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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(51)/RES/14 and GC(52)/RES/12, this document contains progress reports on: support to the African Union's Pan African Tsetse and Trypanosomosis Eradication Campaign (AU-PATTEC) (Annex 1); Programme of Action for Cancer Therapy (Annex 2); use of isotope hydrology for water resources management (Annex 3); Agency activities in the area of nuclear energy (Annex 4); potable water production using nuclear reactors (Annex 5); Agency activities in the development of innovative nuclear technology (Annex 6); small and medium-sized reactors (Annex 7); and infrastructure development for nuclear power (Annex 8).
- Further information on the Agency's activities related to nuclear science, technology and applications can be found in the *Nuclear Technology Review 2009* (document GC(53)/INF/3), the Agency's *Annual Report 2008* (GC(53)/7), in particular the Technology section, and the *Technical Cooperation Report for 2008* (GC(53)/INF/4).

## **Recommended Action**

- It is recommended that the Board take note of Annexes 1 – 8 of this report and authorize the Director General to submit the report to the General Conference at its fifty-third session.



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

## A. Background

1. At its fifty-second session in October 2008, the General Conference, in its resolution GC(52)/RES/12.A.3, 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, and requested the Secretariat, in cooperation with Member States and international organizations, to strengthen – through the Regular Budget, the Technical Cooperation Fund and other partnerships – its support for R&D in and technology transfer to African Member States in order to complement their efforts to create and subsequently expand tsetse-free zones. The General Conference also urged the Secretariat to strengthen capacity building and to support the establishment of regional training centres in the affected Member States so as to promote the development of the human resources necessary for implementing the operational national and regional PATTEC projects and stressed the need for enhanced cooperation with the Commission of the African Union (AU) and other regional and international partners, particularly FAO and WHO, with the aim of harmonizing efforts in line with the AU-implementing national and subregional AU-PATTEC projects. The General Conference requested the Director General to report on the progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its fifty-third (2009) regular session.

## B. Developments since the General Conference's 2008 session

2. The Agency continues to assign high priority to its efforts to contribute to agricultural development, particularly in African Member States. In this context, the transfer of the sterile insect technique (SIT) as part 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, addresses a key problem at the root of rural poverty and food insecurity.

3. In the past year the Agency continued to foster its partnership with AU-PATTEC and to contribute to the implementation of the AU-PATTEC Plan of Action through three regional technical cooperation projects, two of which were approved for the 2009–2011 technical cooperation (TC) cycle. Agency support is being provided through national tsetse TC projects in Botswana, Chad, Ethiopia, Kenya, Senegal, Uganda and Zimbabwe. In addition, other tsetse affected Member States, such as Burkina Faso and the United Republic of Tanzania, have received support through a regional tsetse TC project. One of the new regional tsetse TC projects specifically addresses the need to tackle a common transboundary tsetse fly infestation area in Mozambique and South Africa. Under these national and regional tsetse projects, the Agency continued to assist recipient countries with feasibility assessment

studies, capacity building and pre-operational support for SIT activities, largely through the provision of training, expert services and equipment.

4. In late 2008, the Agency and the AU Commission undertook to strengthen their partnership by formalising the collaborative framework in support of the Pan-African Tsetse and Trypanosomosis Eradication Campaign. Within their respective mandates, internal policies, procedures and resources, the AU and the IAEA are working towards agreement on the following topics and modalities for cooperation: a) planning and implementation of baseline data collection and feasibility assessment for AW-IPM campaigns against the tsetse and trypanosomosis problem; b) development of project documents suitable to approach potential donors; c) assistance in training and capacity building; d) monitoring and evaluation of the implementation of AU-PATTEC projects; e) planning, preparation, funding and implementation of training courses; f) applied research, methods development and validation to address technical gaps and bottlenecks and to improve the efficiency and cost-effectiveness of operational field projects; g) mutual participation in relevant policy coordination, planning, research and other meetings and workshops, training courses and other activities and events; and h) mutual support of each other's programmes at resource mobilisation events.

