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Strengthening the Agency's Activities related to Nuclear Science, Technology and Applications

Report by the Director General

Summary

- In response to General Conference resolutions GC(45)/RES/12 and GC(46)/RES/11, this document contains progress reports on the use of isotope hydrology for water resources management (Annex 1); servicing immediate human needs (Annex 2); nuclear knowledge (Annex 3); Agency activities in the development of innovative nuclear technology (Annex 4); and support to the African Union's Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC) (Annex 5).
- A report on 'Plan for Producing Potable Water Economically Using Small and Medium-sized Nuclear Reactors' was presented to the Board of Governors in March (GOV/2003/13). Annex 6 of this document provides an updated version of that report for submission to the General Conference.
- Further information on the Agency's activities related to nuclear science, technology and applications can be found in the *Nuclear Technology Review — Update 2003* (document GC(47)/INF/6), the Agency's *Annual Report 2002* (GC(47)/2), in particular the Technology section, and the *Technical Co-operation Report for 2002* (GC(47)/INF/8).

Recommended Action

- It is recommended that the Board take note of Annexes 1 – 5 of this report and authorize the Director General to submit the report to the General Conference at its forty-seventh session.

Use of Isotope Hydrology for Water Resources Management

A. Background

1. Resolution GC(45)/RES/12.B requested the Director General to further strengthen the efforts directed towards fuller utilization of isotope and nuclear techniques for water resources development and management; to continue to help Member States to obtain easy access to isotope analysis facilities by upgrading selected isotope hydrology laboratories to the level of regional resource centres and to continue work on dam leakage detection, safety and sustainability; and requested the Agency to continue, along with other relevant United Nations agencies, to develop human resources in isotope hydrology through university courses and training centres. It further requested the Director General to report on achievements in implementing this resolution to the Board of Governors and to the General Conference at its forty-seventh session.

B. Developments since the General Conference's 2001 Session

2. The Secretariat implemented a number of initiatives in response to resolution GC(45)/RES/12.B with the objectives of bringing isotope hydrology into the mainstream of national and international water resource related programmes resulting in a wider use of isotope techniques; increasing the number and funding of technical co-operation projects, particularly those in the areas of surface and groundwater pollution and dam leakage and safety; and increasing the availability of analytical facilities for Member States.

3. Document GC(45)/16 reported on efforts made in the period 1999–2000 towards fuller utilization of isotope techniques for water resources development and management through a number of research and development projects that were reoriented to target resource management issues where isotope techniques offered a comparative advantage, and through technical co-operation activities focused on areas of national priority. These initiatives were successful and were further strengthened in the 2001–2003 period.

4. The technical co-operation programme focused on contributing to the solution of problems in the Member States' water resources sectors. Over 60 technical co-operation projects were operational in the 2001–2002 programme cycle and 81 are operational in the 2003–2004 cycle. These projects include surface and groundwater assessment and management, detection and control of pollution, and dam leakage, safety, and sustainability.

5. Technical co-operation projects aimed at understanding recharge/discharge processes (critical for pollution detection and control) and groundwater dynamics for sustainable development and management of aquifer systems that are shared by several countries were initiated in collaboration with UNESCO and the Global Environment Facility. These projects focus on investigations of:

- the Nile Basin Aquifer system shared by Democratic Republic of the Congo, Egypt, Ethiopia, Kenya, Sudan, United Republic of Tanzania and Uganda.
- the Nubian Aquifer system shared by Chad, Egypt, Libyan Arab Jamahiriya and Sudan.
- the North Western Sahara Aquifer system shared by Algeria, Libyan Arab Jamahiriya and Tunisia.
- the Iullemeden Aquifer system shared by Mali, Niger and Nigeria.
- the Guarani Aquifer in the Latin American region.

6. Laboratory facilities for isotope analyses were strengthened in several countries and those in Egypt, El Salvador, Morocco, Pakistan, Poland and South Africa were used to provide analyses for other technical co-operation projects in the same or different regions.

7. New laboratories were installed or existing facilities were upgraded in Egypt, Ethiopia, Pakistan, Philippines and Slovenia. These laboratories can fulfil national requirements for isotope analysis for hydrology and may also provide support for regional projects.

8. Integration of isotopes into mainstream hydrology was facilitated through increased co-operation with international professional associations. The International Association of Hydrological Sciences, the International Association of Hydrogeologists and the Agency have co-sponsored several symposia on groundwater and river basin management. These sponsorships have resulted in a greater appreciation of the use of isotopes in hydrology and of the Agency's role in transfer of technology.

9. Efforts also focused on increasing awareness of the benefits available through the Agency's water resources programme as an integral part of the United Nations system's work in water resources. In this direction, the Agency led the UN system-wide celebration of World Water Day 2002. These celebrations highlighted the challenges of water for development and the role of science and technology in meeting these challenges; an art exhibition by children from schools in Austria and Uganda; and a dialogue on water for development with distinguished speakers from governments, non-governmental organizations and intergovernmental agencies. Nearly 3000 copies of promotional materials were distributed and a summary report on the celebrations successfully brought attention to the Agency's role in the UN system's involvement in the sustainable development of water resources.

10. The Agency was elected to chair UN Water, which is an inter-agency co-ordination committee for fresh water for 2002–2004. This committee consists of more than 23 UN system entities and several international organizations with interests and programmes in fresh water, and is responsible for co-ordinating action and responding to requests from the UN General Assembly and the Commission on Sustainable Development. Serving as chair of this committee has led to increased awareness of the Agency's activities in water resources, leading to several initiatives for joint programmes.

11. The Agency contributed to major events on water such as the International Conference on Freshwater held in Bonn, Germany, in 2001, the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa, in 2002 (reported in GOV/INF/2002/15 and GOV/INF/2002/15/Corr.1), and the 3^d World Water Forum held in Kyoto, Japan, in 2003. As the chair of the inter-agency co-ordination committee, the Agency moderated many side events and theme sessions at these conferences. The Agency's presentation at a panel discussion on water at the WSSD emphasized the role of science and technology in meeting the goals for sustainable development of water resources.

12. The Agency played a prominent role in the production of the World Water Development Report produced by the UN system under the guidance of the inter-agency co-ordination committee, and, as chair of this committee, moderated the events organized to launch the report.

13. The potential impact of climate change on water resources is an issue of concern under investigation by many international scientific programmes, including the Global Energy and Water Cycle Experiment (GEWEX), managed by the World Meteorological Organization. GEWEX focuses on international efforts in hydrology and meteorology to develop an understanding of the earth's energy and water cycle. Characterization of moisture sources in local precipitation is a current area of interest, and the role of isotope data from the Agency's Global Network for Isotopes in Precipitation (GNIP) in moisture source research has been highlighted by GEWEX. This has resulted in a joint project to use isotope data from GNIP for improved modelling of moisture sources in precipitation.

14. A Memorandum of Understanding was signed between the Agency and UNESCO to launch the Joint International Isotopes in Hydrology Programme (JIIHP). The first meeting of the JIIHP steering committee in June 2002 produced a work plan for 2002–2005, leading to the initiation of training activities. As part of this joint programme, and within the framework of national and regional technical co-operation projects, a training course in hydrogeology was organized in 2002 at the Institute of Fluid Mechanics and Environmental Engineering of the University of the Republic of Uruguay, Montevideo, with trainees from the Latin American region.

15. The development of academic training programmes focusing on the use of isotope techniques for hydrologists is a key requirement for the transfer of water sector skills to developing countries. Through the Agency's assistance, isotope hydrology is now included in a postgraduate programme at the University of Roorkee, India, and the College of Water Resources and Environment at Hohai University, Nanjing, China, has established a new postgraduate semester course.

