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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(49)/RES/12 and GC(50)/RES/13, this document contains progress reports on the use of isotope hydrology for water resources management (Annex 1); Programme of Action for Cancer Therapy – PACT (Annex 2); support to the African Union's Pan African Tsetse and Trypanosomosis Eradication Campaign (AU-PATTEC) (Annex 3); nuclear power applications (Annex 4); Agency activities in the development of innovative nuclear technology (Annex 5) and producing potable water economically using small and medium sized nuclear reactors (Annex 6).
- In response to the request in General Conference resolution GC(50)/RES/13.B that the Director General report to the 51st session of the General Conference on innovative means of financing nuclear power as an option in meeting the energy needs of interested developing countries, the Secretariat has begun preparing a report on the subject. In February 2007, it invited experts to contribute to this task. The Secretariat plans to continue working on issues relevant to the financing of nuclear power with particular emphasis on developing countries, in order to provide Member States with a final report.
- Further information on the Agency's activities related to nuclear science, technology and applications can be found in the *Nuclear Technology Review 2007* (document GC(51)/INF/3), the Agency's *Annual Report 2006* (GC(51)/5), in particular the Technology section, and the *Technical Cooperation Report for 2006* (GC(51)/INF/4).

Recommended Action

- It is recommended that the Board take note of Annexes 1 – 6 of this report and authorize the Director General to submit the report to the General Conference at its fifty-first session.

Use of Isotope Hydrology for Water Resources Management

A. Background

1. At its forty-ninth session in September 2005, the General Conference, through resolution GC(49)/RES/12.B, requested the Director General to continue to strengthen the efforts directed towards fuller utilization of isotope and nuclear techniques for water resources development and management, through increased collaboration with national and other international organizations, to continue to help Member States to obtain easy access to isotopic analysis facilities, to continue its work on groundwater management, to strengthen activities which contribute to the understanding of climate change and its impact on water resources, and to continue to develop human resources in Member States for the practice of isotope hydrology. It further requested the Director General to report on achievements in implementing resolution GC(49)/RES/12.B to the Board of Governors and to the General Conference at its fifty-first session.

B. Developments since the General Conference's 2005 Session

2. The 4th World Water Forum and Ministerial Conference was held in March 2006 in Mexico City, Mexico, and was attended by water ministers from over 80 countries. It called for greater commitment and more intensive actions to meet the safe drinking water goals of the Millennium Declaration and the Johannesburg Plan of Implementation. One of the major conclusions of the meeting was that a substantial increase of resources from all sources, including domestic funds, development assistance and other resources are needed to achieve these agreed water goals. Further, the meeting highlighted that governments have the primary role in promoting improved access to safe drinking water and basic sanitation. It was agreed that this can be best accomplished through the active involvement of all stakeholders, particularly the poorest sections of society, in improving governance at all levels and with enabling regulatory frameworks.

3. The United Nations' International Decade for Action, "Water for Life" (2005–2015) continued to focus worldwide efforts on increasing access to drinking water and sanitation. The Commission on Sustainable Development devoted its 13th session to policy initiatives related to water and sanitation.

4. The Secretariat made significant achievements in its efforts to bring isotope hydrology into the mainstream of national and international water resource related programmes. The Agency held an International Symposium on Advances in Isotope Hydrology and its Role in Sustainable Water Resources Management in Vienna from 21 to 25 May 2007. A record number of nearly 300 participants from 65 countries participated in this symposium. A number of presentations

provided a detailed review of the IAEA-assisted projects where isotope techniques were used for water resources management in Member States.

5. Support to Member States in the area of water resources management remains a major thrust of the Agency's programme. The Agency's assistance continued to focus on helping Member States gain a better understanding and quantifiable estimates of groundwater and surface water resources and design and implement national strategies for the rational exploitation and management of these resources. In this area, 90 technical cooperation projects were operational in the 2005–2006 programme cycle and 105 are operational in 2007. Over \$7 million were disbursed to this end under technical cooperation projects in 2005–2006. The budget approved by the Board of Governors for water resources projects under the Technical Cooperation Fund for 2007–2008 amounts to \$8.1 million.

6. Facilitating the use of isotopes to gain an improved understanding of the water cycle continues to be a priority. A coordinated research project (CRP) designed to expand the knowledge base to improve sustainable management of river basins was completed in 2006. Seventeen research teams developed a unique set of isotope data in rivers that can be used to improve the understanding of groundwater/river interactions, river water balance and human impacts on river discharge under present and future climate conditions. Isotope based monitoring of river hydrology is a cost effective and scientifically sound option to classical approaches based on the measurement of river discharge. This work has provided the rationale for the continuous collection of river isotope data in a Global Network of Isotopes in Rivers.

B.1. Groundwater Management

7. The Agency's collaboration with the UNDP, the Global Environment Facility (GEF), and the World Bank was strengthened with projects in Africa and Asia. As a result of successful cooperation between the Agency and the World Bank, the Bangladesh Atomic Energy Commission signed a memorandum of understanding with the World Bank's Bangladesh Arsenic Mitigation and Water Supply project in Bangladesh to facilitate the use of isotopes for mitigating the effects of arsenic poisoning of aquifers used for drinking water supply.

8. Special efforts were devoted to building partnerships and strengthening collaborative relationships with other UN organizations in support of sub-regional initiatives in Africa consistent with Member States' approaches to implementing programmes related to shared aquifers. Under an ongoing technical cooperation project, an important contribution to the understanding of the water balance of Lake Victoria has been achieved through a cooperative approach involving Kenya, United Republic of Tanzania and Uganda. The project has highlighted the crucial need for the inclusion of a groundwater component for understanding the shared Nile resources. As follow up, a medium-sized project proposal on mainstreaming groundwater considerations into the integrated management of the Nile River Basin was formulated in conjunction with the UNDP and the countries concerned (Burundi, Democratic Republic of the Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, United Republic of Tanzania, and Uganda). The project, which is to be co-funded by GEF to the level of \$1 000 000, will provide the scientific basis and necessary institutional and policy support for incorporating for the first time at large scale the groundwater dimension into planning and management of the Nile Basin.

9. The GEF-funded medium sized project for the "Formulation of an Action Programme for the Integrated Management of the Shared Nubian Aquifer" involving Chad, Egypt,

Libyan Arab Jamahiriya and Sudan was officially launched in 2006, with the Agency as its Executing Agency. An implementation plan agreed upon by counterparts and stakeholders maps out activities to be undertaken over the 30-month life of the project.

10. Two programmes for improved training and education in isotope hydrology were established within the framework of the IAEA/UNESCO Joint International Isotopes in Hydrology Programme. A graduate degree programme in isotope hydrology was established at the UNESCO–IHE Institute for Water Education in Delft, Netherlands. A one month isotope hydrology training programme for Latin American water professionals was established at the University of Montevideo which will now be offered on a yearly basis under the technical guidance and sponsorship of the Agency.

11. The Agency with UNESCO and the World Meteorological Organization co-authored a chapter in the second edition of the United Nations' *World Water Development Report* that was released at the 4th World Water Forum in March 2006.

12. Special technical sessions on the use of isotopes for river basin and groundwater management were organized and co-sponsored by the Agency at the European Geosciences Union meeting held in March 2006 in Vienna.

13. The Agency and the US Geological Survey — with a staff of nearly 4000 in its water resources division — signed a memorandum of understanding for increased cooperation and collaboration.

B.2. Easier Access to Isotope Analysis

14. One major objective of the Agency's water resources programme is to enhance the capacities of Member State laboratories to produce reliable analytical data for addressing national and regional water resource issues. To improve the quality of such data analysis, Agency staff assisted laboratory managers from Egypt, El Salvador, Morocco, Pakistan and South Africa to harmonize procedures for data handling and develop protocols for quality assurance and control.

15. The ability of Member States to collect and analyse water samples for stable isotope and tritium analysis was improved. For over 40 years, the Agency's technical cooperation programme has provided high-density polyethylene bottles to Member States for collecting water samples at substantial cost and potential delays in project implementation. A number of locally purchased bottle types from countries in Africa, Asia, and Latin America were tested. These tests demonstrated that a wide range of bottle types may be used for sampling, as long as the samples are analysed within three months after collection, suggesting that considerable savings can be made in future.

16. The Agency worked in cooperation with the manufacturer of a new machine for isotope analysis that uses a laser spectroscopy technique. Test results lead to further improvements in the machine that would make it suitable for use in most Member States. The laser machine costs about a quarter as much as existing mass spectrometers and, most importantly, performs the analysis with very low operation and maintenance costs.

17. The capacities of twelve Member States (Bangladesh, China, India, Indonesia, Republic of Korea, Malaysia, Mongolia, New Zealand, Pakistan, Philippines, Thailand and Vietnam) were strengthened in carrying out inter-laboratory comparison exercises and stable isotope measurements of water through project RAS/8/092 "Investigating Environment and Water Resources in Geothermal Areas (RCA)".

