ken	x
	Genkai-3	1	Higashimatsura-gun, Saga-ken	—
	Genkai-4	1	Higashimatsura-gun, Saga-ken	—
	Hamaoka-1	1	Ogasa-gun, Shizuoka-ken	x
	Hamaoka-2	1	Ogasa-gun, Shizuoka-ken	x
	Hamaoka-3	1	Ogasa-gun, Shizuoka-ken	x
	Hamaoka-4	1	Ogasa-gun, Shizuoka-ken	—
	Ikata-1	1	Nishiuwa-gun, Ehime-ken	x
	Ikata-2	1	Nishiuwa-gun, Ehime-ken	x
	Ikata-3	1	Nishiuwa-gun, Ehime-ken	—
	Joyo	1	Higashi-gun, Ibaraki-ken	x
	Kashiwazaki-1	1	Kashiwazaki-shi, Niigata-ken	x
	Kashiwazaki-2	1	Kashiwazaki-shi, Niigata-ken	x
	Kashiwazaki-3	1	Kashiwazaki-shi, Niigata-ken	—
	Kashiwazaki-4	1	Kashiwazaki-shi, Niigata-ken	—
	Kashiwazaki-5	1	Kashiwazaki-shi, Niigata-ken	x
	Kashiwazaki-6	1	Kashiwazaki-shi, Niigata-ken	—
	Kashiwazaki-7	1	Kashiwazaki-shi, Niigata-ken	—
Mihama-1	1	Mikata-gun, Fukui-ken	x	
Mihama-2	1	Mikata-gun, Fukui-ken	x	
Mihama-3	1	Mikata-gun, Fukui-ken	x	
Monju	1	Tsuruga-shi, Fukui-ken	x	

Power reactors (cont.)

State ^a	Abbreviated name of facility	Number of reactor units	Location	Subsidiary arrangements in force
Japan (cont.)	Ohi-1&2	2	Ohi-gun, Fukui-ken	x
	Ohi-3	1	Ohi-gun, Fukui-ken	x
	Ohi-4	1	Ohi-gun, Fukui-ken	x
	Onagawa-1	1	Oshika-gun, Miyaki-ken	x
	Onagawa-2	1	Oshika-gun, Miyaki-ken	—
	Sendai-1	1	Sendai-shi, Kagashima-ken	x
	Sendai-2	1	Sendai-shi, Kagashima-ken	x
	Shika	1	Hakui-gun, Ishikawa-ken	—
	Shimane-1	1	Yatsuka-gun, Shimane-ken	x
	Shimane-2	1	Yatsuka-gun, Shimane-ken	x
	Takahama-1	1	Ohi-gun, Fukui-ken	x
	Takahama-2	1	Ohi-gun, Fukui-ken	x
	Takahama-3	1	Ohi-gun, Fukui-ken	x
	Takahama-4	1	Ohi-gun, Fukui-ken	x
	Tokai-1	1	Tokai-Mura, Ibaraki-ken	x
	Tokai-2	1	Tokai-Mura, Ibaraki-ken	x
	Tomari-1	1	Furuu-gun, Hokkaido	x
	Tomari-2	1	Furuu-gun, Hokkaido	x
	Tsuruga-1	1	Tsuruga-shi, Fukui-ken	x
	Tsuruga-2	1	Tsuruga-shi, Fukui-ken	x
Kazakstan	BN-350	1	Aktau	—
Korea, Republic of	Kori-1	1	Pusan	x
	Kori-2	1	Pusan	x
	Kori-3	1	Pusan	x
	Kori-4	1	Pusan	x
	Ulchin-1	1	Ulchin	x
	Ulchin-2	1	Ulchin	x
	Wolsong-1	1	Kyongju	x
	Wolsong-2	1	Kyongju	—
	Younggwang 1	1	Younggwang	x
	Younggwang 2	1	Younggwang	x
Younggwang-3	1	Younggwang	x	
Younggwang-4	1	Younggwang	x	
Lithuania	Ignalina NPP	2	Visaginas	—
Mexico	Laguna Verde	2	Alto Lucero	x
Netherlands	Borssele	1	Borssele	x
	Dodewaard NPP	1	Dodewaard	x
Pakistan	KANUPP	1	Karachi	x
Philippines	PNPP-1	1	Morong, Bataan	x
Romania	Cernavoda-1	1	Cernavoda	—
Slovakia	A1	1	Bohunice	x
	EMO-1	2	Mochovce	—
	V-1	2	Bohunice	x
	V-2	2	Bohunice	x
Slovenia	Kr,ko	1	Kr,ko	x
South Africa	Koeberg-1	1	Cape Town	x
	Koeberg-2	1	Cape Town	x
Spain	Almaraz-1	1	Almaraz	—
	Almaraz-2	1	Almaraz	—

Power reactors (cont.)

State ^a	Abbreviated name of facility	Number of reactor units	Location	Subsidiary arrangements in force
Spain (cont.)	Asco-1	1	Asco	—
	Asco-2	1	Asco	—
	Cofrentes	1	Cofrentes	—
	José Cabrera	1	Almonazid de Zorita	—
	Santa María de Garona	1	Santa María de Garona	—
	Trillo-1	1	Trillo	—
	Vandellos 1	1	Vandellos	—
	Vandellos 2	1	Vandellos	—
Sweden	Barsebäck 1	1	Malmö	—
	Barsebäck 2	1	Malmö	—
	Forsmark 1	1	Uppsala	—
	Forsmark 2	1	Uppsala	—
	Forsmark 3	1	Uppsala	—
	Oskarshamn 1	1	Oskarshamn	—
	Oskarshamn 2	1	Oskarshamn	—
	Oskarshamn 3	1	Oskarshamn	—
	Ringhals 1	1	Göteborg	—
	Ringhals 2	1	Göteborg	—
	Ringhals 3	1	Göteborg	—
	Ringhals 4	1	Göteborg	—
Switzerland	KKB Beznau I	1	Beznau	x
	KKB Beznau II	1	Beznau	x
	KKG Gösgen	1	Gösgen-Däniken	x
	KKL Leibstadt	1	Leibstadt	x
	KKM Mühleberg	1	Mühleberg	x
Ukraine	Chernobyl NPP	3	Chernobyl	—
	Khmelnitski 1	1	Neteshin	—
	Rovno 1 & 2	2	Kuznetsovsk	—
	Rovno 3	1	Kuznetsovsk	—
	South Ukraine 1	1	Yuzhnoukrainsk	—
	South Ukraine 2	1	Yuzhnoukrainsk	—
	South Ukraine 3	1	Yuzhnoukrainsk	—
	Zaporozhe 1	1	Energodar	—
	Zaporozhe 2	1	Energodar	—
	Zaporozhe 3	1	Energodar	—
	Zaporozhe 4	1	Energodar	—
Zaporozhe 5	1	Energodar	—	
Zaporozhe 6	1	Energodar	—	

Research reactors and critical assemblies

State ^a	Abbreviated name of facility	Number of reactor units	Location	Subsidiary arrangements in force
Algeria	NUR Reactor	1	Algiers	x
	Es Salam research reactor	1	Ain Oussera	—
Argentina	Argentine reactor-1	1	Constituyentes	—
	Argentine reactor-3	1	Ezeiza	—
	Argentine reactor-4	1	Rosario	—
	Argentine reactor-6	1	Bariloche	—
	Argentine reactor-0	1	Córdoba	—
	Argentine reactor-8	1	Pilcaniyeu	—
Australia	HIFAR	1	Lucas Heights	x
	MOATA	1	Lucas Heights	x
Austria	ASTRA	1	Seibersdorf	—
	Siemens Argonaut Reactor	1	Graz	—
	Triga II	1	Vienna	—
Bangladesh	Atomic Energy Research Est.	1	Dhaka	x
Belarus	Sosny	1	Minsk	—
Belgium	BR1-CEN	1	Mol	x
	BR2-CEN-BRO2	2	Mol	x
	CEN-Venus	1	Mol	x
	Thetis	1	Gent	x
Brazil	IEA-R1	1	São Paulo	—
	RIEN-1 Argonaut RR	1	Rio de Janeiro	—
	IPR-RI-CDTN	1	Belo Horizonte	—
	IPEN Critical assembly	1	São Paulo	—
	Subcritical assembly	1	Rio de Janeiro	—
	Subcritical assembly	1	Recife	—
Bulgaria	IRT-2000	1	Sofia	x
Canada	Biology, Chemistry, Physics	2	Chalk River	x
	McMaster	1	Hamilton	x
	NRU	1	Chalk River	x
	NRX	1	Chalk River	x
	Slowpoke-AECL	1	Ottawa	x
	Slowpoke-Dalhousie Univ.	1	Halifax	x
	Slowpoke-Ecole Polytechnique	1	Montreal	x
	Slowpoke-Kingston	1	Kingston	x
	Slowpoke-Saskatchewan	1	Saskatoon	x
	Slowpoke-Univ. of Toronto	1	Toronto	x
	Slowpoke-Univ. of Alberta	1	Edmonton	x
	Chile	La Reina	1	Santiago
Lo Aguirre		1	Santiago	—
China	HWRR	1	Beijing	x
Colombia	IAN-R1	1	Bogotá	—
Czech Republic	LR-O	1	e	x
	SR-OD	1	Vochov	x
	Univ. Training Reactor VR-1P	1	Prague	x
	VVR-S	1	e	x
Democratic People's Republic of Korea	Critical Assembly	1	Bungang-Ri, Nyongbyon	x
	IRT	1	Bungang-Ri, Nyongbyon	x

Research reactors and critical assemblies (cont.)