Servicing Immediate Human Needs

A. Sterile Insect Technique for the Control or Eradication of Mosquitoes

A.1. Background

1. Malaria is the most damaging insect-transmitted disease. The causative agents are parasites of the genus *Plasmodium* that are transmitted by female mosquitoes of the genus *Anopheles*. It causes approximately 2 million deaths a year and there are about 300–500 million cases of clinical malaria annually. Over 90% of the world's malaria cases occur in Africa, and in many countries it consumes a major portion of the national health budget. The disease constitutes a major obstacle to poverty reduction in Africa; according to some estimates, it has slowed economic growth in African countries by 1.3% per year.
2. Treatment for malaria requires affordable and effective drugs but the growing problems of drug resistance will necessitate a switch to more expensive alternatives. Malaria vaccines have not currently proved sufficiently protective to warrant use in malaria control. These limitations of current interventions have led to renewed interest by Member States in the potential of the sterile insect technique (SIT) for the suppression of malaria-transmitting mosquitoes in suitable areas. It is envisaged that SIT would be used under specific conditions as an adjunct to more orthodox technologies, conforming to the WHO's Roll Back Malaria strategy of not relying on any single approach to control.
3. In September 2001, the General Conference in resolution GC(45)/RES/12.C requested the Agency to continue to intensify R&D activities and efforts that would lead to possible applications of the SIT in the control or eradication of mosquitoes.
4. It further requested the Director General to report on the achievements in implementing this resolution to the Board of Governors and to the General Conference at its forty-seventh session.

A.2. Developments since the General Conference's 2001 Session

5. Prior to the General Conference's 2001 session, the Agency had convened a meeting in June 2001 with national experts from 8 African countries, international experts, and a representative from the WHO to review the status of the control of malaria-transmitting mosquitoes in Member States including Government policies; review the technology of SIT for possible use as an additional tool for the control of malaria-transmitting mosquitoes; formulate long-term and short-term strategies and action plans for R&D aimed at a possible integrated application of the SIT for the control of malaria-transmitting mosquitoes; and identify international and regional partners and discuss modalities for co-operation.
6. The meeting produced a project document designed to assess the feasibility of the SIT for the suppression of *Anopheles arabiensis* populations in selected areas in Africa. The project specifically aims at developing tools for rearing, separating sexes, sterilizing, and releasing large numbers of male mosquitoes; evaluating the impact of the releases on field populations and, where appropriate, on malaria transmission; and establishing an improved network of centres in Africa, together with strengthened collaboration with centres of excellence elsewhere.

7. In relation to actions by the Agency, the project document described the essential R&D component and developed criteria for the selection of pilot field sites where the feasibility of mosquito SIT could eventually be evaluated. It recommended the development of a mosquito-rearing laboratory in Seibersdorf, supported by a co-ordinated research project (CRP). A suitable area for refurbishment in the laboratories at Seibersdorf was identified and a mosquito-rearing laboratory was constructed and inaugurated in June 2003.
8. The Agency initiated a regional technical co-operation (TC) project for the 2001–2002 biennium. It was extended with core funding of \$125 000 for 2003, and also received an extrabudgetary contribution from France. This project has provided support to the field activities through expert missions, equipment and fellowship training. Expert missions were used for the identification of potential field evaluation sites.
9. A mission in June 2000 to the Northern State of Sudan assessed the suitability of the area and identified a potential site by the Nile river in the provinces of Dongola and Merowe. Two subsequent missions in August 2002 and January/February 2003 confirmed the suitability of the area and a plan of activities was developed for 2003. This included awarding fellowships and purchasing equipment for the development of a geographic information system (GIS) for the target area. A workshop to address the latter issue was held in Vienna in June 2003 with Sudanese counterparts, outside experts and Agency staff.
10. WHO has suggested that the island of Réunion, France, might be a suitable site. An expert mission in April 2002 concluded that the island was suitable and in addition there was very strong local support for pilot field activities. A plan of action for 2003 was prepared that included the setting up of a mosquito colony from locally collected insects, which would later be transferred to the Agency's Seibersdorf mosquito-rearing facility. The small mosquito colony has now been established in Réunion.
11. The Seibersdorf mosquito-rearing facility comprises an area of 70 square metres and is designed to accommodate a larval rearing room, an adult mosquito room and a small office. Two issues of major concern during the design phase were to ensure sufficient biosecurity so that mosquitoes could not escape and the installation of the appropriate climate control systems for mosquito rearing. The refurbishment was carried out as funds became available and it was completed at a total cost of \$500 000, which included extrabudgetary and equipment contributions from Germany and the USA. A cost-free expert was recruited in November 2002 to oversee the refurbishment of the mosquito-rearing laboratory and to support the development of field sites.
12. A sound basis has been created for implementation of the Seibersdorf project with the completion of the mosquito-rearing laboratory and the identification of potential field sites. The immediate goal is the establishment of a mosquito colony at Seibersdorf reared from biological material collected from one or both of the field sites to improve rearing and handling techniques, develop radiation sterilization strategies and create strains for the production of male mosquitoes. These activities will form part of a new CRP that will be planned during 2004 and implemented from 2005 to 2009. Fellowship training at Seibersdorf on mosquito SIT will also be initiated during 2004 and long-term fellows will be identified.

B. Support to Radiation Therapy for the Treatment of Cancer

B.1. Background

13. Cancer incidence is increasing more rapidly in developing than industrialized countries. Radiation therapy plays a major role in the management of solid tumours for cure and palliation. In September 2001, the General Conference noted that a large increase in the number of solid cancers is expected in developing Member States owing to increasing life expectancies. Resolution GC(45)/RES/12.C requested the Agency to continue to support the building-up of indigenous capabilities in radiation therapy to cure or alleviate the life-threatening effects of solid cancers in developing Member States and to improve safety standards.

14. The resolution further requested that the Director General report on the achievements in implementing this resolution to the Board of Governors and to the General Conference at its forty-seventh session.

B.2. Developments since the General Conference's 2001 Session

15. The building-up of indigenous capabilities in radiation therapy has been implemented through the Agency's TC programme. Assistance to Member States for cancer treatment has been through radiation oncology for the treatment of cancer, nuclear medicine for the diagnosis of cancer, and dosimetry and medical physics for the measurement of radiation for treatment and diagnosis. Developing Member States have given cancer management services high priority in their requests to the Agency. As a result there are currently about 100 active technical co-operation projects in this field, ranging in duration from two years up to five years for those directed at initiating radiation oncology services to achieve a fully functional radiotherapy department. The Agency also promoted a public information campaign to raise awareness of the cancer crisis in developing countries which received wide media coverage.

16. The Agency continued its radiotherapy initiation services in Angola, Haiti, Yemen and Zambia through technical co-operation projects. Upgrading of radiotherapy services has been a high priority for many of the Agency's new Member States in Europe, where the Agency is active in 15 countries. Africa, which as a continent has the greatest need for more services, has 20 projects. Similar activities are implemented in the Asia-Pacific and Latin American regions.

17. Many Member States have been co-operative in cost-sharing of major capital items, such as a 'package' of new technology that comprises the therapy machine and its associated equipment for medical physics quality assurance and radiation safety.

18. Further, many Member States have extended, at their own expense, the basic infrastructure (equipment and training) provided by the Agency to enhance performance or increase patient treatment capacity.

19. In-kind contributions to the TC projects have included major items outside the Agency's scope, such as a linear accelerator to Armenia from Russia. The Agency then provides expertise and the associated equipment for medical physics quality assurance and radiation safety.