B.3. Impact of Climate Change on Water Resources

18. The use and availability of global isotope data for precipitation, rivers, lakes and groundwater, required to better understand and monitor the impact of climate change on the water cycle, was substantially improved. A compilation and synthesis of isotope data in Africa was carried out to develop an atlas of isotope hydrology, which provides access to data collected over the past 50 years.

19. A CRP entitled "Geostatistical analysis of spatial isotope variability to map the sources of water for hydrology" was initiated to develop protocols for visualizing, integrating, and mapping hydrological, hydro-chemical and isotope data.

20. A methodology to determine the sustainability of aquifers and rivers under conditions of increased water use and climate change by using the tritium–helium-3 isotope pair was tested and improved through a demonstration project as part of an on-going CRP.

21. The Agency's Water Resources Programme provided technical expertise to GEF's Scientific and Technical Advisory Panel for the theme of "Managing Aquifer Recharge". This theme, which includes activities related to the artificial recharge of groundwater, is important for Member States in arid and semi-arid climates, particularly in the context of climate change.

22. Formulation of GEF-funded projects related to the adaptation of water resources management practices to potential impacts of climate change was initiated. These projects would aim to use isotope data to characterize potential changes in aquifer recharge and river flow due to changing climate and develop appropriate models and monitoring schemes to cope with consequent changes in water availability.

B.4. Support to Capacity Building and Human Resources Development

23. Human resources development continued to receive special attention as the main vehicle for Agency technology transfer in the field of water resources management. Training activities were mainly directed towards meeting specific needs of Member States within the framework of project implementation. In 2005–2006, 221 scientists and technicians were trained in isotope hydrology techniques through fellowship training, scientific visits, and participation in training courses. Furthermore, a total of 224 water specialists participated in 21 meetings organized by the Agency.

24. Under a regional technical cooperation project, the Agency assisted 29 African Member States in developing the expertise in isotope hydrology that is required for the management of water resources. As part of this effort, a regional training course was jointly organized in 2006 by the Agency and Argonne National Laboratory, USA. The course, attended by 14 practising hydrologists, had a major technology transfer component and focused on national water resource assessment by the integration of isotope techniques in the water resources management practices.

25. Likewise, extensive regional training programmes on field techniques, data interpretation, application of isotope and geochemical techniques and quality assurance for chemical analyses were held for Central American Member States (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama).

26. Audio-visual material was developed to support training of Member State scientists to collect and analyse water samples for isotope analysis. This tool will help to improve the quality of data collected in Agency-sponsored projects and will streamline training by increasing the impact and reducing the need for basic level isotope hydrology training courses.

27. The dissemination of technical information to and within Member States was made easier through a set of Internet-based data management tools. This package of tools offers possibilities for presenting and analysing worldwide geo-referenced isotope and hydrochemical data, and will enable Member States to improve their ability to use and integrate isotope hydrology in their water sector.

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

A. Background

1. At its fiftieth regular session in September 2006, the General Conference in its resolution GC(50)/RES/13.A.2, requested the Director General to continue to advocate, build support, and allocate and mobilize resources for the implementation of the Programme of Action for Cancer Therapy (PACT) as one of the priorities of the Agency. It welcomed, inter alia, the number of imPACT missions conducted in Member States and the plan to establish PACT Model Demonstration Sites (PMDSs), and noted the intention of the Secretariat to establish Networks for Regional Cancer Training in each region. It encouraged the PACT Programme Office (PPO) to enter into public-private partnerships at the country, the regional and the global level in order to accelerate expansion and widespread access to sustainable cancer therapy services in low and middle income countries. It also urged the Director General to seek and strengthen the Agency's involvement in international partnerships with non-traditional donors to further pursue, develop and implement PACT, and requested that he continue formalizing, where feasible and appropriate, PACT's collaboration with partners already identified for the benefit of more effective development and implementation of country-level PACT projects. It encouraged the Director General to continue consultations with the Director General of the World Health Organization (WHO) on the feasibility of a joint programme for cancer prevention, control, treatment and research as well as the best means to partner in the implementation of PACT, and recommended that, at an early stage, the PPO, in consultation with relevant Agency departments and WHO, continue to develop tools to assist developing Member States in establishing national plans and strengthening their capabilities to enhance the benefits to be achieved from the implementation of PACT. The General Conference invited Member States, interested organisations, private donors and other non-traditional donors to contribute to the implementation of PACT and requested the Secretariat to keep Member States informed about its efforts in this regard. The Director General was requested to report on the implementation of this resolution to the General Conference at its fifty-first regular session.

B. Cooperation with Member States in Strengthening Capabilities to Fight Cancer

2. Since September 2006, the PPO, in addition to focusing its efforts on the six PMDS projects, has contributed to strengthening Member State capabilities to fight cancer in collaboration with international partners, donors, and through the technical cooperation (TC) programme, by facilitating the training of over 450 professionals working in the cancer care field through a variety of awareness raising and knowledge transfer activities. For example, using in-kind contributions from the US National Cancer Institute (NCI), PACT facilitated the participation of 29 professionals in a summer

training course in the United States of America to learn about cancer prevention and control. PACT also supported the participation of six persons in a training course in France organized by the International Agency for Research on Cancer (IARC) on cancer registration and epidemiology; and 20 persons from Kenya, the United Republic of Tanzania and Uganda, who participated in a workshop organized jointly by the International Network for Cancer Treatment and Research (INCTR) and PPO with funds from NCI and PACT to assess each country's cancer care needs and develop thematic strategies on palliative care. In addition, through the TC programme 5 participants from the United Republic of Tanzania received training in radiation oncology, medical physics and radiation therapy technology in Canada and South Africa with funds raised by PACT.

3. In June 2007, the IAEA Nobel Cancer and Nutrition Fund supported a special training course on Quality Assurance of Physical and Technical Aspects in Radiotherapy that was attended by 16 participants from Africa and held at the US Argonne National Laboratory. Additionally, three IAEA Nobel Cancer and Nutrition Fund "Special Events" were held for Africa (Cape Town), Asia (Bangkok) and Latin America (Buenos Aires), as well as a Forum on Cancer Control in Africa, helping to strengthen awareness among policy makers and the public at large about the looming cancer crisis. Practical training was also provided to specialists at these events to enhance their knowledge and skills through modules on comprehensive cancer control, evidence-based radiation oncology, clinical research, education and training, and emerging techniques in radiotherapy planning and delivery.

4. In coordination with the Department of Technical Cooperation, the PPO conducted post-impACT missions in Albania, Nicaragua, the United Republic of Tanzania, and Yemen and pre-impACT missions in Montenegro and the Syrian Arab Republic. Requests for impACT missions have been received from approximately 40 Member States. The impACT missions, in addition to assessing the national burden posed by cancer and the status of cancer-related planning, resources and capabilities also represent joint international efforts with a view to providing capacity building opportunities in training and increasing public awareness. In this process, approximately 100 individuals received training on various aspects of cancer control planning. To aid Member States in assessing their national cancer burden, a self-assessment questionnaire and an analytical tool was developed that is now used in advance of impACT missions to help establish baseline data about each country.

5. Offers to collaborate with PACT have been received from over 22 Member States¹. Cancer institutions from these Member States have made their facilities including their relevant hospitals and educational centres available in response to the General Conference's call for support to PACT. The PPO has visited a number of relevant institutions in some of these Member States to brief their management on PACT plans and to explore potential areas of collaboration. In line with the Board's approval of PACT in June 2004 as recommended in document GOV/2004/39, many of these institutions are seen to have the potential to act as regional centres of excellence for cancer training and education in due course.

6. The PPO has proposed to develop with interested partners a programme framework and specific funding proposal to establish regional centres for multidisciplinary cancer control training, called *Regional Cancer Training Networks*. These regional centres would serve as hubs providing training to develop sustainable indigenous cancer control capacities and promoting the expansion of cancer control centres and programmes within the 'mentor' country and region. 'Multidisciplinary' in this context refers to training and capability development in all major areas of cancer control, including

¹ Algeria, Argentina, Cuba, France, Greece, Hungary, India, Israel, the Republic of Korea, Malaysia, Monaco, Morocco, Pakistan, Philippines, Poland, Russian Federation, South Africa, Spain, Thailand, Tunisia, Uruguay, and the USA.

cancer epidemiology/registration, prevention, screening and early detection, diagnosis, treatment, palliation, cancer society building, advocacy, public education, fundraising, and policy.

7. The main goals of *Regional Cancer Training Networks* are to expand the indigenous, local ability in each participating country to train all cancer control professionals and replacement staff for its existing cancer centres, to have the capacity to offer training for additional professionals to support new centres, and to act as a regional hubs for training and mentorship throughout the region. The short-term objective is to develop a pilot framework and proposal during 2008–2009 to be applied in a single region, and to submit this proposal for funding. The pilot region will be selected on the basis of evidence-based factors indicating that cancer is presently, or in future, will become, a major impediment to economic development in the region, and that donor interest and support, as well as cooperation with local and regional partners will be available and sufficient to ensure the success of the effort. In order to effectively transform the vision of Regional Cancer Training Networks to fruition and into a comprehensive, multidisciplinary funding proposal, discussions and planning with the host countries and with other PACT partners are envisaged for 2008.