State ^a	Abbreviated name of facility	Number of reactor units	Location	Subsidiary arrangements in force
Denmark	DR-1	1	Roskilde	x
	DR-3	1	Roskilde	x
Egypt	RR-I	1	Inshas	x
Finland	FIR 1	1	Otaniemi	—
Germany	BER-2	1	Berlin	x
	PTB	1	Braunschweig	x
	FH-Furtwangen	1	Furtwangen	x
	FRF-2	1	Frankfurt	x
	FRM	1	Garching	x
	GKSS-FRG1&FRG2	2	Geesthacht	x
	KFA-FRJ2	1	Jülich	x
	SUR 100	1	Bremen	x
	SUR 100	1	Eggenstein-Leopoldshafen	x
	SUR 100	1	Hannover	x
	SUR 100	1	Kiel	x
	SUR 100	1	Hamburg	x
	SUR 100	1	Ulm	x
	SUR 100	1	Stuttgart	x
	SUR 100	1	Berlin	x
	SUR 100	1	Aachen	x
	Tech. Univ. AKR	1	Dresden	x
	Tech. Hochschule ZLR	1	Zittau	x
	Triga	1	Mainz	x
	MHH-Triga	1	Hannover	x
DKFZ-Triga	1	Heidelberg	x	
VKT RAKE & RRR	2	Rosendorf	x	
VKT research reactor	1	Rosendorf	x	
Ghana	GHARR-1	1	Legon-Accra	x
Greece	GRR-1	1	Attiki	x
Hungary	Training reactor	1	Budapest	x
	WWR-S M 10	1	Budapest	x
Indonesia	Gama	1	Yogyakarta	x
	MPR-30	1	Serpong	x
	PPTN	1	Bandung	x
Iran, Islamic Republic of	TRR	1	Tehran	x
	HWZPR	1	Esfahan	—
	MNSR	1	Esfahan	—
Israel	IRR-1	1	Soreq	x
Italy	AGN-201	1	Palermo	x
	Poltec.	1	Milan	x
	RTS-1	1	San Piero a Grado	x
	TAPIRO	1	Santa Maria di Galeria	x
	Triga-RC1	1	Santa Maria di Galeria	x
	Triga-2	1	Pavia	x
Jamaica	Centre for Nuclear Sciences	1	Kingston	x

Research reactors and critical assemblies (cont.)

State ^a	Abbreviated name of facility	Number of reactor units	Location	Subsidiary arrangements in force
Japan	DCA	1	Oarai-machi, Ibaraki-ken	x
	FCA	1	Tokai-Mura, Ibaraki-ken	x
	HTR	1	Kawasaki-shi, Kanagawa-ken	x
	JMTR	1	Higashi-gun, Ibaraki-ken	x
	JMTRCA	1	Higashi-gun, Ibaraki-ken	x
	JRR-2	1	Tokai-Mura, Ibaraki-ken	x
	JRR-3	1	Tokai-Mura, Ibaraki-ken	x
	JRR-4	1	Tokai-Mura, Ibaraki-ken	x
	Kinki University reactor	1	Higashiosaka-shi, Osaka-fu	x
	KUCA	3	Osaka	x
	KUR	1	Sennan-gun, Osaka	x
	Musashi reactor	1	Kawasaki-shi, Kanagawa-ken	x
	N.S. Mutsu	1	Mutsui-shi, Aomori-ken	x
	NCA	1	Kawasaki-shi	x
	NSRR	1	Tokai-Mura, Ibaraki-ken	x
	Rikkyo University R.R.	1	Nagasaka, Kanagawa-ken	x
	TCA	1	Tokai-Mura, Ibaraki-ken	x
	TODAI	1	Tokai-Mura, Ibaraki-ken	x
	TTR	1	Kawasaki-shi, Kanagawa-ken	x
VHTRC	1	Tokai-Mura, Ibaraki-ken	x	
Kazakstan	Kurchatov test reactor	2	Semipalatinsk	—
	WWR-K	1	Almaty	—
Korea, Republic of	Triga II&III	2	Seoul	x
	Kyunghee Univ.	1	Suwoon	x
	Hanaro	1	Taejon	—
Latvia	IRT	1	Riga	—
Libyan Arab Jamahiriya	IRT reactor	1	Tajura	x
Malaysia	Puspati	1	Bangi, Selangor	x
Mexico	Triga Mark III	1	Ocoyoacac	x
Netherlands	HOR	1	Delft	x
	HFR	1	Petten	x
	LFR	1	Petten	x
Norway	HBWR-Halden	1	Halden	x
	JEEP-II	1	Kjeller	x
Pakistan	PARR-1	1	Rawalpindi	x
	PARR-2	1	Rawalpindi	x
Peru	RP-0	1	Lima	x
	RP-10	1	Lima	x
Philippines	PRR-1	1	Quezon City, Diliman	x
Poland	Agata&Anna	2	fwierk	x
	Ewa	1	fwierk	x
	Maria	1	fwierk	x
Portugal	RPI	1	Sacavem	x
Romania	Triga II	1	Pitești Colibaș	x
	VVR-S	2	Magurele	x
Slovenia	Triga II	1	Ljubljana	x

Research reactors and critical assemblies (cont.)

State ^a	Abbreviated name of facility	Number of reactor units	Location	Subsidiary arrangements in force
South Africa	SAFARI-1	1	Pelindaba	x
Sweden	Studsvik RR	2	Studsvik	—
Switzerland	AGN 211P	1	Basel	x
	Crocus	1	Lausanne	x
	Proteus	1	Würenlingen	x
	Saphir	1	Würenlingen	x
Syrian Arab Republic	MNSR		Damascus	x
Thailand	TRR-1	1	Bangkok	x
Turkey	Çekmece Nuclear Research and Training Centre	1	Istanbul	x
	ITU-TRR Triga Mark II	1	Istanbul	x
Ukraine	Kiev RR	1	Kiev	—
	IR-100 RR	1	Sevastopol	—
Uruguay	Centro Investigaciones Nucleares	1	Montevideo	x
Uzbekistan	Photon	1	Tashkent	—
	WWR-SM	1	Tashkent	—
Venezuela	RV-I	1	Altos de Pipe	x
Viet Nam	Da Lat Research Reactor	1	Da Lat, Lam Dong	x
Yugoslavia (Serbia and Montenegro), Fed. Rep. of	RA-RB	2	VinEa	x
Zaire	Zaire Triga II	1	Kinshasa	x

Conversion plants, including pilot plants

State ^a	Abbreviated name of facility	Location	Subsidiary arrangements in force
Argentina	UF ₆ production facility	Pilcaniyeu	—
	UO ₂ conversion plant	Córdoba	—
Canada	CAMECO	Port Hope	x
Chile	Lab. exper. de conversión	Santiago	—
Japan	JCO conv. plant	Tokai-Mura, Ibaraki-ken	x
	Ningyo R&D	Tomata-gun, Okayama-ken	x
	PCDF	Tokai-Mura, Ibaraki-ken	x
Romania	UO ₂ powder fabrication plant	Feldioara	—
South Africa	Conversion plant	Pelindaba	x
	HEU-UF ₆ production plant	Pelindaba	x
Sweden	Ranstad Mineral	Ranstad	—

Fuel fabrication plants, including pilot plants

State ^a	Abbreviated name of facility	Location	Subsidiary arrangements in force
Argentina	Experimental plant	Constituyentes	—
	Fuel fabrication plant	Ezeiza	—
	Fuel fabrication plant	Constituyentes	—
Belgium	BN-MOX	Dessel	x
	FBFC	Dessel	x
	FBFC MOX	Dessel	—
Brazil	Fuel fabrication plant	Resende	—
Canada	CRNL fuel fabrication	Chalk River	x
	Fuel fabrication facility	Chalk River	x
	GEC, Inc.	Toronto	x
	GEC, Inc.	Peterborough	x
	Zircatec	Port Hope	x
Democratic People's Republic of Korea	Nuclear fuel fabrication plant	Nyongbyon	—
Denmark	Metallurgy	Roskilde	x
Germany	Adv. Nuclear Fuels	Lingen	x
	NUKEM	Wolfgang	x
	Siemens Uran (two units)	Hanau	x
	Siemens MOX	Hanau	x
India	Ceramic fuel fab. assembly area	Hyderabad	x
	EFFP-NFC	Hyderabad	x
Indonesia	Experimental fuel element installation (IEBE)	Serpong	x
	Research reactor fuel element production installation (IPEBRR)	Serpong	x
Italy	Fabnuc	Bosco Marengo	x
Japan	JNF	Yokosuka-shi, Kanagawa-ken	x
	MNF	Tokai-Mura, Ibaraki-ken	x
	NFI (Kumatori-1)	Sennan-gun, Osaka	x
	NFI (Kumatori-2)	Sennan-gun, Osaka	x
	NFI Tokai	Tokai-Mura, Ibaraki-ken	x
	PPFF	Tokai-Mura, Ibaraki-ken	x
	PPFF	Tokai-Mura, Ibaraki-ken	x
Kazakstan	Ulbinski Metallurgical Works	Kamenogorsk	—
Korea, Republic of	CANDU fuel fabrication plant	Taejon	x
	KNFFP	Taejon	x
Mexico	Fuel fabrication pilot plant	Ocoayacac	x
Romania	Romfuel	Pite ̄ti Colibasi	x
South Africa	MTR fuel fabrication	Pelindaba	—
	LEU fuel fabrication	Pelindaba	x
Spain	ENUSA fuel fabrication plant	Juzbado	—
Sweden	ABB	Västeras	—

Chemical reprocessing plants, including pilot plants

State ^a	Abbreviated name of facility	Location	Subsidiary arrangements in force
Democratic People's Republic of Korea	Radiochemical Laboratory	Bungang-Ri, Nyongbyon	—
Germany	WAK	Eggenstein-Leopoldshafen	x
India	PREFRE	Tarapur	x
Italy	EUREX ITREC-Trisaia	Saluggia Rotondella	x x
Japan	Tokai reprocessing plant	Tokai-Mura, Ibaraki-ken	x
<i>In addition, the following R&D facilities and locations are associated with reprocessing technology:</i>			
Indonesia	RMI	Serpong	—
Japan	SCF JAERI Tokai R&D PNC Tokai R&D Sumitomi Met. Mining	Tokai-Mura, Ibaraki-ken Tokai-Mura, Ibaraki-ken Tokai-Mura, Ibaraki-ken Tokai-Mura, Ibaraki-ken	x x x x

Enrichment plants, including pilot plants

State ^a	Abbreviated name of facility	Location	Subsidiary arrangements in force
Argentina	Pilcaniyeu enrichment plant	Pilcaniyeu	—
Brazil	Enrichment plant (first cascade) Enrichment laboratory	Resende Ipero	— —
Germany	UTA-1	Gronau	x
Japan	Uranium Enrichment Plant Rokkasho Enrichment Plant	Tomata-gun, Okayama-ken Kamikita-gun, Aomori-ken	x x
Netherlands	URENCO	Almelo	x
South Africa	Semi-commercial enrichment plant MLIS enrichment plant	Pelindaba Valindaba	x —
United Kingdom	URENCO E22 URENCO A3 plant	Capenhurst Capenhurst	x —
<i>In addition, the following R&D facilities and locations are associated with enrichment technology:</i>			
Brazil	Lab. for laser spectroscopy UF ₆ laboratory	San Jose dos Campos Belo Horizonte	— —
Germany	Urenco	Jülich	—
Japan	Asahi Chemical Industry Communication Equipment Works Hitachi laboratory JAERI Tokai R&D Nuclear Development Corp. PNC Tokai R&D Toshiba R&D Centre	Hyuga-shi, Miyazaki-ken Tokai-Mura, Ibaraki-ken Hitachi-shi, Ibaraki-ken Tokai-Mura, Ibaraki-ken Tokai-Mura, Ibaraki-ken Tokai-Mura, Ibaraki-ken Kawasaki-shi, Kanagawa-ken	x x x x x x x
Netherlands	Urenco Ultra-centrifuge	Almelo Almelo	x —