20. The Agency has strong regional projects that address the common problems of each region. These include diverse shortfalls ranging from educational opportunities, for example in the Europe and East Asia and Pacific regions, to patient immobilization in the African and Latin American regions or the viable integration of radioimmunoassay technology in the establishment of a comprehensive approach for the detection and management of cancer in West Asia. The achievements of these

projects have been built upon by their continuation and expansion, as in TC project 'Management of the Most Common Cancers in Africa', now active until 2005 at the behest of the Member State representatives during regional field management meetings.

21. The Agency has supported the improvement of clinical and medical physics quality assurance by assisting trainees from Eastern Europe to attend courses run by the European Society for Therapeutic Radiology and Oncology, based in Belgium, for their own participants. This project has provided support for 369 participants in 2002 and 2003. Russian translation is provided for one of the 8 courses selected annually.

22. The Agency continued to assist relevant Member States in their efforts to comply with paragraphs 23–25 of the *Report on the Implementation of Model Projects for Upgrading Radiation Protection Infrastructure* (document GOV/2001/48). However, in the absence of a fully developed national regulatory infrastructure, the Agency was unable to provide the requested radiation sources to some Member States seeking help to establish their first facility or to upgrade their technology to safer alternatives.

C. Development of Nuclear Techniques for Humanitarian Demining

C.1. Background

23. The prohibition of the use, stockpiling, production and transfer of anti-personnel mines has been the subject of international efforts for many years. However, so far it has not been possible to establish a comprehensive international regime for such prohibitions, and in more than 60 countries abandoned landmines continue to pose threats to life and are constraints on socio-economic development.

24. A co-ordinated research project (CRP) entitled 'Application of Nuclear Techniques to Anti-personnel Landmines Identification' was initiated by the Agency in 1999 to encourage and co-ordinate the development of devices for humanitarian demining through research in Member States.

25. In September 2001, the General Conference in resolution GC(45)/RES/12.C requested the Agency in co-operation with Member States and relevant international organizations, to continue to strengthen, taking into account relevant developments in Member States, its R&D activities relating to applications of nuclear techniques in humanitarian demining, especially in developing countries.

26. It further requested the Director General to report on the achievements in implementing this resolution to the Board of Governors and to the General Conference at its forty-seventh session.

C.2. Developments since the General Conference's 2001 Session

C.2.1. Agency activities

27. Nuclear techniques have a unique capability to detect the explosive content of a landmine. The Agency's contribution to humanitarian demining comprises a CRP with fourteen participating groups from Australia, Canada, Croatia, Egypt, Hungary, Italy, Netherlands, Russian Federation, South Africa, Slovakia, Slovenia, Sweden, United States of America and Vietnam; a regional technical co-operation project on 'Field Testing and use of Pulsed Neutron Generator for Demining' for 2001–

2004, with all TC European recipient Member States plus observers from Asia and Africa; and two national TC projects, in Croatia and Egypt.

28. Five CRP research groups have produced prototype neutron-based devices for the detection and/or identification of landmines. In particular, the group from the USA has adapted an instrument based on a pulsed electrostatic neutron generator (PELAN, Pulsed Elemental Analysis with Neutrons), and the groups from Netherlands and South Africa have developed hand-held devices for the detection of landmines in dry areas. The latter have been tested under field conditions and it is foreseen that such devices will be used in combination with a metal detector for the detection of plastic landmines. The Agency has provided the South African group with extrabudgetary funds for performance enhancement of the plastic landmine detector, with anticipated scanning of 1 square metre of dry soil in 15 minutes.

29. In February 2002, a demonstration of the PELAN device was held at the Atomic Institute of the Austrian Universities in Vienna, under the Europe regional TC project. It attracted considerable interest from the demining community and from the Vienna-based Permanent Missions and resulted in newspaper articles, enhancing public awareness of the potential use of nuclear methods for humanitarian demining.

30. A PELAN system was field-tested in October–November 2002 with real landmines and anti-tank mines (un-fused) near Zagreb, Croatia, in co-operation with scientific staff from the Croatian Mine Action Centre (CROMAC). Tests showed that the PELAN device could reliably identify anti-tank mines with 5-6 kg of TNT buried under 15 cm of soil and anti-personnel mines with 200g of TNT under 5 cm of soil. A definitive conclusion could not be reached in the case of detecting smaller anti-personnel mines. To improve the detection limit and reliability of the PELAN device, the Agency has awarded technical contracts to universities in the Netherlands and the United Kingdom. If successful, PELAN would have high potential for use in humanitarian demining operations. To achieve this success, PELAN would have to be integrated with a suitable anomaly detection device, for example a metal detector or ground penetrating radar, for field applications. During the summer, additional tests will be carried out, and an international expert workshop will be held in order to evaluate the performance of the PELAN device and to propose further action.

D. Research Activities and Capacity-Building for Nutrition

D.1. Background

31. The Agency, as part of the efforts of the United Nations system organizations in nutrition research, has been using isotope techniques for evaluations of human nutritional status and environmental health. These techniques are suitable for measuring the uptake and bioavailability of many important nutrients and for evaluating food supplementation programmes and other interventions aimed at combating many forms of malnutrition. In collaboration with Member States, other United Nations organizations and donors, the Agency has initiated technical co-operation projects in the field of nutrition in more than 50 countries.

32. Resolution GC(45)/RES/12.C requested the Agency, in co-operation with Member States and relevant international organizations, to continue to support research activities and capacity-building programmes for nutrition research and development for meeting basic human needs. It also requested

the Director General to report on achievements in implementing this resolution to the Board of Governors and to the General Conference at its forty-seventh session.

D.2. Developments since the General Conference's 2001 Session

33. Capacity-building and research activities have been implemented through regional and national technical co-operation projects and through co-ordinated research projects (CRPs). Quality assurance has been strengthened in laboratories by including modules on nutritional and environmental metrology in training courses in Argentina, Chile, China, Ghana, Mexico, Senegal, United Republic of Tanzania, Thailand, and Vietnam. A CRP started in 2001, entitled "Isotopic and Complementary Tools for the Study of Micronutrient Status and Interactions in Developing Country Populations Exposed to Multiple Nutritional Deficiencies", is assisting eight PhD students from Bangladesh, Ghana, India, Indonesia, Mexico, Pakistan, Sri Lanka, and Thailand to train as nutritionists using isotopic techniques. Other CRPs for researching issues related to intrauterine growth, body composition and energy expenditure, health impacts of toxic elements in foodstuffs, and nutrition-pollution interactions have provided new insights into measurement problems faced by analysts from developing countries for resolving public health issues.

34. The Agency has facilitated the evolution of networks of measurement analysts in the Asian, African and Latin American regions as a result of regional projects addressing effectiveness of multinutrient supplementation in Asia, evaluation of nutrition intervention programmes in Latin America, diagnosis of stomach infections related to *Helicobacter pylori* in Latin America, and nutrition issues related to HIV/AIDS in Africa. The Agency has also assisted some Member States in building technical resource laboratories for nutritional status assessment using nuclear and related techniques.

35. The Agency has provided technical co-operation assistance to African Member States to assess the impact of food and nutrient supplementation on the health status of vulnerable populations, and for the use of stable isotopes to evaluate and monitor the nutritional status of mothers and children. Similarly, the Agency has assisted Member States in the African, East Asian and Pacific, and Latin American regions to assess the efficacy of food fortification programmes.

36. As a result of evidence that there are links between airborne particulate matter (APM) concentrations and mortality and morbidity rates, a CRP is seeking to determine the extent to which toxic element levels in foods are affected by surrounding industrial activities. It also seeks to assess human exposure to such contaminated foodstuffs by developing harmonized protocols and validation of analytical methodology. The Agency has also established a network of standardized air samplers for collecting coarse and fine APM in about 40 Member States. The network is particularly active in the East Asia and Pacific region where 15 Member States are collecting samples and analysing them for toxic heavy element content using nuclear analytical techniques.