5. The six projects coordinated by AU-PATTEC (in Burkina Faso, Ethiopia, Ghana, Kenya, Mali and Uganda – referred to as the “AU-PATTEC List-I” countries), which have received financial grants and loans from the African Development Bank (AfDB), underwent an AfDB coordinated mid-term review in late May 2009, including a meeting of AU-PATTEC national coordinators in Tunis, on 26–28 May 2009. Within their respective mandates, FAO, WHO and the IAEA have continued to provide advice to these countries for reviewing work plans, milestones and timelines with the available resources, using meetings and the Programme Against African Trypanosomiasis (PAAT) to disseminate information. Tsetse affected Member States continued to benefit from the PAAT information system (PAAT-IS), to which FAO, IAEA, WHO and other partners contribute. Two PAAT meetings were organised in the past year with the participation of the national coordinators PATTEC projects: the 14<sup>th</sup> meeting of the PAAT Advisory Group Coordinators in Kampala, Uganda (14–15 October 2008), and the 13<sup>th</sup> meeting of the PAAT Programme Committee at the conference centre of the Slovak Academy of Sciences in Smolenice (7–8 May 2009).

6. In recognition of the need to provide training to the national coordinators of AU-PATTEC projects, not only on technical aspects, but also on the principles of project management, the AU-PATTEC coordination office organised, in collaboration with the Management Development Institute (MDI) and with the sponsorship of The Arab Bank for Economic Development for Africa (BADEA), a training course on *Strategic Project Management: A Methodological Approach to Tsetse Fly Eradication and Control* in Manzini, Swaziland (23 February–13 March 2009). The Agency contributed – through its regional TC project on *Supporting the Use of the Sterile Insect Technique for Area-Wide Tsetse and Trypanosomosis Management (Phase II)* – several lectures on the the principles of planning for AW-IPM operations against tsetse and the option of an SIT component, and on management principles in the context of large scale insect control and eradication programmes.

7. In late 2008, FAO/IAEA guidelines entitled *Collection of Entomological Baseline Data for Tsetse Area-Wide Integrated Pest Management Programmes* were published under the FAO Animal Production and Health series, and distributed to researchers, tsetse control personnel and managers involved in planning, developing and implementing tsetse intervention measures and related disciplines. The guidelines are being used by several

national PATTEC projects and will enable the standardised collection of required baseline data that will allow for more efficient planning and implementation of tsetse control activities. The baseline data is expected to be used eventually to quantify the control effort.

8. In Ethiopia, the Agency continued to support the Government's Southern Tsetse Eradication Project (STEP), and approved a new TC project on *Creating a Tsetse-Free Zone in the Southern Rift Valley*, which started in 2009. The Agency and the FAO continued implementing activities under the Japanese-funded United Nations Trust Fund for Human Security (UNTFHS) project entitled *Establishing a Zone Free of the Tsetse and Trypanosomiasis Problem in the Southern Rift Valley, Ethiopia, and Assisting Rural Communities in Agricultural and Livestock Development*. The UNTFHS approved the utilisation of some remaining funds through late 2009. Under this project, the Agency continued to assist the STEP Kaliti Tsetse Rearing and Irradiation Centre in Addis Ababa in mass-rearing the main target species (*Glossina pallidipes*) and another species (*Glossina fuscipes fuscipes*) that is present in a small part of the project area.

9. The FAO/IAEA Agriculture and Biotechnology Laboratory is continuing work to develop a strategy for the management of the salivary gland (SG) virus that is hampering the mass-rearing of *Glossina pallidipes*, particularly in Ethiopia. The virus management strategy is based on three axes: a) blocking the virus replication using available commercial antiviral drugs; b) inhibiting the virus infection by silencing virus specific genes using RNAi technology; and c) neutralizing the virus infection using virus specific antibodies.

10. Activities coordinated by the FAO contributed to identifying specific rural development opportunities for communities in the project area and establishing, in close collaboration with the Regional Agricultural Bureau in Awassa, as well as with agricultural and livestock extension services, a plan to realise specific improvements in keeping productive livestock breeds. Separately, trial releases in 2008 of sterile males in a 100 km<sup>2</sup> area of Arba Minch showed higher than expected survival and dispersal rates. These are good prospects in preparing for the proposed operational tsetse SIT phase.