Separate storage facilities

State ^a	Abbreviated name of facility	Location	Subsidiary arrangements in force
Argentina	Central store	Ezeiza	—
	Central store	Constituyentes	—
	Nuclear material store	Constituyentes	—
Australia	Vault storage	Lucas Heights	x
Belgium	Belgoprocess	Dessel	x
	Elbel	Beveren	—
Brazil	Aramar stores (2 units)	Ipero	—
	UF ₆ production facility	Sao Paulo	—
Bulgaria	Long term storage	Kozloduy	x
Canada	Nuclear material	Chalk River	x
	Spent fuel canister store	Chalk River	x
	Douglas Point dry storage	Tiverton	x
	Gentilly-1	Gentilly	x
	Spent fuel storage	Chalk River	x
	AECL Research	Pinawa	x
Chile	PUFDSF	Pickering	—
	BGMN	Santiago	—
Czech Republic	Storage ' koda	Bolevec	—
	HLW store	e	—
	ISFS Dukovany	Dukovany	—
Democratic People's Republic of Korea	Nuclear fuel storage	Bungang-Ri, Nyongbyon	—
Denmark	Risø Store	Roskilde	x
	Risø Waste	Roskilde	—
Finland	TVO-KPA store	Olkilouto	—
France	Cogéma UP2 & UP3	La Hague	x
Germany	Bundeslager	Wolfgang	—
	ANF UF6 Lager	Lingen	x
	KFA AVR BL	Jülich	—
	KFA AVR	Jülich	x
	BZA-Ahaus	Ahaus	—
	LSG Offset-Lager	Hanau	—
	NCS-Lagerhalle	Hanau	—
	Gamma Services	Radeberg	—
	Urananlage	Ellweiler	x
	Energiewerke Nord GmbH	Lubmin	x
Transportbehälterlager	Gorleben	—	
Kernmateriallager	Rosendorf	—	
Hungary	Central radionuclide store	Budapest	x
India	AFR	Tarapur	x
Italy	Compes. deposito	Saluggia	x
	Essor nuclear plant	Ispra	—
	Essor storage	Ispra	x
	Research centre	Ispra	—
Japan	KUFFS	Kyoto	x
Kazakstan	Ulbinski Thorium Storage	Kamenogorsk	—

Separate storage facilities (cont.)

State ^a	Abbreviated name of facility	Location	Subsidiary arrangements in force
Luxembourg	International Metals S.A.	Luxembourg-Dommeldange	x
Pakistan	Hawks Bay depot	Karachi	x
Portugal	Inst. de Armazenagem	Sacavem	x
Russian Federation	Mashinostroitel'nyi Zavod	Ehlektrostal	—
Slovakia	AFRS	Bohunice	x
South Africa	Waste storage	Pelindaba	—
	Bulk storage facility	Pelindaba	x
	HEU storage vault	Pelindaba	—
	Radiation Hill pipe store	Pelindaba	—
Spain	CIEM	Madrid	—
Sweden	Central long term storage	Oskarshamn	—
Switzerland	Diorit storage	Würenlingen	x
Ukraine	Chernobyl storage	Chernobyl	—
United Kingdom	Thorp R&S	Sellafield	x
	Special nuclear material store 9	Sellafield	x
United States of America	Pu storage vault	Hanford, WA	—
	Y-12 plant	Oak Ridge, TN	—
	Vault	Golden, CO	—

Other facilities

State ^a	Abbreviated name of facility	Location	Subsidiary arrangements in force
Argentina	Alpha facility	Constituyentes	—
	Experimental UO ₂ plant	Cordoba	—
	Enriched uranium lab.	Ezeiza	—
	Fuel fabrication plant	Ezeiza	—
	Uranium powder fab. plant	Constituyentes	—
Australia	Research Lab.	Lucas Heights	x
Belgium	IRMM-Geel	Geel	x
	CEN-Labo	Mol	x
	CEN-Waste	Dessel	—
	I.R.E.	Fleurus	x
	CEN-lab. Pu	Mol	x
Brazil	Isotope laboratory	Sao Paulo	—
	Nuclear material lab.	Ipero	—
	Safeguards store	Sao Paulo	—
Chile	UMF	Santiago	—
Czech Republic	Nuclear Fuel Inst. (UJP)	Zbraslav	x
	Research Laboratories	e	x
Democratic People's Republic of Korea	Subcritical assembly	Pyongyang	x
Germany	DESY	Hamburg	—
	KFA-heisse Zellen	Jülich	x
	KFK-heisse Zellen	Eggenstein-Leopoldshafen	x
	KFK-IHCH	Eggenstein-Leopoldshafen	x
	Siemens heisse Zellen	Karlstein	x
	KFA Lab.	Jülich	x
	Transuran	Eggenstein-Leopoldshafen	x
	VKT.UT + LAB	Rosendorf	x
	VKT. Tec. ZTR	Rosendorf	x
Hungary	Institute of Isotopes	Budapest	x
Indonesia	RMI	Serpong	—
Iran, Islamic Republic of	LWSCR	Esfahan	x
	GSCR	Esfahan	x
Italy	CNEN-LAB. PU.	Santa Maria di Galeria	x
Japan	JAERI-Oarai R&D	Higashi-gun, Ibaraki-ken	x
	JAERI-Tokai R&D	Tokai-Mura, Ibaraki-ken	x
	Kumatori R & D	Sennan-gun, Osaka	x
	Mitsui Iwakuni-Ohtake	Kuga-gun, Yamaguchi	x
	Mitsui Toatsu	Takai-shi, Osaka-fu	x
	NDC Fuel Hot Lab.	Tokai-Mura, Ibaraki-ken	x
	NDC fuel laboratories	Tokai-Mura, Ibaraki-ken	x
	NERL, University of Tokyo	Tokai-Mura, Ibaraki-ken	x
	NFD	Higashi-gun, Ibaraki-ken	x
	NFI Tokai-2	Tokai-Mura, Ibaraki-ken	x
	NRF Neutron Radiation Facility	Tsukuba-shi, Ibaraki-ken	x
	PNC FMF	Higashi-gun, Ibaraki-ken	x
	PNC IRAF	Higashi-gun, Ibaraki-ken	x
	PNC-Oarai R&D	Higashi-gun, Ibaraki-ken	x
	PNC-Tokai R&D	Tokai-Mura, Ibaraki-ken	x
	SCF	Tokai-Mura, Ibaraki-ken	x
	Showa-Kawasaki	Kawasaki-shi, Kanagawa-ken	x

Other facilities (cont.)

State ^a	Abbreviated name of facility	Location	Subsidiary arrangements in force
Japan (cont.)	Sumitomo-Chiba Uranium Material Laboratory	Sodegaura-shi, Chiba-ken	x
Korea, Republic of	PIEF	Higashi-gun, Ibaraki-ken	x
	Acrylonitrile plant	Daejeon	x
	HFFL	Ulsan	—
	IMEF	Taejon	—
Netherlands	ECN & JRC	Petten	x
Norway	Research laboratories	Kjeller	x
Poland	Institute for nuclear chemistry and engineering	Warsaw	—
South Africa	Institute of Nuclear Research	fwierk	x
	Decommissioned pilot enrichment plant	Pelindaba	—
	Decontamination and waste recovery	Pelindaba	—
	Hot Cell Complex	Pelindaba	x
Sweden	NU and DU metals plant	Pelindaba	—
	Central storage	Studsvik	x
Switzerland	E.I.R.	Würenlingen	x
Turkey	Nuclear fuel pilot plant	Istanbul	x
Ukraine	Khmelnitski FF Storage	Neteshin	—
	KHFTI	Kharkov	—
	Rovno FF Storage	Kuznetsovsk	—
	South Ukraine Storage	Yuzhnoukrainsk	—
	Zaporozhe FF Storage	Energodar	—
United States of America	Sevastopol Naval Institute	Sevastopol	—
	B&W NNFD	Lynchburg, VA	—

Non-nuclear installations

State ^a	Abbreviated name of facility	Location	Subsidiary arrangements in force
Argentina	Heavy water storage	Buenos Aires	x
Cuba	Storage of equipment	Prov. Havana	—

^a An entry in this column does not imply the expression of any opinion whatsoever on the part of the Agency concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

Note: The Agency was also applying safeguards in Taiwan, China, at six power reactors, six research reactors/critical assemblies, one uranium pilot conversion plant, two fuel fabrication plants and one R&D facility.

Locations in Iraq containing nuclear material which are under the responsibility of the IAEA Action Team under United Nations Security Council Resolution 687

Location C

In the vicinity of Al Tuwaittha

Additional safeguards support provided by States

States and organizations representing groups of States
having formal support programmes

States having R&D contracts
and test programmes

Argentina
Australia
Belgium
Canada
EURATOM
Finland
France
Germany
Hungary
Indonesia
Japan
Netherlands
Russian Federation
Sweden
United Kingdom
United States of America

Argentina
Austria
Latvia
Pakistan
Russian Federation

Main equipment and activities in support of safeguards
1995**1996**

	Total in inventory	
Gamma ray measurement systems		
Low resolution systems	74	79
High resolution systems	49	51
Portable multichannel analysers	163	175
Detectors	367	410
Neutron measurement systems		
Detection heads for active neutron measurements	23	24
Detection heads for passive neutron measurements	22	34
Neutron coincidence counting electronics	82	95
Spent fuel measurement systems		
Cerenkov glow viewing devices	75	84
Spent fuel radiation measuring systems	88	122
Irradiated fuel measuring electronics	64	66
Other measurement systems		
Physical properties devices	122	134
Optical surveillance systems		
Photo cameras	995	993
Video single camera systems	358	381
Video multiple camera systems	18	21
Video review stations	50	68
Seals		
In situ verifiable seals	598	553
Radiation monitoring systems		
CANDU spent fuel bundle counters	30	30
Other monitoring systems	11	17
Activities		
Metal cap seals issued	21 878	21 825
Metal cap seals verified	16 476	19 393
Shipment of equipment and supplies	462	525
Hand carried transport of equipment and supplies	378	408
Shipment of reference material and chemicals to facilities	129	158
Shipment of inspection samples, radioactive material standards and contaminated items to SAL ^a	194	183
Procurement actions	2120	2 093

^a SAL: The Agency's Safeguards Analytical Laboratory.