C. Building Partnerships

8. The PPO also worked with the University of Oxford's Africa consortium AfrOx in organizing a “Forum on Cancer Control in Africa” with the participation of health ministers, over 130 prominent cancer experts, policy makers, donors, and other senior officials from 19 African countries to discuss strategies for assisting African countries in the development of sustainable models for comprehensive national cancer control planning. The Forum, in its “London Declaration on Cancer Control in Africa”, called on research institutions, international organizations, industry, national governments and civil society in developed and developing countries to work together to enable the delivery of comprehensive cancer care in Africa.

9. Model Practical Arrangements (PAs) with partners, building on those agreed by a memorandum of understanding between PACT and the WHO Regional Office for the Eastern Mediterranean (EMRO), have been developed to enhance collaboration in providing assistance to Member States. Such PAs are planned to be signed between the Agency and PACT's international partners. With the same objectives, PACT recently entered into partnerships with three new organizations to expand collaboration among Member States and organizations working to address cancer needs.²

10. The consolidation of PACT partnerships since the General Conference in 2006 has enabled PPO to organize activities in close cooperation with recipient governments, the corresponding national atomic energy commissions and ministries of health, regional training institutes and other regional organizations. Support and participation has been provided by PACT's partner organizations, such as the World Health Organization (WHO), the International Agency for Research on Cancer (IARC), the International Union Against Cancer (UICC), the US National Cancer Institute (NCI), the American Cancer Society (ACS), the International Network for Cancer Treatment and Research (INCTR), the French National Cancer Institute (INCa), University of Oxford, Open Society Institute (OSI), Tata Memorial Centre of India, and MDS Nordion.

² National Cancer Institute (INCa), Breast Health Global Initiative (BHGI), National Foundation for Cancer Research (NFCR).

D. Working with WHO

11. The World Health Assembly in its May 2005 resolution on cancer prevention and control (resolution WHA58.22) requested the Director-General of WHO to explore the feasibility of initiating the development of a joint programme between WHO and the Agency for cancer prevention, control, treatment and research. The PPO has continued working with WHO Geneva, IARC and the WHO Regional Offices to strengthen collaboration. In the process of launching the new Global Action Plan against Cancer during the May 2007 World Health Assembly, as well as in WHO's latest publication entitled *WHO Fights Cancer*, the IAEA's role in fighting cancer was acknowledged, and WHO's collaboration with PACT within the PMDS was highlighted. The promising developments in the cooperation with between the Agency and the WHO in this important area may be further utilised towards a joint programme on cancer control.

12. WHO Regional Offices that were represented at the IAEA Nobel Cancer and Nutrition Fund "Special Events", gave lectures, and delivered messages from their respective Regional Directors. WHO sent representatives to the AfrOx-PACT Forum on Cancer Control in Africa, and discussions are currently underway with WHO to organize a similar event for the Europe region. Additionally, WHO country representatives participated in all of the Nobel Cancer and Nutrition Fund "Special Events" and in PMDS missions. There are good prospects for increasing collaboration with WHO Regional Offices as these are enhancing their assistance to concerned governments in setting up cancer control strategies and activities throughout the WHO regions, beginning with the Regional Offices in Africa and Europe. These encouraging developments will enable PACT to formalize its partnership with WHO and other key agencies in due course, in line with the provisions of resolution GC(50)/RES/13.A.2.

E. PACT Model Demonstration Sites

13. In a joint effort with its international partners, the PPO is in the process of establishing PMDSs in six Member States: Albania, Nicaragua, Sri Lanka, United Republic of Tanzania, Vietnam and Yemen. The main project activities focus on cancer prevention, early detection, registration, treatment, palliation and building a civic-based cancer society. These projects are expected to demonstrate the advantages of cross-sector collaboration in meeting the specific requirements of the PMDSs, as identified during the imPACT reviews, and encourage interested donors to support cancer control efforts in the PMDSs.

14. The Agency's contribution to these efforts includes the provision of radiation medicine-related assistance through TC projects, with the expectation that funding for each PMDS will come from various sources, including domestic and external donors, as well as radiotherapy machine manufacturers. In this connection the PPO maintains contact with the industry to solicit donations of equipment, products and services and particularly, in view of future needs in developing countries, to encourage manufacturers to develop affordable and accessible treatment technologies that are suitable to low-resource situations.

15. Progress in PMDS projects is evidenced by the formation of national steering committees by the ministries of health for four PMDSs; work plans have been developed and are being implemented in several PMDSs. Two radiotherapy machines donated to PACT have been delivered and installed in Nicaragua and United Republic of Tanzania. An additional cobalt-60 machine has been delivered and installed in Albania through joint financing. Work is ongoing in connection with a fourth radiotherapy machine, donated by the Government of India, which is planned to be installed in an Asian country.

F. Funding and Fundraising

16. PACT's fundraising efforts secured a number of significant pledges, grants and donations, amounting to over \$3 million, and more than \$1 million has been received from Member States from their individual allocations of the 2004 cash surplus. So far, contributions or firm commitments have been received from the following Member States: Albania, Canada, Croatia, the Czech Republic, Hungary, Monaco, New Zealand, Norway, Poland, Spain, Switzerland and the United States. In addition, institutions such as the National Cancer Institute and the OPEC Fund for International Development have made pledges and grants. The IAEA Nobel Cancer and Nutrition Fund has also been used to support PACT's programme activities. Of the \$3 million, more than \$2 million have been donated for PACT's programme activities in PMDS, particularly Nicaragua and Tanzania, and more than \$1 million has been received from Member States as contributions from the 2004 cash surplus. In response to a joint PACT-TC proposal, the OPEC Fund for International Development has also pledged an additional amount of \$300 000 for a TC footnote a/ project in Uruguay to upgrade their radiotherapy services. PACT's implementing partners also helped finance activities through in-kind support for training, PMDS missions and technical support to Member States including support from ACS and NCI.

17. The Government of Japan is providing PACT with a cancer expert. Additional staff in the form of cost-free experts or volunteers to work on PACT projects are expected from other Member States. The PPO has also presented proposals for funding to a number of bilateral donor agencies and expects some positive results either in terms of bilateral donations to cancer projects, or support of some of the PMDS projects. One of these, for example was favourably received by Health Canada, which donated CAD\$150,000 to the PMDS Tanzania. Additionally, the PPO has received financial support from the private sector to host special events such as PACT's collaboration with the University of Oxford's AfrOx, which enhances efforts to raise global awareness of the support needed for PACT's efforts.

18. The PPO is working to use non-traditional sources of funds to support its activities, and has initiated the development and implementation of a medium-term global fund raising strategy. The strategy will target foundations, bilateral and multilateral donors, as well as private sector and individual philanthropists. For this to be based on realistic opportunities, the Agency contracted a professional fundraising firm in May 2007 to assist and advise the PPO. This firm has already started its work and currently is conducting planning and feasibility studies needed to establish contacts with most interested donors. The PPO is pursuing three specific fundraising routes: one for the PMDSs with a target of €2–3 million per country within the next 3–4 years; the second focusing on introduction of cancer therapy in Africa with a specific larger scale proposal covering initially 10–15 sub-Saharan countries with a total of €45–60 million in the next 5–6 years, and the third a large proposal for increased capacity building in Member States with existing centres of competence to enable them serve their region, based on the *Regional Cancer Training Networks* concept described earlier. Some of the larger scale project proposals have already been presented and discussed with selected potential

donors. In addition, for donations below €10,000, in April 2007, a fundraising mechanism was launched on the PACT website (<http://www-naweb.iaea.org/pact>) for direct contributions, and the PPO is in the final stages of establishing an “endowment fund³” within the auspices of the US-based National Foundation for Cancer Research (NFCR) to increase its US-based fundraising potential.

G. Raising Awareness

19. Raising awareness about the global cancer burden in low and middle income countries is one of the greatest challenges facing PACT. The IAEA Nobel Cancer and Nutrition Fund “Special Events” held in Bangkok, Buenos Aires and Cape Town generated much public interest. They were covered extensively by the local and international media, helping to raise awareness about the IAEA’s work in fighting cancer, and PACT’s role. Participants of the “Special Events” in Cape Town and Buenos Aires signed declarations calling for greater support by the international community and donors to effectively mitigate the growing cancer burden in Africa and Latin America, and welcomed PACT’s assistance. Their appeals were reinforced by the messages of support from Nobel Peace Prize Laureates Nelson Mandela and Archbishop Desmond Tutu in the Cape Town event.

20. The London Declaration emanating from the Forum on Cancer Control in Africa reported above also contributed to raising awareness about the cancer crisis and of the need to find strategies for effective and sustainable solutions. African officials, health professionals, representatives of international organizations and cancer charities all agreed that such a Declaration was crucial towards building momentum and laying out the essential elements for comprehensive national cancer control programmes. This event too had wide-reaching international media coverage.

21. Special attention was given to upgrading and redesigning PACT’s website with news, description of regional and project activities and access to documents and partner websites. The PACT website has already received a substantial increase in the number of hits compared with last year. In addition, the PACT grant raising brochure is now published in three languages (English, French and Spanish) and promotional posters and publicity material have been produced in several languages. There has been a marked increase in the use of these promotional materials and documents by Member States’ cancer institutes and ministries of health.