11. As part of the results of an overall external and internal review conducted in 2003-2004 of the Agency's tsetse activities, the policy was established that the Agency's contribution to Member States' efforts to create tsetse-free zones must follow a phased and conditional planning and implementation approach consisting of four phases. As STEP is proposed to enter the operational phase-4, the Agency's Office for Internal Oversight Services (OIOS) organised an external review on the status of STEP in late 2008 to assess whether all conditions have been met for the Agency to provide assistance to operational phase-4, involving an SIT component. The evaluation examined managerial, administrative, logistical and technical aspects and concluded that, while the project area appears suitable for establishing a tsetse free zone, dedicated staff are available to the project and good progress has been made in STEP laboratory and field activities, there are several key aspects that need to be addressed in a satisfactory manner before STEP should enter, and before the Agency should support, the operational phase. These include a more developed project management system, up-scaling of sterile male mass-production and generating intensive and area-wide tsetse fly suppression in the entire field area, including the Nech Sar National Park. An effort is also needed to secure additional funds required for completing the project. The Agency and other partners, such as FAO and PAAT, will assist the Ethiopian authorities to address the identified shortcomings and provide full support to initiating the operational phase-4 as soon as all necessary conditions are met.

12. The Agency continued providing technical assistance and guidance to Senegal under a newly approved national TC project on *Implementing the Pre-Operational Phase to Create a Zone Free of Glossina palpalis gambiensis using the Sterile Insect Technique (SIT)*. Excellent progress under this and a preceding TC project has been made due to the strong support provided by the Government and to the collaboration with the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) and the Institut de Recherche pour le Développement (IRD) of France. During the last two years, baseline data were collected on the distribution of the target *Glossina palpalis gambiensis* population, on tsetse population genetics and on the prevalence of the disease nagana in livestock. Based on this data, the total intervention zone in the Niayes area (north of Dakar) and La Petite Côte (south east of Dakar) was estimated at 1300 km<sup>2</sup>. Suppression activities on some commercial farms will be initiated in late 2009. With regard to the SIT component, trial releases are scheduled to take place in the second half of 2009 in selected areas of the Niayes, using sterile male flies originating from the Centre International de Recherche-Développement sur l'Élevage en zone Sub-humide (CIRDES) in Burkina Faso. In that respect, the FAO/IAEA Agriculture and Biotechnology Laboratory at Seibersdorf and CIRDES have started to develop and validate methods for long-distance transport of chilled sterile male flies. It is anticipated that operational releases in the project area will be initiated in 2010.

13. Since the caesium-137 irradiator at CIRDES that is used for SIT activities is beyond its intended life span, the Agency is assisting in efforts both to explore disposal options for the old source, and to obtain a new, X-ray source as a replacement. To avoid any associated disruptions to SIT activities that may result during these processes, contingency plans for the temporary relocation of the tsetse colonies have been developed that will ensure that SIT work in Senegal remains on schedule.

14. In order to help addressing a transboundary tsetse and trypanosomosis problem in the northeast of South Africa and southern Mozambique, the Agency approved a new regional TC project on *Supporting the Creation of a Tsetse-Free Zone in Southern Mozambique and North-East South Africa*. A first regional technical meeting was organised at Hluhluwe, KwaZulu Natal (KZN), South Africa, on 23–24 March 2009, which was attended by representatives of the veterinary services of South Africa, Mozambique and Swaziland<sup>1</sup>, AUPATTEC and FAO/IAEA. The distribution of the two tsetse fly species in Mozambique, South Africa and Swaziland was reviewed and the need for collecting additional entomological baseline data was agreed. A regional training course on the collection of entomological base line data is scheduled to be held in Maputo in early 2010. With regard to the proposed tsetse SIT component as part of the AW-IPM campaign, the existing colonies of the two target species will be used as seed material for a large-scale rearing facility. Like other tsetse TC projects, IAEA assistance to this sub-regional initiative will strictly adhere to the Agency's phased and conditional planning and implementation approach.