Conventions negotiated and adopted under the auspices of the Agency and for which the Director General is the Depositary (status and relevant developments)

Agreement on the Privileges and Immunities of the IAEA (reproduced in INFCIRC/9/Rev.1): During 1996, there was no change in the number of Parties to the Agreement. The number of Member States who have accepted the Agreement remains at 65.

Vienna Convention on Civil Liability for Nuclear Damage (reproduced in INFCIRC/500): Entered into force on 12 November 1977. Now has 27 Parties as a result of accession by 1 State, and 12 signatories as a result of signature by 1 State.

Convention on the Physical Protection of Nuclear Material (reproduced in INFCIRC/274/Rev.1): Entered into force on 8 February 1987. In 1996, 4 States became Party to the convention. By the end of the year there were 57 Parties.

Convention on Early Notification of a Nuclear Accident (reproduced in INFCIRC/335): Entered into force on 27 October 1986. In 1996, succession by 1 State brought the total number of Parties at the end of the year to 76.

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (reproduced in INFCIRC/336): Entered into force on 26 February 1987. There were a total of 72 Parties by the end of 1995 as a result of succession by 1 State.

Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (reproduced in INFCIRC/402): Entered into force on 27 April 1992. Its status remained unchanged during 1996, with 20 Parties.

Extension of the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Energy (AFRA) (reproduced in INFCIRC/377/Add.6): Entered into force on 4 April 1995. Now has 20 Parties as a result of acceptance by 2 States during 1996.

Agreement to Extend the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology, 1987 (RCA) (reproduced in INFCIRC/167/Add.15): Entered into force on 11 June 1992. There was no change in its status during the year, leaving at 17 the total number of acceptances.

Convention on Nuclear Safety (reproduced in INFCIRC/449): Entered into force on 24 October 1996. By the end of 1996, there were 65 signatories and 32 States had consented to be bound. Pursuant to Article 28 of the Convention, the Agency will convene the preparatory meeting of the Contracting Parties provided by Article 21 for 21–25 April 1997.

Co-ordinated Research Programmes (with year of start and completion)

Nuclear Power

Assessment and improvement of nuclear power plant performance

Management of ageing of the reactor pressure vessel primary nozzle	1996	1999
Management of ageing of motor operated valves	1992	1998
Assuring the structural integrity of reactor pressure vessels	1996	1999

Advanced reactor developments

Establishment of a thermophysical properties database for light and heavy water reactors	1990	1996
Thermohydraulic relationships for advanced water cooled reactors	1995	1998
Intercomparison of analysis methods for seismically isolated nuclear structures	1996	1999
Harmonization and validation of fast reactor thermomechanical and thermohydraulic codes and relations using experimental data	1996	1998
Validation of safety related physics calculations for low enriched gas cooled reactors	1990	1996
Validation of predictive methods for fuel and fission product behaviour in gas cooled reactors	1993	1996
Heat transport and afterheat removal for gas cooled reactors under accident conditions	1993	1997
Design and evaluation of heat utilization systems for the HTTR	1994	1999
Potential of thorium based fuel cycles to constrain plutonium and reduce long term waste toxicities	1995	1999

Nuclear fusion

Development of plasma heating and diagnostic systems in institutes in developing countries using small and middle scale devices	1992	1997
Engineering, industrial and environmental applications of plasma physics and fusion technologies	1996	1998

Nuclear Fuel Cycle

Raw materials for reactor fuels

Treatment of liquid effluents from mines and mills during and after operation	1996	2000
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Reactor fuel technology and performance

On-line monitoring of water chemistry related to fuel behaviour and activity transport (WACOL)	1995	2000
Fuel modelling at extended burnup (FUMEX)	1993	1996
Modelling of the activity transport in the primary circuit of water cooled reactors	1996	2000
Corrosion of research reactor fuel cladding during storage	1995	1998
Stress corrosion cracking of zirconium alloys	1993	1998

Spent fuel management, technology and safety

Irradiation enhanced degradation of materials in spent fuel storage facilities	1993	1998
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Co-ordinated Research Programmes (cont.)

Behaviour of spent fuel assemblies and storage equipment under long term storage conditions (BEFAST-III)	1993	1996
Safety, environmental and non-proliferation aspects of the partitioning and transmutation of actinides and fission products	1995	1999

Radioactive Waste Management

Application of tracer techniques in the study of the Black Sea	1993	1996
Modelling of the radiological impact of radioactive waste dumping in the Arctic seas	1993	1996
International Programme on Biosphere Modelling and Assessment Methods (BIOMASS)	1996	2000
Use of the thorium based fuel cycle in accelerator-driven systems to incinerate plutonium and reduce long term waste toxicities	1996	1999
Treatment technologies for low and intermediate level waste from nuclear applications	1991	1996
Performance of high level waste forms and packages under repository conditions	1991	1997
Waste treatment and immobilization technologies involving inorganic sorbents	1993	1996
Extrapolation of short term observations to time periods for isolation of long lived radioactive waste	1996	2000
New methods and techniques for optimization of decontamination for maintenance or decommissioning	1994	1998
Site characterization techniques used in environmental restoration	1995	1999

Comparative Assessment of Nuclear Power and Other Energy Sources

Case studies to assess and compare the potential role of nuclear power and other options in reducing emissions and residuals from electricity generation	1994	1996
Comparative health and environmental risks of nuclear and other energy systems, using case studies	1994	1997

Food and Agriculture
Soil fertility, irrigation and crop production

Management of Rhizobium for enhancing soil fertility and crop production	1993	1997
Use of nuclear techniques in the management of nitrogen fixing trees for enhancing soil fertility	1990	1997
Use of nuclear and related techniques for evaluating the agronomic effectiveness of phosphate fertilizers, in particular rock phosphates	1993	1998
Use of nuclear techniques for optimizing fertilizer application on irrigated wheat to increase the efficiency of use of nitrogen fertilizers and thus reduce environmental pollution	1994	1998
Use of irradiated sewage sludge for enhancing soil fertility and crop production, and reducing environmental pollution	1995	1999
Use of isotopes for developing management practices to reduce soil erosion and increase crop production	1996	2001
Use of nuclear techniques in studies on organic matter management and nutrient turnover in soils for increased and sustainable agricultural production	1996	2001

Co-ordinated Research Programmes (cont.)

Plant breeding and genetics

Induced mutations in connection with biotechnology for crop improvement in Latin America	1993	1998
Induced mutations for sesame improvement	1993	1998
The application of DNA based marker mutations for improvement of cereals and other sexually reproduced crop species	1992	1997
Use of novel DNA fingerprinting techniques for the detection and characterization of genetic variation in vegetatively propagated crops	1992	1997
Induced mutations and other advanced technology for the production of crop mutants suitable for environmentally sustainable agriculture	1993	1998
In vitro techniques for the selection of radiation induced mutants adapted to adverse environmental conditions	1993	1998
Radioactively labelled DNA probes for crop improvement	1994	1999
Improvement of new and traditional industrial crops by induced mutations and related biotechnology	1994	1999
Cellular biology and biotechnology including mutation techniques for the creation of new useful banana genotypes	1994	1999

Animal production and health

Development of supplementation strategies for milk producing animals in tropical and subtropical environments	1993	1998
Improvement of ruminant livestock productivity in developing countries through the use of progesterone RIA to increase efficiency and quality of artificial insemination services	1995	2001
Development of feed supplementation strategies for improving the productivity of dairy cattle on smallholder farms in Africa	1994	1998
Development, standardization and validation of nuclear based technologies for measuring microbial protein supply in ruminant livestock for improving productivity	1996	2002
Improving the diagnosis and control of foot-and-mouth disease in South East Asia using ELISA based technologies	1994	1999
Use of ELISA for epidemiology and control of foot-and-mouth disease and bovine brucellosis in Latin America	1995	1997
Use of immunoassay methods for improved diagnosis of trypanosomosis and monitoring tsetse and trypanosomosis control programmes in Africa	1994	1999

Insect and pest control

Enhancement of the sterile insect technique through genetic transformation using nuclear techniques	1994	1999
Molecular and genetic approach to develop sexing strains for field application in fruit fly sterile insect technique programmes	1994	1999
Genetics application to improve SIT for tsetse control/eradication including genetic sexing	1996	2000
Automation in tsetse fly mass rearing for use in sterile insect technique programmes	1994	1999
Improved attractants for enhancing the efficiency of tsetse fly suppression operations and barrier systems used in tsetse control/eradication campaigns	1994	1999
Evaluation of population suppression by irradiated lepidoptera and their progeny	1992	1998

Co-ordinated Research Programmes (cont.)

Development of female medfly attractant systems for trapping and sterility assessment	1993	1998
Medfly mating behaviour studies under field cage conditions	1993	1999
<i>Agrochemicals and residues</i>		
Development of procedures to stabilize acaricides in livestock dips and of simplified methods to measure their concentration using nuclear techniques	1992	1996
Use of isotopic tracers in studies of herbicide performance in grasses and sedges	1992	1997
Radionuclide transfer from air, soil and fresh water to the food chain of man in tropical and subtropical environments	1993	1997
Use of nuclear and immunochemical methods for pesticide analysis	1993	1998
Agroecological effects resulting from the use of persistent pesticides in Central America	1993	1998
Distribution, fate and effects of pesticides on biota in the tropical marine environment using radiolabelled tracers	1993	1997
Impact of long term pesticide usage on soil properties using radiotracer techniques	1994	1999
Validation of thin layer chromatographic screening methods for pesticide residue analysis	1996	2001
<i>Food preservation</i>		
Irradiation as a quarantine treatment of mites, nematodes and insects other than the fruit fly	1992	1997
Irradiation as a public health intervention measure to control foodborne diseases (cysticercosis/taeniasis and <i>Vibrio</i> infection) in Latin America and the Caribbean (under the co-sponsorship of PAHO)	1993	1998
Standardized methods to verify the absorbed dose of irradiated fresh and dried fruit and tree nuts in trade	1993	1998
Integration of irradiation in a system for reducing post-harvest food losses in Africa	1994	1999
Market development and trade in irradiated food in Asia	1994	1998
Development of shelf stable and convenience foods through irradiation processing	1996	2000
<i>Human Health</i>		
<i>Nuclear medicine</i>		
Research and certification of quality control and preventive maintenance of instruments in nuclear medicine centres (Asia and the Pacific)	1994	1998
Research and certification of quality control and preventive maintenance of instruments in nuclear medicine centres (Latin America) (ARCAL)	1994	1998
Validation of personal computer interface with gamma cameras and software for data processing of clinical studies	1995	1998
Development of an indigenous capability to conduct screening programmes for viral hepatitis in developing countries	1993	1996
Standardization of iodine-131 treatment for hyperthyroidism with an intent to optimize radiation dose and treatment response (RCA)	1995	1999
Qualitative nuclear cardiology	1992	1996

Co-ordinated Research Programmes (cont.)