³ Private giving abroad by U.S. foundations, corporations, voluntary organizations, universities and colleges, religious organizations, and individuals was at least \$95 billion in 2006. Nevertheless, most U.S. private donors, including virtually all foundations, will only contribute to organizations with tax deductible status under U.S. law. Section 501(c)(3) of the U.S. Internal Revenue Code which has provisions for granting exemption from the federal income tax to certain non-profit U.S. organizations dedicated to the support of charitable purposes and U.S. taxpayers making donations to such organizations derive a charitable tax deduction to their gross income. NFCR has had Section 501(c)(3) status in the U.S. since 1973 and a decision by its Board of Directors to establish an endowment fund for PACT will facilitate PACT’s fundraising in the U.S.

H. Challenges and Next Steps

22. Significant progress has been achieved on a number of fronts, particularly the establishment of partnerships that have enabled PACT to provide programming advice and support to Member States through working with its international partners in collaborating to developing funding strategies to support activities in the six PMDSs. However, the fundamental issues of cooperation with Member States to strengthen capabilities to fight cancer, funding and fundraising, strengthening partnerships and raising awareness remain, together with the need to fully establish the PMDSs and to work towards the implementation of regional cancer training networks.

23. The PPO has received over 40 requests from Member States to undertake imPACT assessment missions, which will be implemented as resources become available. This assessment and planning tool will be offered as an international multi-disciplinary service by the Agency similar to other needs assessment and review missions that the Agency conducts at Member States' request through the technical cooperation programme in other fields such as nuclear safety and security. The use of imPACT as a needs assessment and planning tool will assist the Agency to provide effective assistance to Member States in the development of integrated and comprehensive cancer control plans involving full participation of other international organizations and agencies. Only with comprehensive plans and projects in place, can it be expected that the PPO's approach to international donors to assist with additional funds will be successful.

24. The PPO will focus its efforts in 2008 and beyond on a wide-scale awareness and fundraising campaign for the PMDSs based on a fundraising plan and strategy being developed with the support of a professional fundraising firm. PACT estimates around €20 million will be required over the next three years to enable implementation of its three-prong approach to fighting and reducing the burden of cancer in the six PMDS countries and to initiate new efforts in others. Mindful of its emphasis on the significance and impact of public-private partnerships, PACT is seeking support from the private sector. To engage foundations, philanthropists and corporations, within the next few months the PPO will ask the fundraising firm to conduct strategic interviews with over 120 selected potential donors and supporters of PACT around the globe among these groups. This effort will be crucial in developing the direction and potential of PACT and in determining the success of the IAEA as a leading organisation and facilitator in the area of cancer control plans and programmes in the developing world. In addition, the PPO will continue pursuing its Africa proposal with major donors and interested governments based on the outcome of the London Cancer Forum for Africa reported above. Active participation and active support from Member States and their respective national institutions would help this proposal to materialize some basic aspirations of African nations for improved and expanded cancer care services, and the quality of life for patients. Continued support to PACT from Member States, especially from non-traditional sources, will strengthen its ability to perform its duties and implement its plans to support a wider range of Member States in an efficient and consistent manner. For the purpose of providing PACT with the human resources required for the implementation of projects using extrabudgetary funds, a provision was included in the Agency's Human Health Programme for 2008 and 2009 to cover a portion of PACT's requirements in this regard (document GC(51)/2 refers).

25. In order to facilitate communication and collaboration with partner organizations through the utilization of standardized formats for proposals and reporting, the PPO has developed web-based mechanisms using other UN agencies' practices. It is envisioned that such mechanisms will lead to

improved standardization and continuity; improved documentation of achievements and challenges; increased transparency and efficiency; strengthened capacity to monitor and report to stakeholders and donors; and the development of replicable project management tools. Currently, the PPO is testing the mechanisms for the PMDS in Nicaragua. When each partner has used the system via the PACT website and found it satisfactory for their purposes, the procedures will be replicated for the other PMDSs as a structured management framework.

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

A. Background

1. At its fiftieth session in September 2006, the General Conference, through resolution GC(50)/RES/13.A.4, demonstrated its appreciation for the continuous support of the Agency to Member States in their efforts to build capacity and further develop the techniques for applying the sterile insect technique (SIT) in creating tsetse-free zones in Africa. The General Conference called upon Member States to strengthen the provision of technical, financial and material support to African States in their efforts to create tsetse-free zones. It requested that the Secretariat, in cooperation with Member States and international organizations, continue to support R&D and technology transfer to African Member States in order to complement their efforts to create and subsequently expand tsetse-free zones. It stressed the need for continued cooperation with the Commission of the African Union and other regional and international partners with the aim of harmonizing efforts in line with the AU's PATTEC Plan of Action. It requested the Director General to report on the progress made in the implementation of resolution GC(50)/RES/13.A.4 to the Board of Governors and to the General Conference at its fifty-first (2007) regular session.

B. Developments since the General Conference's 2006 Session

2. One of the main areas of Agency assistance to agricultural development in African Member States was the transfer of SIT in the context of area-wide integrated pest management (AW-IPM) to create in selected areas zones that are free of tsetse flies and the disease they transmit. In this context, the Agency continued to contribute to the implementation of the PATTEC Plan of Action through one regional, and ten national technical cooperation projects in Botswana, Burkina Faso, Ethiopia, Kenya, Mali, Senegal, South Africa, Uganda, United Republic of Tanzania and Zimbabwe. Under these projects and within the Agency's regulations for providing technical cooperation (TC) support to Member States, the Agency implemented technology transfer to the Member States to enable feasibility assessment, capacity building and pre-operational support on tsetse SIT, largely through provision of training, expert services and equipment.

3. Coordinated through PATTEC, six tsetse and trypanosomosis (T&T) affected Member States (Burkina Faso, Ethiopia, Ghana, Kenya, Mali and Uganda, referred to as the six 'PATTEC List-I' countries) were successful in 2004–2005 in securing a total of about \$80 million from the African Development Bank (AfDB) in support of national efforts to create T&T-free zones and for related agricultural development. At several international meetings, the FAO, WHO, and the Agency, within their respective mandates, offered coordinated technical assistance to these countries and underlined the need to review some of the projects in an effort to generate more realistic objectives and achievable timelines for generating progress with the available resources.

4. In February 2007, PATTEC and AfDB organized a special donors' conference in Addis Ababa to generate further loans and grants for additional countries embarking on sub-regional T&T control programmes. At the conference the Agency and FAO underlined the advantages of following a phased and conditional planning and implementation approach for the AfDB-supported and other PATTEC projects, as described in the documents resulting from the Agency's "Tsetse — the Way Forward" process, outlining the Agency's guiding principles for support to tsetse-affected Member States.

5. In December 2006 and January 2007, the Secretariat carried out, at the senior management level, annual reviews to assess progress made in implementing the "Tsetse — the Way Forward" process. The main recommendations emanating from the review emphasize the necessity of (i) providing capacity building and training of project staff on technical and, particularly, management and related aspects; (ii) collaborating with PATTEC with increased involvement of other international partners, particularly FAO and WHO, in an effort to provide some objective and impartial quality assurance regarding the planning and utilization of the available and requested substantial funds; (iii) continuing Agency commitment to the development and maintenance of seed and operational tsetse colonies; and (iv) producing — in partnership with other relevant UN agencies — documentation to generate awareness and describe for decision makers at regional and national levels the process to assess the feasibility of creating tsetse-free zones with the current available technologies, and where SIT, as part of an AW-IPM programme, may play a decisive role.

6. The major ongoing undertaking in sub-Saharan Africa with which the Agency is associated is the Southern Rift Valley Tsetse Eradication Project (STEP) in Ethiopia which aims to create a T&T-free zone in an area of 25 000 km², thereby generating an environment conducive to livestock development and improved agricultural production. The Agency continued to support STEP under TC project ETH/5/012 "Integrating Sterile Insect Technique for Tsetse Eradication". Agency staff served as members on the STEP steering committee and technical advisory committee.

7. In 2006, the Japan-funded United Nations Trust Fund for Human Security (UNTFHS) disbursed the first allotment of the total \$1.712 million for a two year project entitled "Establishing a Zone Free of the Tsetse and Trypanosomosis Problem in the Southern Rift Valley, Ethiopia, and Assisting Rural Communities in Agricultural and Livestock Development". The Agency is the executing agency and the FAO is an implementing partner. The Agency and FAO are currently implementing components under the first phase of this project. Furthermore, the Agency utilized \$1.6 million in extrabudgetary funds provided to the Agency by the US Government and additional funds amounting to \$95 000 received from China in support of up-scaling tsetse mass rearing activities under technical cooperation project ETH/5/012.