15. The Agency's efforts to assist in establishing a national capacity for tsetse SIT in Kenya has led to good progress in the past years. Under the national TC project *Integrated Area-Wide Tsetse and Trypanosomosis Management in Lambwe Valley*, population genetic techniques were introduced, a colony of *Glossina pallidipes* was established and guidance was provided on intensive area-wide pre-SIT tsetse fly suppression. A 20 000 female

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<sup>1</sup> Although not an IAEA Member State, Swaziland will participate in the project using a combination of its own funds and some assistance provided by partners such as WHO.

*Glossina pallidipes* fly colony is already available for pilot releases of sterile male flies in 2009. Population genetic techniques have confirmed the confinement of the first target area, the Lambwe Valley, and a level of tsetse suppression has been achieved that appears to permit initiating SIT activities. As a concept note was not submitted for the 2009-2011 IAEA TC cycle, efforts are underway to explore how the Agency or other partners could provide the necessary assistance to conduct laboratory and field activities in preparation for an operational SIT phase. Depending on additional funding, this may start during the current TC-cycle (2009-2011).

16. Burkina Faso has made use of the technical advice provided by the Agency in an exemplary manner. With a focus on the Mohoun river basin as the first tsetse intervention area, available geo-referenced data on the presence and abundance of tsetse fly species and on the tsetse transmitted trypanosomosis were entered into a geographic information system (GIS) to visualise and analyse the tsetse and trypanosomosis situation. Using the systematic approach outlined in the FAO/IAEA guidelines for entomological baseline data collection, the necessary complementary information has been collected. In the past year the Agency has provided an updated set of high-resolution satellite imagery of the entire intervention area and issued a contract for land-use / land cover classification. Making use of available trained field teams and suppression materials obtained through the PATTEC-AfDB loan, tsetse suppression activities have been initiated. Using funds under the regional tsetse TC project and involving an equipment engineering expert, further advice was provided to Burkina Faso on the design of a new tsetse mass rearing factory, and a detailed list of insectary equipment was elaborated for purchase under the AfDB loan.

17. The last research coordination meeting (RCM) of the coordinated research project (CRP) on *Improved and Harmonized Quality Control for Expanded Tsetse Production, Sterilization and Field Application* was held in Addis Ababa, Ethiopia, 13–17 October 2008. The CRP generated information and quality control standards for a) processing and handling tsetse fly blood diet; b) tsetse insectary equipment and materials; c) tsetse mass-rearing procedures; d) mating compatibility and competitiveness of mass-reared male flies; and e) standardised handling and field release of mass-produced sterile male tsetse flies.

18. In February 2009, CIRDES hosted an Agency training workshop on *DNA isolation and detection of tsetse pathogens and symbionts using PCR* and the second RCM of the CRP entitled *Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens*. Eight participants from several African collaborating institutions were trained at the workshop in standardised molecular techniques used to assess the presence of the tsetse SG virus and to assess tsetse symbionts. The RCM reviewed the status of research and methods development to generate knowledge and management tools of the tsetse SG virus and assessed the role of pathogens and symbionts in area-wide integrated campaigns involving SIT against tsetse fly populations.

19. The Agency organised a consultants meeting in Vienna, from 6–8 February 2009, on *Developing a Design Concept for a Tsetse Aerial Release System*. The experience available for chilled adult releases for fruit fly and screwworm fly SIT was used to review the special needs for handling, incubation and release of chilled adult tsetse flies. The meeting specified parameters, including handling and incubation conditions and volumes of tsetse fly materials, to guide efforts towards developing methods for male packing, transport from the fly production centre to the release area and during the release process. One group of meeting participants, involved in large-scale operational releases of fruit flies in Mexico and Central

America, presented a design for a prototype for transport and release of chilled adult tsetse flies. The group is currently in the process of assembling the prototype for testing by the Agency.

20. The Agriculture and Biotechnology Laboratory completed the testing and dosimetry work with X-ray irradiation and concluded that X-ray irradiators can serve as alternative to isotopic irradiators, for which increasing difficulties and restrictions are being experienced with the purchase and international transport.