Comparative evaluation of the efficacy and toxicity of orally administered phosphorus-32 and intravenously administered strontium-89 in the palliation of painful skeletal metastases	1993	1997
Biological discrimination of hormone sensitive and insensitive breast cancer by radioimmunoassay	1994	1997
Diagnosis and follow up of prostatic cancer by radioimmunoassay	1996	1998
Efficacy and toxicity of samarium-153 radiopharmaceuticals in the treatment of painful skeletal metastases	1996	1999
Nuclear imaging for infection and inflammation	1996	1998
Nuclear techniques for diagnosis of bacterial and viral infections (African region)	1993	1996
Radionuclide based molecular techniques in diagnosis of blood borne diseases	1994	1997
Diagnosis of Chagas disease using nuclear techniques	1994	1997
Diagnosis of genetic disorders using radionuclide based molecular methods	1995	1998
<i>Applied radiation biology and radiotherapy</i>		
Comparative assessment of mutagenic and carcinogenic effects of low level radiation and toxic chemicals released from energy cycles	1992	1996
Radiation responsiveness criteria for human tumours as determinant for therapeutic modality planning	1993	1998
Modern techniques in brachytherapy of cancer with special reference to developing countries	1993	1998
Clinical application of radiosensitizers in cancer radiotherapy	1994	1999
Randomized clinical trial of radiotherapy combined with mitomycin C in the treatment of advanced head and neck tumours	1994	1999
Application of heavy charged particles in cancer radiotherapy	1995	1998
Quality assurance in radiotherapy for Latin America	1995	1998
Use of radiotherapy in advanced cancer	1995	1998
<i>Dosimetry</i>		
Characterization and evaluation of high dose dosimetry techniques for quality assurance in radiation processing	1995	1999
Development of a quality assurance programme for Secondary Standard Dosimetry Laboratories	1995	1998
Development of a quality assurance programme for radiation therapy dosimetry in developing countries	1995	1998
Code of practice for radiation measurements with plane parallel ionization chambers	1996	1999
<i>Nutritional and health related environmental studies</i>		
Applied research on air pollution using nuclear related analytical techniques	1992	1997
Development and selection of analytical techniques and procedures for measuring accidentally released radionuclides in the environment	1992	1996
Application of stable isotope tracer methods to studies of amino acid, protein, and energy metabolism in malnourished populations of developing countries	1993	1998
Comparative international studies of osteoporosis using isotope techniques	1994	1998
Development and application of isotopic techniques in studies of vitamin A nutrition	1995	1999
Applied research on air pollution using nuclear related analytical techniques in the Asia and Pacific region (RCA)	1995	1999

Co-ordinated Research Programmes (cont.)

Ingestion and organ content of trace elements of importance in radiological protection (RCA)	1995	1999
Isotopic evaluations of maternal and child nutrition to help prevent stunting	1996	1999
Assessment of levels and health effects of airborne particulate matter in mining, metal refining and metal working industries using nuclear and related analytical techniques	1996	1999
Distribution, fate and effects of pesticides on biota in the tropical marine environment using radiolabelled tracers	1994	1998

Industry and Earth Sciences

Industrial applications

Nuclear methods in the monitoring of wear and corrosion in industry	1993	1996
Stability and stabilization of polymers under irradiation	1994	1996
Use of radiation processing to prepare biomaterial for applications in medicine	1995	1997
Nuclear techniques for advanced ceramics and semiconductors	1993	1996
Nuclear techniques for the evaluation of healing pathways of pollutant damage in the environment	1993	1996
Irradiation treatment of water, wastewater and sludge	1995	1998
Modification of materials by ion treatment for industrial applications	1995	1998

Development of water resources

Application of tracer techniques in the study of the Black Sea	1992	1996
Isotope techniques in lake dynamics investigations	1994	1997
Isotope aided studies of atmospheric carbon dioxide and other greenhouse gases in the atmosphere, phase 2	1995	1998
Isotope techniques in water resources investigations in arid and semi-arid regions	1994	1997
Use of isotopes for analyses of flow and transport dynamics in groundwater systems	1995	1999
Application of isotope techniques to study soil erosion and sedimentation	1995	1998
Isotope techniques in groundwater pollution studies	1994	1997
Isotope based assessment of groundwater renewal and related anthropogenic effects in water scarce regions	1995	1998
Isotope techniques in studying the dynamics of slow moving groundwater for the hydrogeological appraisal of radioactive waste disposal sites	1995	1998

Physical and Chemical Sciences

Nuclear and atomic data for applications

Compilation and evaluation of fission product yield nuclear data	1991	1996
Plasma interaction induced erosion of fusion reactor materials	1991	1996
Improvement of measurements, theoretical computations and evaluations of neutron induced helium production cross-sections	1992	1996
Establishment of an international reference data library of nuclear activation cross-sections	1993	1998
Collection and evaluation of reference data on thermomechanical properties of fusion reactor plasma facing materials	1994	1996

Co-ordinated Research Programmes (cont.)

Development of a reference input parameter library for nuclear model calculations of nuclear data	1994	1997
Measurement, calculation and evaluation of photon production data	1994	1998
Radiative cooling rates of fusion plasma impurities	1994	1997
Tritium retention in fusion reactor plasma facing components	1995	1998
Atomic and plasma wall interaction data for fusion reactor plasma modelling	1995	1998
Development of a reference charged particle cross-section database for medical radioisotope production	1995	1998
Compilation and evaluation of photonuclear data for applications	1996	1999
<i>Nuclear instrumentation</i>		
Specialized software utilities for gamma ray spectrometry	1996	1998
Bulk hydrogen analysis using neutrons	1997	1999
Computer based troubleshooting tools	1996	1998
<i>Utilization of research reactors and particle accelerators</i>		
Analysis of research reactor transients	1995	1998
<i>Chemistry</i>		
Application of nuclear techniques for environment preservation in resource extraction and processing	1994	1996
Labelling, quality control and clinical evaluation of monoclonal antibodies for scintigraphy	1994	1996
Optimization of the production and quality control of radiotherapeutic radionuclides and radiopharmaceuticals	1993	1996
Development of agents for imaging central neural system receptors based on technetium-99m	1996	1999
Technetium-99m labelled peptides for imaging of peripheral receptors	1996	1999
Nuclear analytical techniques in atmospheric and surface water pollution studies (ARCAL)	1995	1998
<i>Radiation Safety</i>		
<i>Occupational radiation protection</i>		
Intercomparison of in vivo counting systems using a reference Asian phantom	1995	1997
Reference Asian man project Phase II: Ingestion and organ content of trace elements of importance in radiation protection	1995	1997
Limitations of radioepidemiological assessments for stochastic radiation effects in relation to radiation protection	1994	1997
Radiation protection in diagnostic radiology in Asia and the Far East	1994	1997
Radiation protection in diagnostic radiology in eastern European countries	1993	1997

Co-ordinated Research Programmes (cont.)

Radiation protection of the public and the environment

Radionuclide transfer to humans in tropical and subtropical environments	1994	1997
Accident severity at sea during the transport of radioactive material	1994	1997
Development of relevant accident data for quantifying risks associated with the transport of radioactive material	1994	1997
Regional personal dosimetry intercomparison	1996	1998
Intercomparison for individual monitoring of external exposure from photon radiation	1996	2000

Safe transport of radioactive material

Accident severity at sea during the transport of radioactive material	1994	1997
Assessment of the safety of uranium hexafluoride (UF ₆) transport packages in fires	1992	1996
Development of relevant accident data for quantifying risks associated with the transport of radioactive materials	1994	1997

Safety of Nuclear Installations

Engineering safety issues of nuclear power plants

Benchmark study for seismic analysis and testing of WWER type nuclear power plants	1993	1996
Management of ageing of the concrete containment building	1992	1995
Management of ageing of in-containment instrumentation and control cables	1992	1995
Seismic data for the siting and site revalidation of nuclear facilities	1989	1996

Operational safety of nuclear power plants

Development of methodologies for optimization of surveillance testing and maintenance of safety related equipment at nuclear power plants	1996	1999
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Research reactor safety

Application of non-destructive testing and in-service inspection to research reactors	1995	1998
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Nuclear safety assessment practices

Validation of accident and safety analysis methodology	1995	1998
Collection and classification of human reliability data for use in probabilistic safety assessments	1994	1997

Training courses, seminars and workshops in 1996 (with location)

Nuclear Power

Interregional course on electricity demand forecasting for nuclear power planning	USA
Regional course (Asia and Pacific) on integrated energy and electricity planning for nuclear power development with emphasis on the ENPEP package	Thailand
Regional workshop (Europe) on electric system expansion planning (WASP)	Lithuania
Regional workshop (Latin America) on the review of experience in the use of Agency planning methodologies	Brazil
Regional workshop (west Asia) on electric system expansion planning (WASP)	Kazakstan
Interregional course on qualification of operations personnel	Spain
Interregional course on ageing phenomena and diagnosis for PWR type reactors	Germany
Regional course on nuclear power plant maintenance	Russian Federation
Regional workshop on the role of nuclear power plant management in public information	Czech Republic
Regional workshop on modifying the existing organizational structure to achieve better results	Bulgaria
Regional workshop on management tools for economic analysis	Russian Federation
Regional workshop on the training, retraining, qualification and licensing of nuclear power plant management personnel	Russian Federation
Seminar on systematic approach to training based personnel training for nuclear power plants — needs analysis	Ukraine
Seminar on systematic approach to training based personnel training for nuclear power plants — design phase	Ukraine
Management workshop on quality assurance implementation and safety culture	India

Radioactive Waste Management

Regional workshop (AFRA-1) on the adoption and harmonization of safety regulations in radioactive waste management	Morocco
Regional course on a national system required for the management of radioactive waste from nuclear applications	Egypt
Interregional course on the management of radioactive waste from nuclear power plants	France
Regional workshop (AFRA-1) on modalities for the promulgation of waste management regulations and guidelines	Tunisia
Regional course on the management of radioactive waste from nuclear applications	Chile
Regional course on radioactive waste management in WWERs	Hungary
Regional course on the near surface disposal of low and intermediate level wastes	United Kingdom
Workshop on the planning and management of decommissioning for WWER nuclear power plants	Germany
Workshop on environmental restoration in central and eastern Europe	Ukraine; Romania
Course on marine radioactivity studies	Finland
Workshop on alpha radioactivity	Turkey

Training courses, seminars and workshops in 1996 (cont.)