8. The funds contributed jointly by the United Nations Fund for International Partnerships (UNFIP) and the Government of the United States of America were used to help Member States in (i) developing geographic information system (GIS) based maps that are to be used in planning and management of tsetse and trypanosomosis intervention projects; (ii) generating standardized entomological baseline data; (iii) designing tsetse mass rearing facilities; (iv) supporting colonization of tsetse flies in STEP; and (v) the development of sub-regional intervention strategies for tsetse and the diseases it transmits. In addition, procurements were made for the development of a general computer based training package on using Global Positioning System (GPS) instruments and GIS techniques in data management for insect pest control programmes and to assist Member States by providing IT equipment for GIS work and miscellaneous rearing equipment and supplies. Future activities planned in 2007 to be supported by these funds include guidance and training in project management practices; a regional training course on standardized sampling and processing of tsetse flies for population genetic and morphometric analyses; and to finalize guidelines for Member States on the suitable location of, and required design and equipment for, tsetse mass rearing facilities.

9. The Ethiopian authorities organized an official inauguration ceremony of the STEP tsetse rearing and irradiation centre at Kaliti, Addis Ababa, on 3 February 2007, subsequent to the PATTEC special donors' conference. This enabled delegates from T&T affected Member States, as well as donor representatives to participate in the ceremony and visit the largest tsetse fly facility so far constructed. Although in 2006 there was a steady increase in the colony size of the main tsetse fly species in the STEP work area, namely *Glossina pallidipes*, substantial efforts still need to be invested to reach the number of mass reared tsetse flies needed for eventually initiating the operational SIT phase. In May 2007, first test releases of sterile male tsetse flies, derived from the Kaliti colony, were successfully conducted to assess the performance of the sterile flies in the field.

10. Besides support to improved tsetse fly mass-rearing, the Agency also used the available TC core funds and extrabudgetary resources to prepare the field activities for the first operational phase of STEP. This included expert advice on routine, standardized, entomological monitoring activities. A key issue that remains to be addressed by STEP and the Ethiopian authorities is to assess the feasibility and develop a policy for the aerial spraying of non-persistent insecticides for area-wide tsetse fly suppression operations. Repeated area-wide tsetse suppression applied over the entire target area is a prerequisite for the initiation of operational sterile male releases.

11. Under a technical cooperation project, the Agency assisted national counterparts in undertaking a comprehensive study on the various components and prerequisites for including SIT in an AW-IPM programme aimed at creating a zone free of *Glossina brevipalpis* and *Glossina austeni* in KwaZulu-Natal, South Africa. The feasibility study document includes a proposed strategy to go forward with the eradication programme as well as the modalities for the necessary involvement of Mozambique.

12. A project coordination meeting of PATTEC List-I country national counterparts of the Agency's supported TC projects was held in Vienna 16–18 July 2007, within the framework of the regional project RAF/5/051 "Sterile Insect Technique for Area-wide Tsetse and Trypanosomosis Management". Counterparts from T&T affected Member States and also representatives from PATTEC, FAO, WHO) participated. The meeting reviewed the status and progress made under the AfDB-supported PATTEC List-I country programmes and discussed specific support that FAO, WHO and the Agency can provide to these projects within their respective mandates by following a phased and conditional planning and implementation approach.

13. The Agency continued to foster partnerships for PATTEC through its interaction — alongside other mandated United Nations organizations (notably FAO and WHO) and other stakeholders — in the PAAT forum. Agency staff also used PAAT and other international meetings to inform counterparts, collaborators and partner institutions of the focused contributions of the Agency to the Member States' efforts against the T&T problem, as specified in the Agency's "Tsetse — The Way Forward" policy documents. These meetings included — besides the above-mentioned PATTEC special donors' conference and the meeting of national coordinators — the 12th meeting of the PAAT Advisory Group (Kasane, Botswana, 18–19 October 2006) and the 11th PAAT Programme Committee meeting (Geneva, Switzerland, 24–25 April 2007).

14. Agency staff and collaborating researchers participating in the coordinated research project (CRP) on improved and harmonized quality control for expanded tsetse production, sterilization and field application met in Nairobi, Kenya, 7–11 May 2007 and presented progress on research findings and methods developed to further streamline and standardize some laborious, time-consuming and quality-sensitive steps of tsetse mass-production. Following a consultants meeting, the Agency initiated in early 2007, a new CRP on improving SIT for tsetse flies through research on their symbionts and pathogens. A key topic to be addressed under this new CRP is to build on and further enhance substantial progress made in 2006 at the FAO/IAEA Agriculture and Biotechnology

Laboratory on sequencing the genome of a tsetse salivary gland virus and other efforts to develop virus management techniques in support of improved tsetse mass-rearing. A consultants meeting on applying geographic information systems (GISs) and population genetics was held in Vienna, Austria, 16–20 April 2007. The meeting explored the feasibility of developing a new CRP on using GIS techniques together with genetic and morphometric analyses as a tool for improved planning of SIT-based AW-IPM programmes against key livestock pests, namely tsetse flies and screwworm flies.

15. Based on comments received from various African collaborators, a new part on the basic biology and anatomy of the tsetse fly was added to the *FAO/IAEA Guidelines for Collection of Tsetse Baseline Data for Area-wide Integrated Pest Management Programmes*. These FAO/IAEA guidelines will serve as the basis for a second PATTEC/FAO/IAEA regional training course on standardized baseline data collection which is planned for 2008 in Dakar, Senegal. Another PATTEC/FAO/IAEA regional training course on standardized collection and processing of tsetse flies for molecular tsetse population genetic and morphometric analyses is planned November 2007 in Tororo, Uganda. Furthermore, a regional workshop on area-wide tsetse population suppression in preparation of tsetse-SIT operations is scheduled to be held in late 2007 or early 2008.

16. The Agency conducted a validation exercise on the latest model of the semi-automated tsetse fly holding, feeding and production unit (TPU 3.2) at the FAO/IAEA Agriculture and Biotechnology Laboratory at Seibersdorf, Austria. The work resulted in some minor technical adjustments and design modifications, which have improved fly survival and productivity. The technical adjustments and design modifications identified have already been incorporated into the equipment at the Ethiopian Kaliti Tsetse Rearing and Irradiation Centre.

17. The Agency completed a comprehensive analysis on the lessons learned from various AW-IPM projects with an SIT component. The general guidelines of this analysis have been summarized in a paper that is being published in a new textbook entitled *Area-wide control of insect pests — from research to field implementation*.

18. All current tsetse SIT operations depend on the availability of caesium-137 or cobalt-60 gamma irradiators for reproductive sterilization of males and for decontamination of locally collected blood for feeding tsetse fly colonies. As the purchase and international transport of gamma irradiators is facing increasing restrictions, the Agency and FAO have started exploring alternatives. With regard to blood diet decontamination, several alternative methods were researched at the FAO/IAEA Agriculture and Biotechnology Laboratory at Seibersdorf, Austria. Currently the most promising alternative appears to be the use of ultraviolet irradiation. Concerning fly sterilization the Agency has purchased a small prototype high-dose X-ray irradiator to explore whether this provides a practical alternative to gamma-irradiation for insect sterilization. It is anticipated that, subject to the availability of funding for the procurement of full-scale test equipment, the Agency will be in a position to present the first test results at the end of 2008.

Nuclear Power Applications

1. This annex summarizes highlights of relevant nuclear power activities not covered in Annexes 5, 6 and 7, which address innovative financing of nuclear power in developing countries, innovative nuclear technologies, and producing potable water using small and medium-sized reactors.
2. Each year, the Agency updates its low and high projections for global growth in nuclear power. In 2007 both the low and high projections were revised upwards. In the updated low projection, global nuclear power capacity reaches 447 GW(e) in 2030, compared to 370 GW(e) at the end of 2006. In the updated high projection it reaches 692 GW(e).
3. The Agency has seen a substantial increase in requests for assistance with national energy studies. It currently supports studies in 77 Member States. Twenty-nine of these studies are exploring nuclear energy as an option. One regional study (Estonia, Latvia, Lithuania) compared the costs and efficacy of various national and regional energy security measures. The main finding was that regional approaches would reduce costs substantially for all three countries.
4. The Agency attended the 12th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP-12), the 2nd meeting of the Parties to the Kyoto Protocol (CMP-2), the 15th session of the Commission on Sustainable Development (CSD-15) and the finalization of the 4th Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC).
5. Given significant developments in nuclear power around the world since the ministerial conference on the future of nuclear power in Paris in 2005, initial arrangements have been made for a second such meeting to be held in China in 2009.
6. To assist Member States, the Secretariat summarized the most important issues that need to be considered by States in the context of establishing a nuclear power programme in a paper presented to the Board in March 2007 on 'Considerations to launch a nuclear power programme' (GOV/INF/2007/2), which was subsequently also published as a brochure.
7. The Agency held a workshop on issues for the introduction of nuclear power in December 2006 and has recently published several related technical documents, including *Basic infrastructure for a nuclear power project* (IAEA-TECDOC-1513, June 2006), *Potential for Sharing Nuclear Power Infrastructure between Countries* (IAEA-TECDOC-1522, October 2006), *Managing the First Nuclear Power Plant Project* (IAEA-TECDOC-1555, May 2007). Another, titled *Milestones in the Development of a National Nuclear Power Infrastructure*, is still in preparation. A workshop to discuss the milestones for nuclear power infrastructure development is scheduled to take place in November 2007. New technical cooperation (TC) projects have begun in seven Member States to provide direct advice on introducing nuclear power and setting up the necessary infrastructure. Two regional TC projects address the same topics.
8. The Agency works with other international organizations on plant life management (PLiM) for long term operation. Two coordinated research projects (CRPs) are run jointly with the European Commission's Joint Research Centre's (JRC's) Institute for Energy on the master curve approach to monitor fracture toughness of reactor pressure vessels in nuclear power plants, and on the review and benchmark of calculation methods for structural integrity assessment of reactor pressure vessels (RPVs) during pressurized thermal shock (PTS). The OECD Nuclear Energy Agency published *Nuclear Power Plant Life Management for Long Term Operation* jointly with the Agency.