37. In May 2002, the 55th World Health Assembly requested the WHO Secretariat to develop a global strategy on diet, physical activity and health in consultation with United Nations system organizations. Isotopic techniques for nutrition studies are well suited to meet some relevant measurement needs to support this strategy, thus opening a collaborative link between the Agency and WHO. The CRP on energy metabolism, started in 2003, includes participants from Member States linked to the WHO initiative and provides for harmonized measurements for body fat distribution. The Agency and WHO have joint interests in nutritional interventions in vulnerable groups with HIV/AIDS, including children and women. The Agency has started a regional project on nutrition and HIV/AIDS in 2003 in the Africa region, in which isotopic techniques have a significant role to play in determining muscle wasting in HIV/AIDS patients.

Nuclear Knowledge

A. Background

1. In September 2002, the General Conference noted that the need to preserve, enhance or strengthen nuclear knowledge arises irrespective of the future expansion in the applications of nuclear technologies, and requested the Director General to note the high level of interest of Member States in the range of issues associated with preserving and enhancing nuclear knowledge in the process of preparing the Agency's programme. It further requested the Director General to report on the progress made in the implementation of GC(46)RES/11.B to the Board of Governors and to the General Conference at its forty-seventh (2003) session.

B. Developments since the General Conference's 2002 Session

B.1. Responses of the Major Programmes

2. Many activities in the Agency's programme have a nuclear knowledge component, and are reported to the Board of Governors and the General Conference through the Annual Report¹, the Nuclear Technology Review², the Nuclear Safety Review³, and the Technical Co-operation Report⁴. However, as a result of increasing interest in nuclear knowledge management issues as noted by the General Conference the Agency has increased the level of attention given to nuclear knowledge related activities, and sought to increase the level of awareness of the issues both internally and externally. 'Nuclear knowledge' has been established by the Agency as a cross-cutting activity, with the understanding that all Major Programmes have nuclear knowledge components. Major Programme managers have nominated representatives to a Knowledge Management Liaison Group to ensure a common approach and to share and contribute information on knowledge management activities.

3. Major Programme 1, Nuclear Power, Fuel Cycle and Nuclear Science, includes a subprogramme entitled 'Maintenance of Knowledge in Nuclear Science and Technology' in the 2002–2003 programme cycle. Activities have focused on providing guidance in nuclear knowledge issues, nuclear education and training, and preservation of nuclear knowledge. An ad-hoc advisory group was convened in December 2002 to prepare detailed concepts for networking of nuclear education and training. Additionally, the Standing Advisory Group on Nuclear Energy confirmed the importance of knowledge management, in particular the work of the International Nuclear Information System (INIS). The Agency project on preservation of knowledge of fast reactors seeks to establish a comprehensive, international inventory of fast reactor data and knowledge that would be sufficient to form the basis for fast reactor development 20 to 40 years from now. Retrieval and preservation of

¹ See document GC(47)/INF/2 for The Annual Report for 2002.

² See document GC(47)/INF/6 for the Nuclear Technology Review — Update 2003.

³ See document GC(47)/INF/3 for the Nuclear Safety Review for the Year 2002.

⁴ See document GC(47)/INF/8 for the Technical Co-operation Report for 2002.

data from the German experimental fast reactor KNK II, presently being decommissioned, commenced in 2003. Documents are being scanned and converted into electronic form. Bibliographical records will be produced using the Agency's INIS methodology. The Agency has also started to build a knowledge base on high temperature gas cooled reactors (HTGRs) incorporating technical information that is publicly available from selected projects, including information on the DRAGON reactor in the United Kingdom and the AVR reactor in Germany. More information is available on the Agency's knowledge management website (<http://www.iaea.org/km>). In the 2004–2005 programme cycle knowledge management activities have been moved to the new Programme C, Capacity Building and Knowledge Maintenance for Sustainable Energy Development, with additional resources. An international conference and one seminar on nuclear knowledge management are being proposed as key activities.

4. Major Programme 2, Nuclear Techniques for Development and Environmental Protection, comprises programmes in food and agriculture, human health, water resources, protection of the marine and terrestrial environments, and physical and chemical applications. The diversity of programme topics means that a common nuclear knowledge approach would not be appropriate to all of the scientific disciplines involved, also because many relevant activities are carried out by commercial enterprises. However, an internal review of Agency activities was carried out to categorize the common elements across programmes. The activities were listed under the headings of: Training and Education; Databases; Production of Guidelines, Guidebooks and Protocols; Production of Integrated Documentation; and Documentation of Research and Development Activities. The review was given to the Standing Advisory Group on Nuclear Applications (SAGNA) at its June 2003 meeting, with a request to advise on adequacy of activities and to make suggestions for the future. SAGNA recognized the complexity of the issues and acknowledged the work done in relation to knowledge management in Major Programme 2. It made recommendations in three specific areas: internal knowledge management (within the Agency), continuity of human resources, and public knowledge of nuclear matters.

5. Major Programme 3, Nuclear Safety and Security, is paying great attention to knowledge management and networking. Two main initiatives are under way. The first, dealing with knowledge management inside the Agency is the Integrated Safety Approach. This aims at ensuring an integrated approach, including a feedback mechanism, between the development of safety standards and their application, for example in safety services, education and training, technical co-operation (TC) projects and co-ordinated research projects. The second initiative dealing with knowledge management outside the Agency is the establishment by interested Member States of an Asian Nuclear Safety Network (ANSN) for pooling, analysing and sharing nuclear safety knowledge. It is envisaged as a model for other regional safety networks and eventually as a global nuclear safety network. It has also been recognized that knowledge management initiatives are driven by specific project needs, with the underlying aim of progressively expanding the frontiers of knowledge. A 'road map' for application of knowledge management activities in the Major Programme has been developed and is being implemented with an objective of improving the sharing of nuclear safety knowledge with Member States.

6. Major Programme 4, Nuclear Verification, seeks to strengthen knowledge management activities to maintain and develop appropriate information collection, processing and evaluation techniques, as well as other essential infrastructure and wide-ranging professional expertise, both within the Secretariat and in Member States. Due to the inherent confidentiality of verification activities, nuclear knowledge in Major Programme 4 is essentially inward focused. The main task is to develop and preserve the 'tacit knowledge' that allows staff to interpret the available information to identify diversion, misuse or incomplete declaration of nuclear material. A key role is therefore played by activities, like training, that will allow the knowledge of nuclear processes in different facilities and

countries to be created and transmitted to staff, and IT systems development and deployment, that will enable better and easier use of all information available.

7. Major Programme 6, Management of Technical Co-operation for Development, manages, through the TC programme, the main part of the Agency's technology, know-how and knowledge transfer to Member States, covering all geographic regions and all aspects of nuclear technology for power and non-power applications. In 2002, the programme comprised nearly 900 projects in over 100 developing countries and disbursed some \$75 million for its various components, of which over \$20 million (approx. 30%) was spent on training and capacity building and thus on human resources development in recipient Member States. Based on already successful examples in all regions, TC is helping to pave the way for national and regional self-reliance through regional co-operation, utilization of regional resource centres, and greater ownership by Member States of the solutions to national and regional development problems, including most importantly human resources development.

8. The Agency contributed to and interacted with relevant initiatives in Member States, including, for example, the conference entitled "Universities, Industry and Government — Partners for the future of Nuclear Education and Technology" held in the United States of America in October 2002, and organized jointly by the Nuclear Energy Institute, the United States Department of Energy and the Rensselaer Polytechnic Institute, and a ministerial-level meeting on the problems of preserving nuclear knowledge in Russia and CIS countries held in the Russian Federation in May 2003.