Comparative Assessment of Nuclear Power and Other Energy Sources

National workshop to present the DECADES computer tools and databases	Brazil; Republic of Korea; United Kingdom
Regional course on DECADES	Poland
National workshop to present the DECADES computer tools and databases	Republic of Korea
Interregional workshop on the use of the DECADES computer tools and databases	USA

Food and Agriculture

Soil fertility, irrigation and crop production

FAO/IAEA regional course on the use of nuclear techniques in studies on soil/plant relationships	Ethiopia
FAO/IAEA interregional course on the use of nuclear techniques in studies of soil/plant relationships with emphasis on soil water management	FAO/IAEA Laboratory, Seibersdorf
FAO/IAEA regional course on the use of nuclear techniques in studies of soil/plant relationships	Mexico

Plant breeding and genetics

FAO/IAEA regional course on molecular approaches, mutants and other biotechnologies for the improvement of vegetatively propagated plants	Malaysia
Regional workshop (AFRA) on implementation of 'on farm' evaluation of improved mutant lines of important African crops	Argentina
Workshop on the evaluation of promising cereal mutants	Tunisia
Workshop on the development of in vitro techniques for mutant selection in date palm	Mali

Animal production and health

FAO/IAEA regional course on the use of immunoassay technologies for studies on the diagnosis and control of foot-and-mouth disease in South Asia	Viet Nam
FAO/IAEA workshop on the use of RIA kits for progesterone determination in milk	Peru
FAO/IAEA regional workshop on the use of immunoassay and related techniques in animal production in Africa	Egypt
FAO/IAEA regional workshop on improving animal production through the application of feed supplementation strategies and immunoassay techniques	Sri Lanka
FAO/IAEA national course on the use of immunoassay methods for animal disease diagnosis and control	Mongolia
FAO/IAEA interregional course on the use of molecular techniques (PCR, DNA probes) for the diagnosis and monitoring of the major livestock diseases	FAO/IAEA Laboratory, Seibersdorf
FAO/IAEA/ILRI regional workshop on the epidemiology and monitoring of tick-borne disease using enzyme immunoassays.	Zimbabwe

Insect and pest control

FAO/IAEA interregional course on the use of the sterile insect and related techniques for the area wide management of insect pests	USA
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Training courses, seminars and workshops in 1996 (cont.)

Agrochemicals and residues

FAO/IAEA regional course on the application of good laboratory practices in pesticide residue studies Hungary

FAO/IAEA interregional course on the use of radiotracer, chromatographic and immunochemical techniques for the analysis of pesticides in food samples Austria

Food irradiation

Regional course on food irradiation Egypt

Regional course on process and quality control in radiation processing Japan

Human Health

Nuclear medicine

Interregional course on the maintenance, quality control and upgrading of gamma cameras India

Interregional course on radionuclide techniques in medical diagnosis Japan

Regional course (Africa) for nuclear medicine technologists South Africa

Regional course on radioimmunosciintigraphy United Arab Emirates

Regional course on basic reagent production methods for neonatal hypothyroid screening by RIA Syrian Arab Republic

Regional course on the preparation of primary reagents for neonatal hypothyroid screening by RIA Egypt

Regional course on reagent production for the detection of hepatitis B markers by radioimmunoassay Costa Rica

Regional course on the diagnosis and typing of human pathogenic trypanosomatids Brazil

Regional workshop on the servicing and maintenance of cobalt-60 radiotherapy units Sudan

Regional workshop on the upgrading of analog gamma cameras with IBM PCs and relevant clinic software Islamic Republic of Iran

Regional workshop on the quality control of SPECT systems Peru

Regional workshop on the effective use of portable image processing software Chile

Regional workshop on the quality control of gamma cameras Tunisia

Regional workshop on the quality control of gamma cameras Lebanon

Regional workshop on the quality control of multi-head SPECT systems Republic of Korea

Applied radiation biology and radiotherapy

Regional course (ARCAL) on quality assurance in clinical radiotherapy Panama

Regional course (AFRA) on techniques and dosimetry in interstitial brachytherapy South Africa

Dosimetry

Regional course (Asia and Pacific) on quality assurance and dosimetry in radiotherapy Philippines

Regional workshop on quality assurance for external therapy and brachytherapy Bolivia

Regional course on radiation sterilization — regulations and international standards for process validation Chile

Training courses, seminars and workshops in 1996 (cont.)

Nutritional and health related environmental studies

Regional course (Latin America and the Caribbean) on isotope techniques in human nutrition	Peru
RCA application of ISO-25 and other international QA/QC standards in laboratories employing nuclear and complementary techniques for environmental analyses (regional RCA, Asia and the Pacific)	Republic of Korea
Determination of radionuclides in environmental samples	Germany/Austria
Analysis of chlorinated pesticides and PCBs	Morocco
Analysis of petroleum hydrocarbons	IAEA-MEL, Monaco
Analysis of trace metals in marine samples	IAEA-MEL, Monaco

Industry and Earth Sciences

Industrial applications

National course on the use of ionizing radiation in the polymer industry	Costa Rica
National course on the utilization of nucleonic equipment in industry	Cuba
National course on nuclear techniques (NCS and tracers) in industry	Venezuela
National course on applications of nuclear techniques in heat transfer equipment	Colombia
Regional course (ARCAL) on fundamental aspects of radiation chemistry and applications	Ecuador
Regional course (ARCAL) on radiosterilization regulations and international standards for process validation	Chile
Regional executive management seminar (RCA) on the application of nucleonic control systems (NCS) to coal processing operations	Thailand
Regional workshop (RCA) on the application of NCS to coal processing operations	Thailand
Regional course (RCA) on the application of electron beam technology for the purification of flue gases	Japan
Regional course (RCA) on process and quality control in radiation processing	Japan
Regional course (RCA) on radiation curing	Japan
Regional workshop (RCA) on NCS in the paper industry	China
Regional workshop (RCA) on NDT examination for non-metallic materials	Singapore
Regional course (RCA) on industrial sterilization (regulations, standards and enforcement)	Malaysia
Regional workshop (RCA) on regulation and inspection of operation of radiation facilities	Indonesia
Regional (AFRA) course on NDT quality management	Egypt
Regional course (AFRA) on the applications of radiation to NDT in African industries	South Africa
Regional course (west Asia) on NDT applications in industry	Syrian Arab Republic
Regional workshop (ARCAL) on high dose dosimetry and process and quality control in industrial radiation processing	Argentina
Regional seminar (ARCAL) on industrial applications of isotopes and radiation	Colombia

Training courses, seminars and workshops in 1996 (cont.)

Development of water resources

Seminar on the use of isotope techniques in marine environmental studies	Greece
Regional workshop on numerical flow and transport modelling for groundwater systems	Headquarters
Group fellowship course on the use of isotope and chemical techniques in the exploration and development of geothermal systems in Central America	Mexico
Regional course on advanced applications of isotope techniques to water resources development	China
Regional course on the application of nuclear techniques in studies of the interconnection between surface and groundwater (ARCAL XVIII)	Chile
Regional workshop on isotope techniques in hydrology and geochemistry for geothermal energy development in East Asia and the Pacific	China
Interregional course on isotope applications for the analysis of flow and transport dynamics in hydrological systems	Headquarters
Regional workshop for the preparation of an interregional project on the use of saline groundwater for sustainable plant production in barren areas	Pakistan
Regional course on the application of isotope and geochemical techniques to reservoir management in geothermal areas in Latin America	El Salvador
Regional course on the use of isotope techniques in water resources development and management	Morocco

Physical and Chemical Sciences

Nuclear data

Workshop on nuclear reaction data and nuclear reactors	Italy
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Nuclear instrumentation

Regional workshop on strategies for the maintenance of scientific equipment	Sudan
Regional course on the design and development of small nuclear instruments	Ethiopia
National workshop on the application of XRF techniques in mineral, industrial and environmental analysis	Nigeria
National course on the repair and maintenance of switch mode power supplies	Zambia
Interregional course on interfacing in nuclear experiments	El Salvador
Interregional course on nuclear electronics	Slovenia
National course on liquid scintillation counting	El Salvador
National course on the repair and maintenance of nuclear instrumentation	Myanmar
National course on the testing and quality control of nuclear instruments	Myanmar
Regional workshop on the preparation of a national course on the repair and operation of nuclear instruments for industry (ARCAL XIX)	Chile
Regional seminar on the problems of maintenance and repair of nuclear instruments (ARCAL XIX)	Brazil

Training courses, seminars and workshops in 1996 (cont.)

National course on the repair and maintenance of nuclear instrumentation (ARCAL XIX)	Panama
National course on the repair and maintenance and quality control of X ray equipment (ARCAL XIX)	Uruguay
National workshop on the quality control of nuclear instruments	Viet Nam
National course on design of power supplies	Sri Lanka
National course on the interfacing of personal computers	Sri Lanka
National course on XRF analysis and applications	Thailand
<i>Utilization of research reactors and particle accelerators</i>	
National workshop on preliminary studies for the establishment of a research reactor in Tunisia	Tunisia
Regional workshop (AFRA) on research reactor utilization	South Africa
<i>Chemistry</i>	
Advanced regional workshop (ARCAL) on harmonization of registration and control of radiopharmaceuticals in Latin American countries	Venezuela
Regional advanced workshop (ARCAL) on radiopharmacokinetics	Mexico
Regional workshop (ARCAL) on therapeutic radionuclides and radiopharmaceutical production	Peru
<i>Radiation Safety</i>	
Interregional course on the planning, organization and implementation of radiation protection at a national level	USA
Joint IAEA/European Commission course on the safe transport of radioactive material	Belgium
Regional post-graduate educational course on radiation protection	France
Regional post-graduate educational course on radiation protection and nuclear safety	Argentina; Russian Federation
Regional (RCA) training course on implementation of the IAEA Basic Safety Standards	India
Regional (RCA) training workshop on contamination monitoring	Japan
Regional course for radiation protection officers	Ghana
Regional course on notification, licensing and control of radiation sources	Cuba
Regional course on techniques for external and internal dose assessment	Saudi Arabia
Regional workshop on emergency planning, accident assessment and response to nuclear and radiological accidents	United Arab Emirates
Regional workshop on maintenance and trouble shooting of radiation monitoring equipment	South Africa
Regional workshop on radiation protection and quality assurance in diagnostic radiology	United Arab Emirates
Regional workshop on radiation protection infrastructure	Yemen
Second national workshop on nuclear and radiation safety	Cuba

Training courses, seminars and workshops in 1996 (cont.)