# Programme of Action for Cancer Therapy

## A. Background

1. At its fifty-first regular session in September 2007, the General Conference, in resolution GC(51)/RES/14.A.2, reiterated Member States' concerns about the suffering of cancer patients and their families, particularly in developing countries with low resources, and highlighted the serious threat posed by cancer to socio-economic development. It requested the Director General to continue to advocate and 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; to continue seeking, strengthening and facilitating the Agency's involvement in international partnerships with non-traditional donors to further pursue, develop and implement PACT; and to continue consultations with the Director General of WHO on the feasibility of a joint programme of the Agency and WHO for cancer prevention, control, treatment and research.

2. The General Conference recommended that imPACT missions (integrated missions of PACT) should continue to be developed, in consultation with Member States, as an Agency service; that the PACT Programme Office (PPO) continue to raise awareness about the global cancer burden in low and middle-income countries, and that, in this regard, the PPO use all tools at its disposal, including partnerships with local, national and international media, to meet this objective; and that the PPO, in consultation with relevant Agency departments and WHO, as appropriate, continue to assist developing Member States in establishing integrated and comprehensive national cancer control plans. The General Conference requested the Director General to report on the implementation of this resolution at its fifty-third (2009) regular session.

## B. Support for Member States in Capacity Building to Fight Cancer

3. Since September 2007, PPO has concentrated on facilitating training for health professionals working in cancer control in low and middle income countries, with an emphasis on the PACT Model Demonstration Sites (PMDS) in Albania, Nicaragua, Sri Lanka, the United Republic of Tanzania, Vietnam and Yemen. The continuing in-kind contribution by the US National Cancer Institute (NCI) allowed for the participation of 42 professionals nominated by PACT in summer training courses on cancer prevention and control at the NCI in 2008 and 2009.

4. PACT also supported the participation of eight PMDS cancer researchers during 2008 and 2009 in training courses conducted by the International Agency for Research on Cancer (IARC) on cancer registration and epidemiology. An additional 20 participants from Africa and Latin America were trained in quality assurance in radiotherapy at the Argonne Laboratories in the United States in 2008.

5. In late 2007 and in 2008, PACT supported the participation of 18 doctors and nurses from African countries in an annual workshop in Burkina Faso on the provision of palliative care. PACT sponsored the participation of seven cancer control officials from six African countries in the African Organisation for Training and Research in Cancer (AORTIC) Congress, as well as an expert from each of the six PMDS to attend the 2<sup>nd</sup> International Cancer Control Congress held in Brazil in late 2007.

6. Representatives of four PMDS participated in a cancer control planning forum in Geneva for developing countries co-organized by the American Cancer Society (ACS) and PACT in advance of the International Union Against Cancer (UICC)'s World Cancer Congress 2008, where PACT supported the participation of a representative from each of the six PMDS. Through the TC programme, several cancer professionals from Africa received training in medical physics and radiation therapy in Canada, India and South Africa using PACT funds.

7. In coordination with the TC Department, the Division of Human Health (NAHU), WHO regional and country offices and other key partners, 13 post-imPACT missions were conducted in all six PMDS. In addition, full imPACT missions were carried out in Madagascar and the Republic of Moldova, and pre-imPACT missions were carried out, upon request, in the Dominican Republic, Mongolia and Uganda. These missions were implemented using contributions from Monaco, New Zealand and Spain, and with technical support from France's International Cancer Network. To date more than 60 Member States have requested imPACT missions.

8. In addition to assessing the national burden posed by cancer and the status of cancer-related planning, resources and capabilities, imPACT missions also represent a joint international effort aimed at providing capacity building opportunities in training and increasing public awareness. To assist Member States in this process, an imPACT self-assessment tool that is used by Member States in advance of imPACT missions to help establish baseline data was updated in collaboration with WHO. In addition, the PPO has developed a template to prepare the Country Cancer Profile (CCP) for each of the countries requesting an imPACT review that uses existing Agency databases, the WHO Country Cooperation Strategy and other open source data.