B.2. Managing Nuclear Education

9. The Agency has supported networking of education and training activities through co-ordination with and contributions to the European Nuclear Engineering Network (ENEN) and through a project to establish an Asian Network for Higher Education in Nuclear Technology (ANENT). The Agency also interacted with the German Network of Competence in Nuclear Technology and is participating, as an observer, in the Organisation for Economic Co-operation and Development's Nuclear Energy Agency Expert Group on International Collaboration to Achieve Nuclear Support Excellence.

10. General Conference resolution GC(45)/RES/10.C urged the Secretariat to implement the Strategic Plan as mentioned in Note by the Secretariat 2001/Note 20, Strategic Approach to Education and Training in Radiation and Waste Safety, which aims at establishing sustainable education and training programmes in Member States by 2010. Efforts have continued to develop a training programme in nuclear and radiation safety, including standard training material and distance learning modules. Standard training material has been prepared and made available to Member States⁵. A pilot project of the ANSN on sharing nuclear safety education and training knowledge is due for completion by end of 2003.

11. The Agency is supporting an initiative of the World Nuclear Association to promote the establishment of a World Nuclear University as a network of institutions.

⁵ See Annex 3 of document GOV/INF/2003/15- GC(47)/INF/4 for details.

B.3. Survey of Ongoing Programmes

12. The Agency has surveyed programmatic activities that have a nuclear knowledge component as a cross-cutting exercise, with the aim of identifying activities that contribute to nuclear knowledge management in the categories of: enhancing nuclear education and training; preserving and maintaining nuclear knowledge; pooling and analysing nuclear knowledge; and promoting policy and guidance for nuclear knowledge management. A questionnaire covering both education and training, and preservation of knowledge projects was sent to Member States through the INIS Liaison Officers in July 2003.

Agency Activities in the Development of Innovative Nuclear Technology

A. Background

1. In resolution GC(46)/RES/11.C on Agency activities in the development of innovative nuclear technology, the General Conference requested the Director General to report on the progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its forty-seventh session. This document provides an overview of the background and progress of the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) as of July 2003.
2. The General Conference in resolution GC(44)/RES/21 invited all interested Member States to combine their efforts under the aegis of the Agency in considering the issues of the nuclear fuel cycle, in particular by examining innovative and proliferation-resistant nuclear technology, and in resolution GC(44)/RES/22 invited Member States to consider to contribute to a task force on innovative nuclear reactors and fuel cycles. In response to this invitation, the Agency established INPRO.
3. At the first meeting of the INPRO Steering Committee in May 2001, the following issues were discussed and approved: the organizational structure, the outline of the INPRO report, resources, the overall schedule, the work plan and task contents. It was decided to define an INPRO member as a Member State or international organization, which provides extrabudgetary resources, either in form of cost-free experts, and/or funding to the Agency for the INPRO project. The third Steering Committee in May 2003 recommended that an interested Member State also qualify as an INPRO member, if a work package were performed at a national institution. This work package should address a specified need within the INPRO project and should consist of a contract with at least three man-months effort at no cost to the Agency.

B. Project Implementation

4. INPRO is an Agency-wide project, being co-ordinated by the Department of Nuclear Energy with contributions from all relevant Agency Departments and Divisions. The framework for the implementation of the project consists of the following:
 - The Steering Committee, comprising, as members, senior officials from INPRO members and, as observers, representatives from interested Member States and international organizations. Agency project management is also represented. The Steering Committee meets as appropriate (approximately two times per year) to provide overall guidance, advise on planning and methods of work and review the results achieved;
 - The International Co-ordinating Group (ICG), comprising cost-free experts from INPRO members, which co-ordinates and implements the project on the basis of experts' work in Member States and international organizations;

- Technical Expert Groups, comprising experts from Member States, which are convened as appropriate by the ICG to consider specific subjects; and
 - The Agency support, including project management, administrative and technical support.
5. INPRO is mainly implemented by the ICG using extrabudgetary resources offered by INPRO members. Extrabudgetary contributions for 2003 were provided by Bulgaria, Canada, Pakistan, and the Russian Federation.
6. Phase 1 of INPRO was initiated in May 2001. During Phase 1, work is divided in two sub phases:
- Phase 1A (completed in June 2003): Selection of criteria and development of methodologies and guidelines for the comparison of different concepts and approaches, taking into account the compilation and review of such concepts and approaches, and determination of user requirements.
 - Phase 1B (started in July 2003): Validation of the INPRO methodology through case studies and examination of innovative nuclear energy technologies made available by Member States against criteria and requirements. This examination will be performed by Member States on the basis of user requirements, criteria and methodology established during Phase 1A.

C. Progress

7. At the fourth meeting of the INPRO Steering Committee in December 2002, the Steering Committee noted the progress reports on Phase 1A presented by the Secretariat and made several recommendations with regard to the technical and organization approaches taken by INPRO. It also expressed appreciation for a new interregional technical co-operation (TC) project to be implemented by the Agency in 2003–2004 in support of activities in the frame of the INPRO project. The Steering Committee requested the Agency Secretariat to consult with the Secretariat of the Generation IV International Forum (GIF) about co-ordination with INPRO in order to ensure complementarity of efforts, which is in progress.

8. During the fifth meeting of the INPRO Steering Committee in May 2003 the results achieved within Phase 1A were reviewed and discussed and the final draft report of Phase 1A of INPRO was approved in general while some comments were made for consideration by the Secretariat for its further improvement. The Steering Committee noted that INPRO terms of reference remain the basic guidance for carrying out the next phase of INPRO and requested the Agency to take a lead co-ordinating role in harmonizing the activities on innovative nuclear reactors and fuel cycles. The Steering Committee also invited all interested Member States to make scientific and technical contributions and encouraged international participation in further studies within INPRO.

9. The main output of Phase 1A of the project is the Report on Innovative Nuclear Reactors and Fuel Cycles. The Report provides the methodology for assessment of innovative nuclear energy systems as based on the defined set of basic principles, user requirements and criteria structured along the topics of economics, sustainability and environment, safety, waste management, proliferation resistance and cross cutting issues (see document IAEA-TECDOC-1362 *Guidance for the evaluation of innovative nuclear reactors and fuel cycles*, June 2003).

10. In Phase 1B an assessment of the efficiencies of the methodology will be performed by applying it in a number of case studies. Feedback and experience from case studies will then be used to sharpen and adjust the INPRO basic principles, user requirements, and criteria of the methodology. At present, three case studies have been started on a national basis by Argentina (CAREM-X), India (Advanced Heavy Water Reactor), and the Russian Federation (BN-800). Additional case studies are to be proposed by Member States by the end of July 2003 on a national and individual basis. It was agreed that case studies would take account of as many components of the complete nuclear power system as currently possible. After the validation of the INPRO methodology, interested Member States will be able to perform an assessment of innovative technologies against basic principles, user requirements and criteria.

11. Upon successful completion of Phase 1, taking into account advice from the INPRO Steering Committee, and with the approval of participating Member States, Phase 2 of INPRO may be initiated. Drawing on the results from Phase 1, it will be directed at examining in the context of available technologies the feasibility of commencing an international collaborative project, and identifying innovative technologies, which might be appropriate for implementation by Member States of such an international project.

12. As of July 2003, the following 15 Member States and international organizations have become INPRO members: Argentina, Brazil, Bulgaria, Canada, China, Germany, India, Republic of Korea, Netherlands, Pakistan, Russian Federation, Spain, Switzerland, Turkey and the European Commission. In total, 20 cost-free experts have been nominated by INPRO members and worked at the Agency as members of the INPRO International Co-ordinating Group.