Safety of Nuclear Installations

Interregional course on fire safety and environmental qualification of equipment important to safety in nuclear power plants	USA; Canada
Interregional course on operator/regulatory interface for nuclear power plants	USA
Interregional course on safety review and upgrading of nuclear power plants	USA
Regional course on assessment techniques for the operational safety of nuclear power plants	Spain
Regional course on general approach to nuclear safety (principles and fundamentals)	Finland
Regional course on regulatory control of nuclear power plants	Republic of Korea
Regional course on regulatory control of nuclear power plants (for newcomers)	Germany

Safeguards

OPANAL seminar	Jamaica
State's system of accounting for and control of nuclear material	Russian Federation

Direction and Support

Seminar for nuclear lawyers and regulators from eastern European countries and the NIS	Romania
Regional workshop on nuclear information systems	Malaysia; Syrian Arab Republic
INIS training seminar	Headquarters
Physical protection of nuclear material	Czech Republic

Publications issued in 1996
(with series and number)

Nuclear Power

Energy, electricity and nuclear power estimates for the period up to 2015	Reference Data Series No. 1
Nuclear power reactors in the world	Reference Data Series No. 2
Quality assurance for safety in nuclear power plants and other nuclear installations	Safety Series No. 50-C/SG-Q
Policy issues for nuclear power programmes	Special publication
Operating experience with nuclear power stations in Member States	Annual publication
Nuclear power plant personnel training and its evaluation: A guidebook. Executive summary	Technical Reports Series No. 380/ES
Nuclear power, nuclear fuel cycle and waste management: Status and trends 1996	Part C of the IAEA Yearbook 1996
Recent experience in the use of IAEA planning methodologies for energy, electricity and nuclear power planning among Member States of Europe, the Middle East and North Africa	IAEA-TECDOC-863
Design and development status of small and medium reactor systems 1995	IAEA-TECDOC-881
Technical feasibility and reliability of passive safety systems for nuclear power plants	IAEA-TECDOC-920
Review of design approaches of advanced pressurized LWRs	IAEA-TECDOC-861
Progress in design, research and development and testing of safety systems for advanced water cooled reactors	IAEA-TECDOC-872
Fast reactor database	IAEA-TECDOC-866
Progress in liquid metal fast reactor technology	IAEA-TECDOC-876
Comparison of observed effects with computer simulated effects on reactor cores from seismic disturbances	IAEA-TECDOC-882
Absorber materials, control rods and designs of shutdown systems for advanced liquid metal fast reactors	IAEA-TECDOC-884
Conceptual design of advanced fast reactors	IAEA-TECDOC-907
Fast reactor fuel failures and steam generator leaks: Transient and accident analysis approaches	IAEA-TECDOC-908
Design and development of gas cooled reactors with closed cycle gas turbines	IAEA-TECDOC-899
Graphite moderator life cycle behaviour	IAEA-TECDOC-901
Safe core management with burnable absorbers in WWERs	IAEA-TECDOC-858
Options identification programme for demonstration of nuclear desalination	IAEA-TECDOC-898
Potential for nuclear desalination as a source of low cost potable water in North Africa	IAEA-TECDOC-917
Advanced fuels with reduced actinide generation	IAEA-TECDOC-916
Designing nuclear power plants for improved operation and maintenance	IAEA-TECDOC-906
Good practices for cost effective maintenance of nuclear power plants	IAEA-TECDOC-928
Performance analysis of WWER-440/230 reactors	IAEA-TECDOC-922
Computerized support systems in nuclear power plants	IAEA-TECDOC-912

Publications issued in 1996 (cont.)

Management of procurement activities in a nuclear installation	IAEA-TECDOC-919
Processing of nuclear power plant waste streams containing boric acid	IAEA-TECDOC-911
In-core fuel management benchmarks for PHWRs	IAEA-TECDOC-887
Technical basis for the ITER interim design report, cost review and safety analysis	IAEA/ITER EDA/DS/07
ITER Council proceedings: 1995	IAEA/ITER EDA/DS/08
ITER interim design report package and relevant documents	IAEA/ITER EDA/DS/09
ITER interim design report package documents	IAEA/ITER EDA/DS/10
ITER monthly newsletter	
Nuclear Fusion	Monthly journal

Nuclear Fuel Cycle

Guidebook to accompany the IAEA map: World distribution of uranium deposits	Special publication
The Nuclear Fuel Cycle Information System.	Special publication
A directory of nuclear fuel cycle facilities: 1996 edition	
Design and performance of WWER fuel	Technical Reports Series No. 379
Management and storage of spent nuclear fuel at research and test reactors	IAEA-TECDOC-900
Spent fuel management: Current status and prospects 1995	IAEA-TECDOC-894
Significant incidents in nuclear fuel cycle facilities	IAEA-TECDOC-867
Fuel technology and performance of non-water cooled reactors	IAEA-TECDOC-850
Behaviour of LWR core materials under accident conditions	IAEA-TECDOC-921
Guidebook on the development of regulations for uranium deposit development and production	IAEA-TECDOC-862
Uranium Production Safety Assessment Team — UPSAT — An international peer review service for uranium production facilities	IAEA-UPSAT-96
Innovations in uranium exploration, mining and processing techniques, and new exploration target areas	IAEA-TECDOC-868
Steps for preparing uranium production feasibility studies: A guidebook	IAEA-TECDOC-885
UPSAT guidelines: 1996 edition	IAEA-TECDOC-878

Radioactive Waste Management

Environmental impact of radioactive releases	Proceedings Series
Clearance levels for radionuclides in solid materials. Application of exemption principles. Interim report for comment	IAEA-TECDOC-855
Modelling of radionuclide interception and loss processes in vegetation and of transfer in semi-natural ecosystems. Second report of the VAMP Terrestrial Working Group	IAEA-TECDOC-857
Planning for environmental restoration of radioactively contaminated sites in central and eastern Europe	IAEA-TECDOC-865
Application of quality assurance to radioactive waste disposal facilities	IAEA-TECDOC-895

Publications issued in 1996 (cont.)

Validation of models using Chernobyl fallout data from southern Finland — Scenario S. Second report of the VAMP Multiple Pathways Assessment Working Group	IAEA-TECDOC-904
Issues in radioactive waste disposal	IAEA-TECDOC-909
Requirements and methods for low and intermediate level waste package acceptability	IAEA-TECDOC-864
Conditioning and interim storage of spent radium sources	IAEA-TECDOC-886

Comparative Assessment of Nuclear Power and Other Energy Sources

Electricity, health and the environment: Comparative assessment in support of decision making	Proceedings Series
Comparison of energy sources in terms of their full-energy-chain emission factors of greenhouse gases	IAEA-TECDOC-892
Health and environmental aspects of nuclear fuel cycle facilities	IAEA-TECDOC-918

Food and Agriculture

Food irradiation with emphasis on process control and acceptance in Asia	IAEA-TECDOC-871
Nuclear methods for plant nutrients and water balance studies	IAEA-TECDOC-875
Nuclear techniques to assess irrigation schedules for field crops	IAEA-TECDOC-888
Isotope studies on plant productivity	IAEA-TECDOC-889
Use of mutation techniques for improvement of cereals in Latin America	IAEA-TECDOC-859
Development of feed supplementation strategies for improving ruminant productivity on smallholder farms in Latin America through the use of radioimmunoassay techniques	IAEA-TECDOC-877
Standardization of medfly trapping for use in sterile insect technique programmes	IAEA-TECDOC-883
Application of an immunoassay method to improve the diagnosis and control of African trypanosomosis	IAEA-TECDOC-925
Irradiation of “red” meat	IAEA-TECDOC-902
Insect and pest control newsletter	
Agrochemicals and residues newsletter	
Soils newsletter	
Mutation breeding newsletter	
Animal production and health newsletter	
Food irradiation newsletter	

Human Health

Radiation dose in radiotherapy from prescription to delivery	IAEA-TECDOC-896
Review of data and methods recommended in the international code of practice IAEA Technical Reports Series No. 277, absorbed dose determination in photon and electron beams	IAEA-TECDOC-897

Publications issued in 1996 (cont.)

Survey of reference materials, Vol. 2: Environmentally related reference materials for trace elements, nuclides and microcontaminants IAEA-TECDOC-880
SSDL Newsletter

Industry and Earth Sciences

Residence time distribution software analysis. User's manual Computer Manual Series No. 11
Nuclear techniques in the coal industry IAEA-TECDOC-845
Isotope field applications for groundwater studies in the Middle East IAEA-TECDOC-890
Manual on mathematical models in isotope hydrogeology IAEA-TECDOC-910
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Plasma physics and controlled nuclear fusion research 1994 Proceedings Series
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CINDA 96: Index to literature and computer files of microscopic neutron data Annual publication
Microanalysis data acquisition and control program: User's manual Computer Manual Series No. 9
SPEDAC Pro for DOS. Format conversion of spectral data from nuclear experiments. User's manual Computer Manual Series No. 10
Manual for troubleshooting and upgrading of neutron generators IAEA-TECDOC-913
Antibodies immobilized on magnetic particles for radioimmunoassay and immunoradiometric assay of hormones IAEA-TECDOC-914
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International bulletin on atomic and molecular data for fusion, Nos 50, 51 IBAMD/50-51
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Index of nuclear data libraries (revision 96) IAEA-NDS-7
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Selection of evaluations for the FENDL/A-2 activation cross-section library INDC(NDS)-341
Activation cross-sections for the generation of long lived radionuclides of importance in fusion reactor technology INDC(NDS)-342
First Research Co-ordination meeting on tritium retention in fusion reactor plasma facing components INDC(NDS)-345
Final Research Co-ordination meeting on plasma-interaction induced erosion of fusion reactor materials INDC(NDS)-346
Neutron Metrology File NMF-9: An integrated database for performing neutron spectrum adjustment calculations INDC(NDS)-347
Electron impact excitation cross-section data for helium INDC(NDS)-348
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Second Research Co-ordination meeting on collection and evaluation of reference data for thermomechanical properties of fusion reactor plasma facing materials	INDC(NDS)-354
International benchmark calculations of radioactive inventory for fission reactor decommissioning	INDC(NDS)-355
Selection of basic evaluations for the FENDL-2 library	INDC(NDS)-356
Nuclear Reaction Data Centres Network	INDC(NDS)-359
Advisory Group meeting on co-ordination of the Nuclear Reaction Data Centres report	INDC(NDS)-360
<i>Radiation Safety</i>	
Direct methods for measuring radionuclides in the human body	Safety Series No. 114
International basic safety standards for protection against ionizing radiation and for the safety of radiation sources	Safety Series No. 115
Emergency planning and preparedness for re-entry of a nuclear powered satellite	Safety Series No. 119
Radiation protection and the safety of radiation sources	Safety Series No. 120
Radiation and society: Comprehending radiation risk, vol. 2	Proceedings Series
One decade after Chernobyl: Summing up the consequences of the accident	Proceedings Series
The International Chernobyl Project. An Overview	Miscellaneous publication
An electron accelerator accident in Hanoi, Viet Nam	Miscellaneous publication
The radiological accident at the irradiation facility in Nesvizh	Miscellaneous publication
Lessons learned from accidents in industrial irradiation facilities	Miscellaneous publication
Radiological conditions at Bikini Atoll: Prospects for resettlement	Special publication
Manual for the classification and prioritization of risks due to major accidents in process and related industries	IAEA-TECDOC-727 (Rev. 1)
Assessment and treatment of external and internal radionuclide contamination	IAEA-TECDOC-869
Methods for estimating the probability of cancer from occupational radiation exposure	IAEA-TECDOC-870
Establishment and use of national registries for actinide elements in humans	IAEA-TECDOC-879
Radiodosimetry and preventive measures in the event of a nuclear accident	IAEA-TECDOC-893
Directory of national competent authorities' approval certificates for package design, special form material and shipment of radioactive material, 1996 edition	IAEA-TECDOC-903
Supplement to safe transport of radioactive material — Second edition	Training Courses Series No. 1