9. Interest in uranium exploration, mining and production has risen, driven partly by uranium price increases. The Agency has increased training activities and organized meetings in Argentina, China, India and Kazakhstan. A further meeting is scheduled to be held in Namibia in October 2007. The 2008–2009 biennium will include a further expansion of such activities and an international symposium on uranium exploration, mining, production and the longer term availability of uranium.

10. The global volume of stored spent fuel continues to increase, and expected storage periods continue to lengthen. Agency activities cover technology for spent fuel storage and the long term behaviour of spent fuel and storage components. It has recently published *Operation and Maintenance of Spent Fuel Storage and Transportation Casks/Containers* (IAEA-TECDOC-1532, January 2007), *Optimization Strategies for Cask Design and Container Loading in Long Term Spent Fuel Storage* (IAEA-TECDOC-1523, December 2006) and *Data Requirements and Maintenance of Records for Spent Fuel Management: A Review* (IAEA-TECDOC-1519, November 2006). *Selection of Away-from-Reactor Spent Fuel Storage Facilities* (IAEA-TECDOC-1558, 2007) will be published in autumn 2007. The Agency's Network of Centres of Excellence on Training and Demonstration in Underground Research Facilities, supported by six donor countries, will conduct training courses during 2007 on methods for geological disposal of spent fuel and high level waste, and modelling for performance assessment of such disposal facilities.

11. Worldwide, 245 research reactors are in operation. As many are underutilized, the Agency began a programme to stimulate alliances among operators to improve utilization and broaden the scope of services they provide. This will be a principal focus of the International Conference on Research Reactors: Safe Management and Effective Utilization being organized by the Agency in Sydney, Australia, in November 2007.

12. At the request of Member States, within the framework of the Global Threat Reduction Initiative (GTRI), the Reduced Enrichment for Research and Test Reactors (RERTR) programme, and the Russian Research Reactor Fuel Return (RRRFR) programme, the Agency assists Member States in converting research reactors from the use of high enriched uranium (HEU) to low enriched uranium (LEU) fuel and in shipping HEU fuel back to its country of origin. In 2006, under contracts arranged by the Agency, more than 300 kg of fresh HEU fuel were returned to the Russian Federation from Germany, Libyan Arab Jamahiriya and Poland. The Agency contracted for the repackaging and shipment of spent fuel from Serbia to the Russian Federation. One CRP has started on the conversion of miniature neutron source reactors with HEU cores. A second CRP addresses the use of LEU or neutron activation for small scale indigenous production of molybdenum-99. The Triga reactor in Pitești, Romania, and the RECH 1 facility in La Reina, Chile, were fully converted from HEU to LEU fuel in 2006 within the framework of national technical cooperation projects.

13. To help recover and condition spent high activity radioactive sources (SHARS), the Agency and several contractors developed and manufactured the 'SHARS Installation', a mobile hot cell. The first unit was manufactured in 2006 and a pilot operation was successfully performed and evaluated by a peer review team in South Africa in March 2007. Conditioning operations are planned in several African countries. Depending on progress in Africa, the infrastructure will be expanded to Latin America and Asia.

14. The Agency is assessing the potential of borehole disposal of disused sealed sources (BOSS) for countries that generate small volumes of radioactive waste and have no other disposal options, and for countries where, given the high radioactivity and long lived radionuclides typical of certain sealed sources, boreholes might be productively co-located with near-surface repositories. The technology is being transferred with TC support to Member States in different regions, including Africa, Asia and Latin America, and the Agency is preparing a detailed technical manual on this subject.

15. In June 2007, the Agency, in cooperation with the European Atomic Forum, the European Commission, the Japan Atomic Energy Agency, the Nuclear Energy Institute, the OECD Nuclear Energy Agency, the World Nuclear Association and the World Nuclear University, organized an International Conference on Knowledge Management in Nuclear Facilities. It reinforced the importance of nuclear knowledge management for maintaining core knowledge for safe operation, improving performance, pursuing innovation efficiently and training the next generation.

16. The Agency published *Knowledge Management for Nuclear Industry Operating Organizations* (IAEA-TECDOC-1510) in November 2006. Based on this publication, three nuclear knowledge management assist visits have been conducted in 2007 — to Ontario Power Generation (OPG) Darlington and Bruce Power in Canada, and to the Ignalina nuclear power plant in Lithuania.

17. The International Nuclear Library Network (INLN), coordinated by the IAEA Library, fosters the exchange of and access to nuclear information through international cooperation amongst nuclear libraries worldwide. The INLN welcomed one new member in 2006 and two more in 2007 for a total of eight partnering libraries.

Agency Activities in the Development of Innovative Nuclear Technology

A. Background

1. In September 2006, in resolution GC(50)/RES/13.B.1, the General Conference, conscious of the need for sustainable development and of the potential contribution of nuclear power to meeting growing energy needs in the 21st century and in line with similar previous resolutions, invited all interested Member States to contribute to innovative nuclear technology activities in terms of scientific and technical information, financial support or the support of technical and other relevant experts, and by performing joint innovative nuclear power system collaborative projects.
2. The General Conference also requested the Director General to report to the Board of Governors and to the General Conference at its fifty-first session on the progress made in the implementation of resolution GC(50)/RES/13.B.1, including the INPRO conclusions on refining of common user criteria for small and medium sized nuclear power reactors.

B. Developments since the General Conference's 2006 Session

B.1. International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

3. INPRO is an Agency-wide project, coordinated by the Department of Nuclear Energy with contributions from all relevant Agency Departments. Since 2004, INPRO has been funded partly by the Regular Budget, although it continues to be implemented using mainly extrabudgetary resources. INPRO became an Agency subprogramme in the 2006–2007 budget cycle.
4. As of July 2007, the following 27 Member States and one international organization are members of INPRO: Argentina, Armenia, Belarus, Belgium, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, France, Germany, India, Indonesia, Japan, Republic of Korea, Morocco, Netherlands, Pakistan, Russian Federation, Slovakia, South Africa, Spain, Switzerland, Turkey, Ukraine, USA and the European Commission (EC). Algeria and Kazakhstan have announced their intention to join INPRO.
5. Since INPRO began, a total of 32 cost-free experts from 15 INPRO member countries, have worked at the Agency as members of the INPRO International Coordinating Group. As of July 2007, 5 full-time and 3 part-time cost-free experts are working for INPRO in the Agency's Secretariat and two cost-free experts are expected to join INPRO before September 2007.
6. Implementation of Phase-2 of INPRO, covering three sets of activities (methodology finalization, activities addressing institutional and infrastructure issues, and collaborative projects) began in July 2006.

7. A nine-volume user manual (overview, economics, reactor safety, fuel cycle safety, environment, waste management, proliferation resistance, physical protection and infrastructure) will be published as a TECDOC in 2007. It will describe how the INPRO methodology should be applied for the assessment of innovative nuclear energy systems (INSs).

8. The INPRO methodology is currently being used in assessment studies by Argentina, Armenia, Brazil, China, France, India, Ukraine and the EC. It is also being used in a joint assessment of a closed fuel cycle with fast reactors by Canada, China, India, Japan, Republic of Korea, Russian Federation and Ukraine. The overall goal of these assessments is to identify those INSs that can best contribute to sustainable development under country, or region specific conditions. The assessments will also generate recommendations for future international collaborative projects addressing development needs for INSs, as well as providing feedback to further improve the INPRO methodology.

9. With regard to activities addressing institutional and infrastructure issues in connection with the development of nuclear power reactors designed to reflect the needs of developing countries, INPRO has begun working on common user criteria (CUC) and actions with respect to the development and deployment of nuclear power plants in developing countries. Its objective is to facilitate understanding between technology users and holders by fostering information exchange about users' needs and joint consideration of the actions necessary to fulfil those needs. This new task was endorsed by the INPRO Steering Committee in December 2006, with the specific support of Canada, China, France, Republic of Korea, Russia and the USA.

10. The common user criteria task will be carried out in two stages over two years (from January 2007 to December 2008). The first stage (2007) involves establishing CUC. These CUC will cover the common characteristics required by potential users, including general technical and economic characteristics of nuclear power reactors as well as associated infrastructure and institutional factors. In the second stage (2008), the steps required for planning the development and deployment of different options (including different fuel cycle options) will be defined jointly by technology holders and users. The second stage will also identify options and designs (including different power levels, coolants and design characteristics) in addition to the institutional and infrastructure arrangements that will assist deployment and help achieve sustainable use of nuclear energy.