13. A periodically updated homepage for INPRO has been established under:
<http://www.iaea.org/programmes/ne/nenp/nptds/newweb2001/inpro/entirelyinpro.htm>

D. Outreach

14. Interim results of INPRO were presented at the following international meetings:

- 2003 International Congress on Advances in Nuclear Power Plants, 4–7 May 2003, Córdoba, Spain.
- 18th Korea Atomic Industrial Forum/Korean Nuclear Society Annual Conference, 9–11 April 2003, Seoul, Republic of Korea.
- FORATOM Meeting "Safety Standard Seminar", 8 May 2003, Brussels, Belgium.
- 23rd CONCERT Group Meeting (Regular Meeting of Representatives of the European Commission and Nuclear Regulatory Authorities of East and West Europe), 5–7 May 2003, Prague.
- 11th International Conference on Nuclear Engineering, April 20–23, 2003, Tokyo, Japan.

15. The Agency, in co-operation with the World Nuclear Association, the World Energy Council, the International Science and Technology Center and the Electric Utilities Cost Group, organized the International Conference on Innovative Technologies for Nuclear Fuel Cycles and Nuclear Power in Vienna from 23 to 26 June 2003. The conference succeeded in bringing together top managers, policy makers and specialists from developed and developing countries as well as representatives of research and development activities in Member States and international projects. There was broad agreement

among the participants that the Agency is to take a key role in co-ordinating international efforts to develop innovative technologies and that international collaboration in general and the collaboration especially between GIF and INPRO should be improved and substantially expanded.

Support to the African Union's Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC)

A. Background

1. Tsetse flies and the trypanosomosis disease they transmit are a major transboundary problem in 36 African countries and are one of the greatest constraints to the continent's socio-economic development, affecting the health of humans and livestock, limiting land use, and causing increased poverty. In recognition of the severity of the problem, Heads of State and Government of the Organization of African Unity (OAU)⁶ made a decision at their 2000 Summit in Togo to free Africa of tsetse flies. Subsequently, at their 2001 Summit in Lusaka, Zambia, the Heads of State and Government endorsed a Plan of Action for implementing the Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC). The PATTEC Plan of Action recognizes the technical and economic feasibility, the environmental friendliness and the indispensability of the sterile insect technique (SIT) for creating tsetse-free zones. The SIT played a central role in the eradication of tsetse flies from Zanzibar, United Republic of Tanzania, through the assistance of the Agency.

2. For the purpose of implementing the PATTEC Plan of Action, the OAU set up in 2001 a PATTEC Co-ordination Office (PCO) at its Commission in Addis Ababa, Ethiopia. The PCO acts as the focal point and spokes-office of the Commission on the PATTEC initiative and serves its Member States in fulfilling their individual and collective obligations. It also mobilizes support and commitment for PATTEC and is charged with developing and co-ordinating partnerships with donors and other partners, mediating between affected countries to work out modalities of inter-State and regional co-operation, and to build and enhance capacity in Member States

3. In September 2001, the General Conference requested the Agency in resolution GC(45)/RES/12.D, in co-operation with Member States and relevant international organizations, to continue supporting African Member States in their efforts to eradicate tsetse flies, and in particular to support the OAU Plan of Action for the eradication of tsetse flies through utilization of the SIT within available resources. The resolution also called upon Member States to provide technical, financial and material support to African States in their efforts to eradicate tsetse flies and stressed the need for international co-operation to enable African countries to widely utilize the SIT for tsetse fly eradication, wherever possible through the TCDC (technical co-operation among developing countries) mechanism.

4. In September 2002, in resolution GC(46)/RES/11.D, the General Conference expressed appreciation for the increased efforts being made by the Director General to support expanded application of the SIT in the creation of tsetse fly-free zones in African Member States in support of the OAU Plan of Action for PATTEC, and stressed the need for continued international co-operation and the harmonization of efforts in support of PATTEC, including through the TCDC mechanism. The resolution requested the Secretariat to continue supporting African Member States in their efforts to

⁶ On 9 July 2002, the OAU was replaced by the African Union.

create and subsequently expand tsetse fly-free zones in line with the OAU's Plan of Action through utilization of the SIT, and to continue to further develop scientific research in this field. It also requested the Secretariat to co-ordinate with the New Partnership for African Development (NEPAD).

5. Resolution GC(46)/RES/11.D further requested the Director General to report on the progress made and the effectiveness in the implementation of this resolution to the Board of Governors and to the General Conference at its forty-seventh (2003) session.

B. Developments since the General Conference's 2002 Session

6. The Agency contributes directly to the PATTEC Plan of Action through the implementation of one regional, and eight national technical co-operation (TC) projects in Botswana, Burkina Faso, Ethiopia, Kenya, Mali, South Africa, United Republic of Tanzania and Uganda. The support was largely through provision of training to Member State personnel, expert services and equipment. Assistance has been provided to supply semi-automated feeding units for validation under operational conditions; to construct and improve tsetse-rearing facilities in Burkina Faso, Ethiopia and the United Republic of Tanzania; to perform test sterile fly release in Mali; to develop standardized recording, reporting and management system for field operations; to collect entomological and veterinary baseline data in target areas; to carry out genetic studies of tsetse fly populations; to establish a DNA extraction laboratory in West Africa; and to develop tsetse prediction maps. The Agency, as in previous years, has contributed to the organization of the third WHO/MSF⁷/IAEA training course on African trypanosomiasis in May 2003 in Lisbon, Portugal. Through the above support, the capacity (tsetse rearing and irradiation etc.) of Member States to apply the SIT for the creation of tsetse-free zones has been enhanced in several countries.

7. One of the key activities of the regional technical co-operation project is to provide support for ongoing and future activities through short-term assignments of three technical experts covering the areas of area-wide tsetse control involving the SIT, tsetse mass-rearing and geographic information systems (GISs) attached to the PCO. This support has been very useful for PATTEC. For example, it has enabled the PCO to design and conduct a three-week regional GIS training course in Addis Ababa, Ethiopia, in May 2003, sponsored by the Agency. The PCO has facilitated consultations between Ethiopia and Sudan that culminated in the signing of a Memorandum of Agreement in May 2003, and consultations involving countries in the Kwando/Zambezi region (Angola, Botswana, Namibia, Zambia and Zimbabwe) resulting in the agreement in June 2003 to initiate a joint campaign, building on the progress made in tsetse control by Botswana in the Okavango Delta. In 2002–2003, the PCO facilitated partnerships for PATTEC with the Common Market for Eastern and Southern Africa, the Economic Commission for West African States, and the African Development Bank.

8. Two FAO/IAEA co-ordinated research projects (CRPs) relevant to the SIT have been completed on tsetse rearing automation and on tsetse attractants. All significant research findings and developmental methods will be published and made available to Member States by the end of 2003. A third CRP on tsetse population genetics, which will be completed with the publication of a comprehensive report in 2004, will be instrumental in the assessment of the degree of isolation of target tsetse populations and in facilitating strategic planning of integrated area-wide tsetse and

⁷ Médecins Sans Frontières.

trypanosomosis intervention projects. A new CRP on the development of standardized production and product quality control of sterile tsetse fly males was recently initiated. Additionally, research at the Agency's Seibersdorf laboratory continues to support PATTEC objectives by studying fly release systems; fly mating and compatibility trials; a mechanism for separating male and female tsetse flies, and initiation of experiments to characterize the virus in *Glossina pallidipes* originating from Ethiopia.

9. The Agency is continuing to make efforts on its part to build technical, strategic and financial partnerships for supporting the PATTEC initiative. For example, the Programme Against African Trypanosomosis (PAAT)⁸ Advisory Group meeting in September 2002 in Nairobi, Kenya, resulted in a broadened consensus with partners such as the International Fund for Agricultural Development and institutions of the Consultative Group on International Agricultural Research, and was followed in July 2003 by a joint planning workshop at FAO. The workshop developed a draft concept note and a timetable for joint efforts by the Ethiopian authorities and the PAAT community on securing funding and international support for tsetse intervention in a designated initial area of 10 500 square kilometres of the Ethiopian Southern Rift Valley, where the Agency has been assisting Ethiopia by means of a TC project since 1997.