Publications issued in 1996 (cont.)

The safe use of radiation sources	Training Courses Series No. 6
Manual on gamma radiography	IAEA-PRSM-1 (Rev. 1)
Manual on shielded enclosures	IAEA-PRSM-2 (Rev. 1)
Manual on nuclear gauges	IAEA-PRSM-3 (Rev. 1)
Manual on high energy teletherapy	IAEA-PRSM-4 (Rev. 1)
Manual on brachytherapy	IAEA-PRSM-5 (Rev. 1)
Manual on therapeutic uses of iodine-131	IAEA-PRSM-6 (Rev. 1)
Manual on self-contained gamma irradiators (categories I and III)	IAEA-PRSM-7 (Rev. 1)
Manual on panoramic gamma irradiators (categories II and IV)	IAEA-PRSM-8 (Rev. 1)
National competent authorities responsible for approvals and authorizations in respect of the transport of radioactive material — List No. 27 (1996 edition)	IAEA-NCAL-27
<i>Safety of Nuclear Installations</i>	
Human reliability analysis in probabilistic safety assessment for nuclear power plants	Safety Series No. 50-P-10
Assessment of the overall fire safety arrangements at nuclear power plants	Safety Series No. 50-P-11
Procedures for conducting probabilistic safety assessments of nuclear power plants (level 3)	Safety Series No. 50-P-12
External man-induced events in relation to nuclear power plant design	Safety Series No. 50-SG-D5 (Rev.1)
Inspection and enforcement by the regulatory body for nuclear power plants	Safety Series No. 50-SG-G4 (Rev.1)
Defence in depth in nuclear safety	INSAG Series No. 10
Nuclear Safety Review 1996	Part D of the IAEA Yearbook 1996
Advances in the operational safety of nuclear power plants	Proceedings Series
Selected safety aspects of WWER-440 model 213 nuclear power plants	Miscellaneous publication
Simulation of a loss of coolant accident without high pressure injection but with secondary side bleed and feed	IAEA-TECDOC-848
Development of safety related expert systems	IAEA-TECDOC-856
ASCOT guidelines — revised 1996 edition	IAEA-TECDOC-860
Application and development of probabilistic safety assessment for nuclear power plant operations	IAEA-TECDOC-873
OSART programme highlights 1993–1994. Operational safety practices in nuclear power plants	IAEA-TECDOC-874
Operational safety experience feedback by means of unusual event reports	IAEA-TECDOC-891
Approaches to the safety of future nuclear power plants	IAEA-TECDOC-905
RBMK nuclear power plants. Generic safety issues	IAEA-EBP-RBMK-04
Guidelines for accident analysis of WWER nuclear power plants	IAEA-EBP-WWER-01
Technical basis for instrumentation and control design improvements in WWER-440/230 nuclear power plants	IAEA-EBP-WWER-02

Publications issued in 1996 (cont.)

Safety issues and their ranking for WWER-440 model 213 nuclear power plants	IAEA-EBP-WWER-03
Databases on safety issues for WWER and RBMK reactors: User's manual	IAEA-EBP-WWER-04
Safety issues and their ranking for WWER-1000 model 320 nuclear power plants	IAEA-EBP-WWER-05
WWER-440/230 reactor pressure vessel integrity	IAEA-EBP-WWER-06
Development of measures to assess the safety of existing nuclear power plants and the effectiveness of regulations and regulatory actions (including 'prescriptive' and 'performance based' approaches)	PDRP-1

Direction and Support

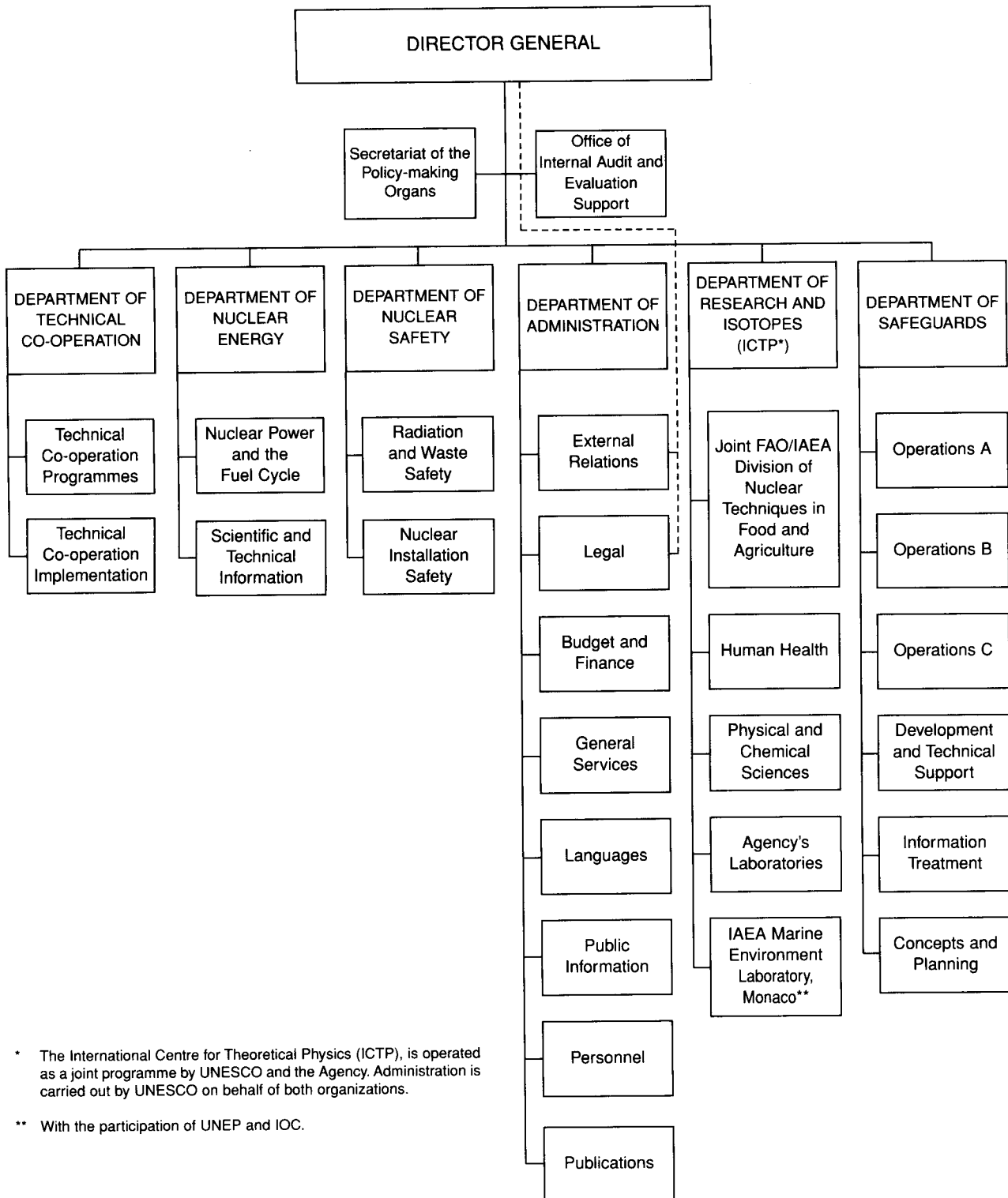
IAEA Yearbook 1996	Annual publication
INIS Periodic Report 1995	IAEA-INIS-PER95

ABBREVIATIONS

ABACC	Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials
ARCAL	Regional Co-operative Arrangements for the Promotion of Nuclear Science and Technology in Latin America
BWR	Boiling water reactor
CRP	Co-ordinated research programme
EURATOM	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
FORATOM	Forum atomique européen
HWR	Heavy water reactor
IAEA-MEL	IAEA Marine Environment Laboratory
ICTP	International Centre for Theoretical Physics
ILO	International Labour Organisation
INDC	International Nuclear Data Committee
IOC	Intergovernmental Oceanographic Commission (UNESCO)
ISO	International Organization for Standardization
LWR	Light water reactor
NEA	Nuclear Energy Agency of the OECD
OECD	Organisation for Economic Co-operation and Development
OLADE	Organización Latinoamericana de Energía
OPANAL	Organismo para la Proscripción de las Armas Nucleares en América Latina y el Caribe
PAHO	Pan American Health Organization/WHO
PHWR	Pressurized heavy water reactor
PWR	Pressurized water reactor
RBMK	Light boiling water cooled graphite moderated pressure tube reactor (former USSR)
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
SQ	Significant quantity
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WHO	World Health Organization
WMO	World Meteorological Organization
WWER	Water cooled and moderated energy reactor (former USSR)

ORGANIZATIONAL CHART

(as of 31 December 1996)



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** With the participation of UNEP and IOC.