11. In order to carry out the first stage of the CUC task, INPRO teams will visit a selected group of developing countries, chosen on the basis of their specific interest in new nuclear power plants, for detailed discussions with stakeholders – government officials, regulators, industries, researchers, financiers, decision makers, etc. – to prepare the draft CUC. Potential user countries will then be invited to a workshop where the draft CUC will be reviewed and finalized.

12. Pre-visit questionnaires covering issues relating to the introduction of nuclear power plants have been prepared. As of 16 July, five countries (Bangladesh, Belarus, Egypt, Indonesia and Lithuania) had been visited and additional visits to Malaysia and Mexico are scheduled later in 2007.

13. The Agency cooperates with other international efforts promoting innovative technology development, such as the Generation IV International Forum (GIF). Experts from INPRO and GIF have participated in each other's technical and policy-making meetings.

14. Initial proposals for collaborative projects were formally made by INPRO members at the 10th INPRO Steering Committee meeting in December 2006. The proposals covered joint methodology development, benchmarking and experiments for technology development, safety and reliability of innovative reactors and fuel cycles, and associated steps for their planning and deployment. These proposals were further reviewed by the 11th INPRO Steering Committee meeting in July 2007.

15. In addition to approving 14 collaborative project proposals, the Steering Committee also identified potential interested partners and discussed a preliminary action plan for 2008–2009 which includes the three main activities listed in paragraph 6.

16. INPRO has presented the results of its work at a number of important international conferences, including the 15th Pacific Basin Nuclear Conference (October 2006), the International Congress on Advances in Nuclear Power Plants (May 2007) and the 13th International Conference on Emerging Nuclear Energy Systems (June 2007).

17. An INPRO home page (<http://www.iaea.org/INPRO>) provides regularly updated information for INPRO members and the general public.

B.2. Nuclear Power, Fuel Cycle and Nuclear Science

18. Advanced nuclear reactor designs currently under development include water cooled reactors (light water reactors (LWRs) and heavy water reactors (HWRs)), gas cooled reactors, fast reactors, and various transmutation and actinide utilization reactors, both critical and sub-critical.

19. Passive safety systems based on natural circulation are employed in several evolutionary and in many innovative water cooled reactor designs. Such systems promise improved economics and a very high level of safety through reduced design complexity. A CRP on natural circulation phenomena, modelling and reliability of passive systems that utilize natural circulation is under way. The scope includes natural circulation to remove core power under normal operation (start-up, nominal and shutdown) and accident conditions, and to provide cooling of the containment. Building on the shared expertise of the CRP's participating organizations, the Agency has recently published an IAEA Technical Document (IAEA-TECDOC-1474) entitled *Natural Circulation in Water Cooled Nuclear Power Plants*, which forms the basis of an intensive Agency education course on natural circulation in water cooled NPPs for scientists and engineers involved in the design, testing and analysis of natural circulation systems. In June 2007, the course was held at the International Centre for Theoretical Physics (ICTP) in Trieste, Italy, and in 2008 it will be held at the Idaho National Laboratory, USA.

20. The Agency maintains an Internet database of thermo-physical properties of nuclear reactor materials (<http://www.iaea.org/THERPRO>). The database provides materials properties data to registered, authorized users and contains over 13 000 files of data, descriptions of experiments and bibliographic information collected from open literature. Additional data, made available by research institutes, are being added to the database continuously. The use of accurate data for thermo-physical properties of materials in reactor design can obviate the need to incorporate excessively large margins into new reactor designs simply to allow for uncertainties in data. The THERPRO database is owned by the Agency and managed by its Designated Centre for Nuclear Materials Properties Database Management located at Hanyang University, Seoul, Republic of Korea. One immediate use of the THERPRO database has been in nuclear engineering design classes at university level.

21. A new activity on innovative water cooled reactors, introduced in 2007 on the advice of the Agency's Technical Working Groups on Advanced Technologies for Light Water Reactors and Heavy Water Reactors, is a CRP on heat transfer behaviour and thermal hydraulics code testing for supercritical water cooled reactors (SCWRs). SCWRs would achieve high thermal efficiencies (44-45%) and promise improved economic competitiveness utilizing and building on recent developments for highly efficient fossil power plants. The SCWR has been selected as one of the concepts for development by the Generation IV International Forum. The OECD/NEA, which serves as the technical secretariat to GIF, has agreed to cooperate with the IAEA on the establishment of a database on SCWR thermalhydraulics in the framework of this CRP.

22. The Technical Working Group on Fast Reactors reviewed fast reactor and accelerator-driven system (ADS) research and technology developments at its May 2007 meeting in Japan. Back-to-back technical meetings were held to review the status of ADS R&D and technology, and to review the status of fast reactor R&D and technology to establish the contents, authors and schedules for forthcoming status reports in these two areas.

23. An update of the Agency's fast reactor database was published in February 2007 as IAEA-TECDOC-1531 entitled *Fast Reactor Database: 2006 Update*. The Agency also convened a technical meeting on implementation of the Fast Reactor Data Retrieval and Knowledge Preservation initiative, which reinforced support of fast reactor knowledge preservation activities and outlined the structure of and the specific implementation requirements for the fast reactor knowledge preservation portal under development by the Agency. In 2007, the first Research Coordination Meeting (RCM) with a view to establishing a CRP work plan on the analyses of, and lessons learned from, the operational experience with fast reactor equipment and systems was held.

24. In the area of innovative fast neutron spectrum systems for actinide utilization and long-lived nuclide transmutation, studies of advanced technology options for effective incineration of radioactive waste continued in the framework of a CRP on the comparative assessment of the dynamics of transmutation systems. The third and final RCM of the CRP on studies of innovative reactor technology options for effective incineration of radioactive waste reviewed the results of all participants and their contributions to the final report, and produced the first draft of the final report.

25. The Agency published an IAEA Technical Document (IAEA-TECDOC-1520) entitled *Theoretical and Experimental Studies of Heavy Liquid Metal Thermal Hydraulics*, documenting generic R&D activities relevant to innovative fast neutron systems.

26. Cooperation with the OECD/NEA's group working on lead alloy-cooled advanced nuclear energy systems (LACANES) was established in benchmarking natural circulation tests with lead-bismuth coolant performed in the Heavy Eutectic Liquid Metal Loop for the Integral Test of Operability and Safety (HELIOS) being carried out at Seoul National University, Republic of Korea.

27. The Agency continues to review enabling technologies for small and medium sized reactors (SMRs). A detailed plan of action for a new activity on competitive considerations for SMRs, including a country-independent model for the assessment needs for SMRs was developed. In January 2007, the Agency published an IAEA Technical Document (IAEA-TECDOC-1536) titled *Status of Small Reactor Designs Without On-Site Refuelling*. It identifies possible common criteria for e.g., grid sizes and economic requirements, long-lifetime cores, safeguardability, ensuring safety and providing for robust protection against the misuse of fissile materials for proscribed purposes, etc. Together with IAEA-TECDOC-1485, which is dedicated to SMRs with conventional refuelling schemes and was published in 2006, this latest report provides important input for the INPRO activity described in paragraphs 9-11 on common user criteria.

28. The second RCM on the IAEA's CRP on small reactors without on-site refuelling was convened in Vienna in June 2007 to review the results of benchmark exercises, e.g. on source term calculations justifying reduced off-site emergency planning for innovative SMRs.

29. In the area of non-electric applications of nuclear energy, the Agency organized, in cooperation with the OECD Nuclear Energy Agency and the International Desalination Association, a conference entitled 'Non-electric applications of nuclear power: seawater desalination, hydrogen production, district heating and other industrial applications' in April 2007 in Oarai, Japan. The case for using nuclear heat for desalination and synthetic fuels (synfuels) was elaborated on by many speakers, and the conference reviewed potential solutions for pressing problems, e.g. supplying water and making

synfuels to alleviate both the causes and impact of greenhouse gas (GHG) emissions. A major focus was on desalination and included discussion of environmental impacts and the issue of costs of nuclear desalination. It also provided a forum for exchanging the latest R&D results on hydrogen production, transportation and safety and highlighted new design features of high temperature gas cooled reactors and other high temperature process heat applications.

30. The Technical Working Group on Gas Cooled Reactors (TWG-GCR) met in Vienna in January 2007 to present the national programmes of its Member States and to make recommendations to the IAEA on activities in the area of GCRs and their application for electricity generation and process heat, such as desalination of sea water, enhanced oil recovery and hydrogen production. A renewed interest in the helium-cooled high temperature gas cooled reactors (HTGRs) was reported, and related R&D programmes are progressing in several countries, including China, France, Germany, Japan, Republic of Korea, Netherlands, Russian Federation, South Africa, Switzerland, United Kingdom and USA. Some countries, such as China, South Africa and the USA, are considering building demonstration plants. The European Commission supports and coordinates several important projects on HTGR, such as Euratom's Reactor for Process Heat, Hydrogen and Electricity Generation (RAPHAEL) project for process heat applications and electricity generation and GCFR for gas cooled fast reactors for electricity generation and fuel breeding. The results of work performed within two Generation-IV projects on helium-cooled reactors, i.e. the very high temperature reactor and the gas cooled fast reactor, were reported.