9. PACT has also developed, in collaboration with WHO, a comprehensive imPACT questionnaire covering all areas of cancer control, including cancer control planning, cancer registration and surveillance, cancer outcomes and evaluation, prevention, cancer treatment and cure, palliative care and support, knowledge transfer and training, advocacy and education, civil societies, and resource mobilization. The questionnaire is normally sent to the Ministry of Health after the CCP mentioned above has been completed and reviewed by the authorities. PPO may organize national workshops as part of the pre-imPACT mission to bring all stakeholders together to discuss the completion of the questionnaire. Following the pre-imPACT mission, the full-scale imPACT review is planned and conducted.

10. PACT has collaborated with the TC Department and NAHU in two TC regional projects in the 2009-2011 cycle: one in Africa, on *Supporting the Development of Comprehensive*

*National Cancer Control Programmes*, and the second in Asia and the Pacific on *Supporting National Cancer Control*. Each project aims at assisting Member States to develop comprehensive national cancer control strategic plans by furthering the training needed on a regional basis for cancer control planning and development, and by developing the Agency's capacity to provide imPACT missions as a service to Member States. Two regional planning and coordination meetings were held with WHO and participating Member States, one in Egypt (June 2009) and another in Vienna (July 2009), with a total of 76 participants from African and Asian Member States. These workshops were supported by experts from PACT partner organizations, such as the WHO regional offices, ACS, IARC, UICC and the International Network for Cancer Treatment and Research (INCTR).

11. The Agency also worked closely with the Pan American Health Organization (PAHO) to design a subregional project on *Cancer Prevention and Integral Cancer Care in Central America and the Dominican Republic*, which began implementation in 2008.

12. France's National Cancer Institute (INCa) has provided two experts to support cancer control planning meetings with francophone African Member States held during the past two General Conferences. In 2008, the National Cancer Institute of Brazil submitted a concrete *Proposal for Technical Cooperation in Radiotherapy* for training of cancer professionals from Latin America and Africa in radiotherapy, medical physics, quality assurance and quality control. This is being followed up together with the TC Department for implementation.

13. India's Tata Memorial Centre provides significant expert support to imPACT reviews in addition to offering a comprehensive radiation oncology training programme, including certification, to countries that have conducted an imPACT review. The fellows participating in the scheme are placed through the TC programme.

14. One of PACT's newest partners is the Organization of European Cancer Institutes - European Economic Interest Grouping (OECI), an organization of nearly sixty cancer research and care institutes throughout Europe. The OECI has expertise in licensing and accreditation and will make its institutes available for the training of PACT fellows.

15. To date over 25 Member States<sup>2</sup> have offered to collaborate with PACT using various modalities. Cancer institutions from these countries have made their facilities available, including hospitals and educational centres, 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. Many of these institutions have the potential to act as regional centres of excellence for cancer training and education.

16. The critical bottleneck to advancing cancer care capacity in low and middle income countries, whether in treatment or prevention, is education and training of staff in all areas of cancer care. In this regard, the loss of newly trained professionals to higher income countries is a particular concern. To achieve sustainable cancer care capacity in low and middle income countries, there must be a dramatic increase in the number of trained professionals in cancer care. Expanded facilities and tools are required for the education and training of new

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<sup>2</sup> Algeria, Argentina, Brazil, Canada, China, Cuba, the Czech Republic, France, Greece, Hungary, India, Israel, the Republic of Korea, Malaysia, Monaco, Morocco, Pakistan, Philippines, Poland, Russian Federation, South Africa, Spain, Thailand, Tunisia, Turkey, Uruguay, and the USA.

radiotherapy professionals (at their home institutions, to the extent possible), as well as for the retention of the existing staff by continuing professional development.