10. During the African Union Heads of State and Government summit held in July 2003 in Maputo, Mozambique, a meeting under the auspices of the PCO involving the NEPAD Secretariat and the Agency agreed on modalities for incorporating PATTEC activities within the NEPAD agenda.

11. The Agency is also fostering partnerships for PATTEC through its representation to the PATTEC Policy and Mobilization Committee (PATTEC-PMC) alongside other mandated United Nations organizations (FAO and WHO) and stakeholders such as PAAT. PATTEC-PMC is a committee set up by the Chairperson of the African Union, with three categories of membership — individual experts from various parts of the world; Ambassadors accredited to the African Union representing the five African regions; and institutional representatives such as the Agency, FAO and WHO. The committee provides advice and guidance to the Chairperson of the African Commission on policies and management of PATTEC, determines the most effective and appropriate approaches for execution of the campaign, and mobilizes resources.

⁸ The Programme Against African Trypanosomosis is a forum used by the African Union, FAO, WHO and the Agency to concert their efforts.

Plan for Producing Potable Water Economically Using Small and Medium-Sized Nuclear Reactors

A. Background

1. The Board of Governors considered the report by the Director General entitled “Plan for Producing Potable Water Economically Using Small and Medium-Sized Nuclear Reactors” in GOV/2003/13 in its meeting of March 2003 and authorized the Director General to submit the report, updated as appropriate, to the General Conference for consideration at its forthcoming session. Accordingly, this is an updated version of GOV/2003/13 for submission to the General Conference, which provides an overview of activities concerning nuclear seawater desalination and small and medium-sized reactors (SMRs) undertaken by the Secretariat between August 2001 and June 2003.

B. Nuclear Seawater Desalination

2. Since the completion of the Agency’s Options Identification Programme for Demonstration of Nuclear Desalination in 1996 and the international symposium on nuclear desalination of sea water in 1997, many Member States have taken steps to evaluate, plan, or in some cases, initiate nuclear desalination projects. In order to facilitate these activities, the Agency’s programmes on nuclear desalination are gradually shifting their focus from generic studies to specific needs-oriented programmes in the form of co-ordinated research projects (CRPs) and technical co-operation (TC) projects.

B.1. International Nuclear Desalination Advisory Group

3. The International Nuclear Desalination Advisory Group (INDAG) held its sixth meeting in July 2002. INDAG members exchanged information on the progress of national and interregional activities in the field of nuclear desalination and reviewed the progress of the Agency’s work, as well as activities planned for 2004–2005. INDAG also discussed how the Agency could contribute to facilitating nuclear desalination activities in Member States. The second issue of INDAG’s newsletter was published in September 2002. The third issue of INDAG’s newsletter is under preparation.

B.2. Activities of the Member States

4. Among the national activities reported at the INDAG meeting are the following: Argentina continues its active participation in the Agency’s ongoing CRPs related to nuclear desalination. Canada is considering industrial application of its advanced reverse osmosis (RO) desalination design methodology, possibly including collaboration with other countries. China carried out a pre-project study of a nuclear desalination plant for the Shandong area, using its nuclear heating reactor (NHR)-200. A test system was set up in the Institute of Nuclear Energy Technology for validating the thermal-hydraulic parameters of a chosen multi-effect distillation process. Egypt completed a feasibility study for a nuclear plant at El-Dabaa to cogenerate potable water and electricity.

Construction of a test facility is about to be completed to study the characteristics of pre-heated seawater RO. France is co-ordinating the European Union's (EU's) EURODESAL project, grouping together five industrial organizations and two R&D organizations from the EU and Canada. India is proceeding with the commissioning of the nuclear desalination demonstration plant at Kalpakkam, which is due to be completed in early 2004. Israel provided technical and economic information on low-cost desalination technologies and their application to large-scale desalination plants. The Republic of Korea completed the basic design of its System-Integrated Modular Advanced Reactor (SMART). Construction of a one-fifth scale pilot plant of SMART (SMART-P) is under way for technical demonstration. Libya is continuing its investigation on domestic viability and competitiveness of nuclear energy for seawater desalination. Morocco established a standing commission in order to formulate an adequate and sound legal and institutional framework. Pakistan is designing the coupling of a desalination plant with the existing pressurized heavy water reactor (PHWR) at Karachi nuclear power plant (KANUPP) for demonstration purposes. The Russian Federation continues its R&D activities in the use of small reactors for nuclear desalination. Construction of a floating pilot plant using a KLT-40C reactor and a Canadian RO desalination system is being planned for 2005–2006 at the shipyard in Severodvinsk. The United States of America will include in its Generation IV roadmap initiative a detailed discussion of potential nuclear energy products, in recognition of the important role that future nuclear energy systems can play in producing fresh water.

B.3. Activities of the Agency

5. The fourth and final Research Co-ordination Meeting (RCM) of the CRP entitled “Optimization of the Coupling of Nuclear Reactors and Desalination Systems” was held in February 2003 with the participation of seven research institutions. Progress made since the third RCM in October 2001 was reviewed. Coupling configurations using various reactor systems (pressurized water reactors (PWRs), PHWRs, NHR, etc.) are being optimized. Safety analyses are being performed to confirm that coupling does not impose additional safety risks to the integrated cogenerating complex. The content of a Technical Document (TECDOC) containing the salient features of work from the CRP was discussed.

6. A new CRP entitled “Economic Research on, and Assessment of, Selected Nuclear Desalination Projects and Case Studies” was launched in February 2002 with the participation of research institutions from 13 Member States. The overall objective of the CRP is to enhance prospects for the demonstration, and, eventually, for the successful implementation of nuclear desalination in Member States. The specific objectives of the CRP are to evaluate economic aspects and to investigate the competitiveness of nuclear desalination under specific conditions, identify innovative techniques leading to further cost reduction of nuclear desalination, and refine economic assessment methods and tools. The first RCM was held in July 2002, during which progress was reviewed and future work plans were discussed. A TECDOC that will come out of the CRP was discussed and an upgrade to the Desalination Economic Evaluation Program (DEEP) software was recommended. The second RCM is scheduled for October 2003.

7. After two successful consecutive training workshops on nuclear desalination, held at the International Centre for Theoretical Physics (ICTP), Trieste, Italy in April–May 2001, a similar workshop was held at the same location in March–April 2003. Training was provided to 23 scientists and engineers mainly from developing countries in appropriate technologies and in economic evaluation methods for nuclear desalination, focusing in particular, on the use of the Agency DEEP software.