31. The third RCM on the IAEA's CRP on HTGR Core Physics and Thermal Hydraulic Benchmark was held in Vienna in September 2006 to review results achieved and prepare the final report. The technical document is currently being edited and will be sent for publication in 2008.

32. In support of education and training in the area of advanced and innovative fuel technology development, the Agency is preparing a basic factbook on high temperature reactor fuels and materials, primarily for the new generation of scientists and engineers. In this connection, the Agency is also planning a workshop in December 2007 on coated particle fuel in collaboration with Euratom's RAPHAEL project.

Producing Potable Water Economically Using Small and Medium Sized Nuclear Reactors

A. Background

1. At its forty-ninth session in September 2005, the General Conference, through resolution GC(49)/RES/12.E, underlined the urgent need for regional and international cooperation in helping to solve the serious problem of potable water shortages, particularly through desalination of seawater, and noted the interest of a number of Member States in activities related to seawater desalination using nuclear energy. It requested the Director General to continue consultations and interactions with interested Member States and other competent organizations about seawater desalination using nuclear energy, to note the high priority given to this topic by interested Member States, and to promote effective international information exchange and cooperation in this area. It requested the Director General and interested Member States to include in feasibility studies the social and economic impacts of this technology. It invited the International Nuclear Desalination Advisory Group (INDAG) to continue its functions as a forum for advice and review on nuclear desalination activities, and the Director General to raise seed funds and other appropriate funding from extrabudgetary resources to catalyze and contribute to the implementation of all Agency activities relating to nuclear desalination and the development of innovative small and medium sized reactors (SMRs). It further requested the Director General to report on progress made in implementing this resolution to the Board of Governors and to the General Conference at its fifty-first session. This document provides an overview of activities relating to nuclear seawater desalination and SMRs undertaken by the Secretariat between August 2005 and June 2007.

B. Nuclear Seawater Desalination

B.1. International Nuclear Desalination Advisory Group

2. INDAG held its eighth meeting in February 2006. INDAG members exchanged information on the progress of national and interregional activities in nuclear desalination, reviewed the progress of the Agency's work as well as Agency planned activities for 2006–2007, and discussed how the Agency could further contribute to facilitating nuclear desalination activities in Member States. The fifth and sixth issues of INDAG's newsletter were published in September 2005 and September 2006, respectively.

B.2. Activities of the Member States

3. National activities were reported on at the February 2006 INDAG meeting and at the technical meeting on Integrated Nuclear Desalination Systems, held in December 2006. Argentina has selected the site of Puerto Deseado for its small reactor (CAREM) which could be used for desalination. In China, a major effort in nuclear desalination is under way to increase localization in the manufacturing of reverse osmosis (RO) and distillation technologies to more than 60%. At its El-Dabaa site, Egypt

has completed a feasibility study for both a nuclear co-generation plant (electricity and water) and for construction of a pre-heat RO test facility.

4. France has recently concluded several international collaborative projects, including joint techno-economic feasibility studies, with the Libyan Arab Jamahiriya for the possible adaptation of the Libyan experimental reactor at Tajoura into a nuclear desalination demonstration plant using hybrid multi-effect distillation (MED) and RO processes; with Morocco on the Amane project; and with India on the development of advanced calculation models for hybrid multi stage flash-reverse osmosis (MSF-RO) systems.

5. India is commissioning a 6300 m³/day demonstration plant at Kalpakkam using a hybrid (MSF-RO) desalination system, which will be connected to the existing PHWR. Plans also call for coupling the future Advanced Heavy Water Reactor (AHWR) with a desalination unit. Israel has acquired extensive experience of the construction and operation of non-nuclear desalination technologies, which is also of great interest to nuclear desalination. Japan is conducting R&D on innovative nuclear technologies for nuclear desalination with the focus on small reactors of 350 to 450 MW, such as the Integrated Modular Water Reactor (IMR) and the Compact Containment Boiling Water Reactor (CCR). The Republic of Korea has completed the basic design of a 330 MW(th) SMART. In parallel, a one-fifth scale pilot plant SMART-P is planned for construction for out-of-pile tests along with an MED unit by 2008. Morocco has, with the help of the Agency, established a nuclear law that covers both nuclear radiation and safety and creates a framework for the possible introduction of nuclear desalination. Pakistan has started the process of commissioning a demonstration 4800 m³/day MED thermal desalination plant coupled with a PHWR at Karachi. In the Russian Federation, the construction of a co-generation plant to include desalination is to start in 2007.

6. The USA is including in the implementation of its Generation IV roadmap initiative, and in recognition of the important role that future nuclear energy systems can play in producing fresh water, a detailed discussion of the potential of nuclear energy for desalination purposes.

7. Further R&D activities on nuclear desalination are also underway in Indonesia and Saudi Arabia. In addition, interest has been expressed by Algeria, Brazil, Islamic Republic of Iran, Iraq, Italy, Jordan, Lebanon, Philippines, Syrian Arab Republic and UAE in the potential of nuclear desalination for their countries or regions.

B.3. Activities of the Agency

8. A consultancy meeting to prepare a status report on nuclear desalination systems was held in Vienna, 9-10 February 2006, and the report published in January 2007 as TECDOC-1524, *Status of Nuclear Desalination in IAEA Member States*.

9. Within the framework of the CRP on 'Economic Research on, and Assessment of, Selected Nuclear Desalination Projects and Case Studies', a fourth and final Research Coordination Meeting (RCM) was held in October 2006. The final results of this CRP are to be published as TECDOC-1561 entitled *Economics of Nuclear Desalination - New Developments and Site-specific Studies - Final Report of a coordinated research project 2002-2006*.

10. A training course on desalination system modelling – technology and economics was held at ICTP, Trieste, Italy, 24-28 April 2006.

11. Two technical meetings were held in Vienna on 12-14 June and 11-14 December 2006. Various aspects of thermal, membrane and hybrid desalination technologies to reduce water costs and improve environmental impacts were discussed in detail. The first meeting concluded that more emphasis should be given to collateral issues such as infrastructure development, socio-economic and

environmental aspects, and public perception. At the second meeting, appropriate infrastructures and manpower development as a prerequisite for nuclear energy deployment were emphasized. Suitability and the preference by some Member States for small and medium power reactors, as well as the economic advantages of hybrid nuclear desalination systems were also discussed.

12. In 2006, expert missions under TC projects were undertaken to Algeria, Egypt, Jordan, Libya, and United Arab Emirates. The objectives of these missions varied from revisiting original work plans to reviewing progress on feasibility studies and, in some cases, to conducting national training courses on DEEP and APROS software. In 2007, two fact-finding missions were undertaken to Jordan and the Gulf Cooperating Council (GCC) by a team of 7 IAEA experts. The objective was to assess needs, to advise on the best approach for launching a nuclear power programme with particular emphasis on desalination, and to consider the outline of a related feasibility study. New TC projects to assess the feasibility of nuclear desalination in Member States such as Algeria and Jordan were implemented.

13. In terms of outreach, the IAEA nuclear desalination website (www.iaea.org/nucleardesalination) continues to provide access to all relevant IAEA publications and up-to-date information on the status of nuclear seawater desalination technology and the Agency's ongoing and future activities.

C. Small and Medium Sized Reactors for Desalination

14. Small and medium sized reactors (SMRs) are of particular interest to those Member States, who are considering modest, incremental power capacity additions or who are investigating the use of nuclear power for specific applications such as desalination. SMRs for all principal reactor lines are under development, and the Agency conducts a number of dedicated activities in this area to assess technical and economic viability. 'The International Conference on Non-Electric Applications of Nuclear Power: Seawater Desalination, Hydrogen Production and other Industrial Applications', organized by the Agency in cooperation with the NEA/OECD and IDA, and hosted by the Government of Japan (through the Japanese Atomic Energy Agency) was held on 16-19 April 2007 in Oarai, Japan. It included presentations on a broad range of efforts related to design and technology development of dedicated co-generation plants, which have a seawater desalination option and incorporate innovative SMRs as an energy source. Designers are optimistic that several first-of-a-kind (FOAK), or prototype nuclear power plants, with innovative SMRs could be deployed by the middle of the next decade. The designers claim excellent safety characteristics for the FOAKs, thereby enabling their potential location close to consumers. They also claim improved economies based on design simplification and capital cost reduction owing to both the shorter construction period and learning experience, multiple unit effects and factory mass production. Such plants could be attractive to many different types of investor because they offer a significant capital-at-risk reduction.

15. The IAEA-TECDOC-1536 on *Status of Small Reactor Designs Without On-Site Refuelling*, published in January 2007, presents, inter alia, 30 such structured design descriptions of reactor concepts and designs developed in Member States. It also provides an analysis of SMR usage for desalination, and the design descriptions contain an explanation of nuclear desalination systems and a summary of their characteristics.