8. A DEEP user group meeting was held at Obninsk in May 2003. The purpose of the meeting was to share information and experience between users of DEEP from various Member States, to introduce a new code upgrade and discuss future possible improvements.
9. The Agency's TC project, "Feasibility Study on a Nuclear Co-generation Plant (Production of Electricity and Water) at El-Dabaa", Egypt, was completed at the end of 2001. A new two-year TC project, "Simulation of Nuclear Desalination Plant", started in 2001. In the first phase, an advanced process simulator software system was installed at the offices of the Nuclear Power Plants Authority of Egypt and a training workshop on its use was organized by the Agency. Recently, the Agency has also been discussing with the US Oak Ridge National Laboratory the possibility of supporting the development of the nuclear desalination simulator.
10. Since its launch in 1999 by the Agency, the interregional TC project entitled "Integrated Nuclear Power and Desalination System Design" has co-ordinated international collaboration for joint development of a nuclear desalination plant between technology holders and potential end-users. At the international conference "Nuclear Desalination: Challenges and Options" held in Marrakesh in October 2002, a forum was arranged for the exchange of information on individual projects and on the Indian demonstration project at Kalpakkam, and to promote further international collaboration.
11. In January 2002, a three-year joint study was initiated on the preliminary economic feasibility of nuclear desalination on Madura Island, Indonesia. The study was based upon an agreement signed in October 2001 under the Agency's interregional TC project between BATAN and the Korea Atomic Energy Research Institute, Republic of Korea. The study includes technical aspects, as well as an evaluation of the social and economic impact of using nuclear technology in producing potable water using the SMART concept. Division of responsibilities and the project plan were agreed at the kick-off meeting in January 2002, and the first project review meeting in September 2002 reviewed the progress. It was recommended to construct a SMART plant in the next decade on Madura Island during the second project review meeting in January 2003. The results of the study are expected to be completed in 2004.
12. As part of the interregional TC project, a pre-feasibility study of a nuclear power and desalination plant at Skhira, Tunisia has been conducted jointly by Tunisia and the Atomic Energy Commission of France.
13. Pakistan has launched a feasibility study for the demonstration of nuclear desalination unit at KANUPP. In response to a request by the Pakistan Atomic Energy Commission in 2001, three Agency missions have been carried out to facilitate project planning under the interregional TC project on nuclear desalination. The conceptual design has been put in place and the construction of the unit is expected to be completed in 2005.
14. The report TRS-410, *Market Potential for Non-electric Applications of Nuclear Energy* focuses on the market potential and the economics of the nuclear option in district heating, supply of process heat, seawater desalination, ship propulsion, outer space applications, and on innovative areas such as fuel synthesis (including hydrogen production) and oil extraction. The document concludes that the growing number of facilities needed to meet global fresh water requirements will increase the attractiveness of nuclear desalination.
15. The work on safety was mainly related to the continuation of the review process of the Agency's safety standards, which include non-electrical applications such as desalination. The TECDOC-1366, *Considerations in the development of safety requirements for innovative reactors: Application to modular high temperature gas cooled reactors*, which describes a general approach for the preparation

of design safety requirements, has been prepared and issued. This approach should be followed in respect of nuclear power plants coupled with desalination units.

16. The integration of the database for non-electrical application systems into the Power Reactor Information System (PRIS) was initiated in 2001 and data from about 70 cogenerating nuclear power plants in Member States have been integrated into PRIS. Training on the questionnaire for data collection, including definitions used, was provided to the Member States in 2002. Upon integration of the database for non-electrical application systems into PRIS, data collection will be done through the new PRIS data acquisition system on the Web from 2003, which is currently under testing by selected Member States. The next steps include the development of a query system on the Internet in the next two years.

17. The Agency co-operated in organizing the international conference “Nuclear Desalination: Challenges and Options”, which was held jointly by the World Council of Nuclear Workers and the Moroccan Association of Nuclear Engineers in October 2002, in Marrakesh. About 150 participants from 37 countries attended the conference. It has highlighted technology features, including design, coupling, economics, and safety aspects of nuclear desalination plants. From the deliberations of participants, there was clear evidence of the ever-increasing shortage of fresh water in many parts of the world. There was also a clear emphasis on economics and safety as the two main issues driving the future of nuclear desalination. Several participants referred to the Agency’s DEEP as their main tool for economic evaluation of nuclear desalination designs and expressed the need for the Agency to take a leading role in its further upgrading.

18. A new CRP on the prospects of using high temperature gas cooled reactors (HTGRs) in fresh water cogeneration is being considered by the Agency. There are indications that this type of reactor design has the potential to produce low-cost fresh water by seawater desalination. A consultancy held in Marrakesh during the international conference on nuclear desalination in October 2002 examined the potential level of interest of Member States and recommended to pursue co-ordinated research in this area.

19. A website (www.iaea.org/nucleardesalination) for nuclear desalination has been established, at which up-to-date information is accessible on the status of technology for nuclear seawater desalination, TECDOCs, as well as ongoing and future activities of the Agency.

B.4. Interaction with other Organizations

20. Interaction between the Agency and other international organizations in the field of nuclear seawater desalination include the following:

- As the lead UN agency in charge of the World Water Day (WWD) activities for 2002, the Agency hosted the official WWD in Vienna on 22 March 2002. As part of the event, the Agency’s nuclear desalination activities were presented, which illustrated the significant contribution that nuclear desalination could make to producing urgently needed fresh water in several water-starved regions around the world.
- The Agency provided input to the World Health Organization (WHO) initiative to issue guidelines for drinking water quality from desalination plants. Safety guidelines for drinking water produced through nuclear desalination will be issued by the WHO (on water quality) and by the Agency (on safety-related issues of relevant technical installations).
- Information on the Agency’s activities on nuclear desalination was provided to the Nuclear Energy Agency of the Organisation for Economic Co-operation

- and Development (OECD/NEA). A representative of OECD/NEA participated in the INDAG meeting in July 2002.
- The Agency co-operated with the World Council of Nuclear Workers and the Moroccan Association of Nuclear Engineers to organize an International Conference on “Nuclear Desalination: Challenges and Options” in Marrakesh in October 2002.

C. Small and Medium-Sized Reactors

21. SMRs are of interest for desalination in many developing Member States because the production of fresh water requires considerably less thermal energy than is produced by large reactors. The projected demand for desalination is mainly in developing countries where SMRs are better suited to smaller electrical demands and transmission system capacities. Innovation is needed for SMRs, especially in terms of economic competitiveness.

C.1. Current and Future Activities

22. An international conference on the nuclear option in countries with small and medium electricity grids was organized in June 2002 in Dubrovnik, Croatia, by the Croatian Nuclear Society in co-operation with the Agency and sponsored by the European Nuclear Society. The conference was attended by 125 participants from 29 countries and provided an excellent forum for review and discussion of strategies for the introduction of SMRs in developing countries, technology transfer and international co-operation.

23. The Agency has co-ordinated the development of nuclear reactor simulators for use on personal computers, which simulate responses of a number of reactor types (boiling water reactors, PWRs and heavy water reactors) at operating and accident conditions. The purpose is to provide training tools for university professors and engineers involved in the nuclear sector. The simulator software has also been provided to students, engineers and scientists interested in broadening their understanding of the topic. Since 1997, 12 workshops have been sponsored by the ICTP. In 2002, two workshops were held: the first in March was attended by 41 participants from 30 countries and the second in October was attended by 31 participants from 14 countries. The annual workshop for 2003 will be held at ICTP in October/November.

C.2. Extrabudgetary Contribution

24. The extrabudgetary resources received by the Agency since the forty-fifth session of the General Conference in 2001 for the implementation of activities relating to nuclear desalination and the development of SMRs, are summarized below:

1. Pakistan Atomic Energy Commission (\$5000)
2. Turkish Atomic Energy Authority (\$3000)
3. Tunisian Ministry of Scientific Research and Technology (\$3000)

C.3. Publications

25. Publications issued by the Agency since the report to the General Conference in 2001 include:

- Safety aspects of nuclear plants coupled with seawater desalination units, IAEA-TECDOC-1235, Vienna (2001)
- Status of design concepts of nuclear desalination plants, IAEA-TECDOC-1326, Vienna (2002)
- Market Potential for Non-electric Applications of Nuclear Energy, Technical Reports Series-410, Vienna (2002)
- Small and Medium-Sized Reactors: Status and Prospects, International Seminar, Cairo, Egypt, 27–31 May 2001, Proceedings, C&S Papers Series 14/P, Vienna (2002)
- Considerations in the development of safety requirements for innovative reactors: Application to modular high temperature gas cooled reactors, IAEA-TECDOC-1366, Vienna (2003)