17. In 2008, PACT launched a project to accelerate cancer control education and training through a *Regional Cancer Training Network* concept supported by a *Virtual University for Cancer Control* (VUCC) to ensure that investments in cancer capacity building programmes, technology and facilities will have maximum public health impact and will be synergistic and sustainable. By the end of 2009, a plan to establish the first Regional Cancer Training Centre on a pilot basis will be completed and submitted for funding by PACT and its partners. Discussions with potential host countries and with WHO and other PACT partners began late in 2008 in coordination with NAHU to develop and plan the implementation of the first Regional Cancer Training Network. The Agency will identify the core curricula needed in the major areas of cancer control that could be taught via the VUCC, using new and existing standardized materials. The VUCC project is expected to be implemented during the 2010–2011 cycle. Already some donors have expressed interest in collaborating with the Agency on this project.

18. In April 2009, PACT and NAHU hosted a side event during the International Conference on Advances in Radiation Oncology (ICARO) to which leading experts and manufacturers of diagnostic and radiotherapy equipment were invited to discuss the development of cancer therapy equipment that is affordable and technologically suitable for developing countries. The event was attended by over 80 participants from 19 companies, and it was recommended that an advisory group should be established comprising experts from developing Member States' cancer centres, radiotherapy manufacturers, as well as representatives from WHO and the Agency, to continue discussions on this subject.

## **C. WHO-IAEA Joint Programme on Cancer Control**

19. Building upon the steadily increasing cooperation with WHO regional offices and IARC in the coordination of imPACT reviews and implementation of PMDS programme initiatives, and in response to several resolutions of the governing bodies of both WHO and the Agency, arrangements for a WHO-IAEA Joint Programme on Cancer Control entered into force on 12 March 2009, upon signature by the Directors General of both organizations. The overall objective of the Joint Programme is to strengthen the development and implementation of comprehensive national cancer control programmes (NCCPs), including the development of cancer therapy capacity, with special emphasis on low and middle-income countries<sup>3</sup>.

20. The Joint Programme's main areas of common interest are: (i) developing and enhancing cancer registration and planning capacity; (ii) strengthening support to countries implementing measures and interventions to prevent cancer; (iii) supporting countries establishing and evaluating early detection programmes to ensure timely diagnosis for curable

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<sup>3</sup> NCCPs have four basic components: 1) Cancer prevention, with emphasis on integrated risk factor prevention strategies; 2) Early detection (early diagnosis and screening); 3) Diagnosis and treatment; and 4) Palliative care.

cancers; (iv) increasing access and strengthening effectiveness of treatment, including radiotherapy and other treatments, to cure cancer and extend productive life; (v) increasing access to effective pain management and palliative care; (vi) promoting research in cancer prevention and control; (vii) building national capacity required for managing and evaluating comprehensive national cancer control programmes; and (viii) mobilizing resources to build capacity for a comprehensive approach to cancer control in Member States.

21. While the Joint Programme's efforts initially will focus on the full implementation of PACT's six PMDS, collaboration will not be limited to these countries. Depending on the level of resources available, additional PMDS may be developed and supported. The Joint Programme will provide the framework that will enable the two organizations to build on their respective areas of expertise and create a more coordinated and robust approach to combating cancer in low and middle income countries. In practical terms, this will mean working with Member States to integrate diagnostic and treatment-related activities into the cancer control plans of the country based on WHO cancer control guidelines and strategies in each region.

## **D. Building Additional Partnerships**

22. PACT has continued to pursue all potential avenues to build new partnerships. Model PACT Practical Arrangements (PAs) were finalized in 2007 to formalize collaboration between the Agency and international partners in supporting cancer control efforts in Member States. Individual PAs were concluded with IARC, INCTR, OECD, UICC, the Program for Appropriate Technology in Health (PATH), the Alliance for Cervical Cancer Prevention (ACCP), the Lance Armstrong Foundation (LAF) and Axios.

23. Other valued partnerships have been established during the last two years with the ACS, C-Change, the French National Cancer Institute (INCa), the State Office for Nuclear Safety of the Czech Republic, the University of Oxford, the Open Society Institute (OSI), the Tata Memorial Centre of India, the Korea Nuclear International Cooperation Foundation (KONICOF), and MDS Nordion/Best Medical International<sup>4</sup>. PPO continues to seek potential collaborative partnerships with other leading relevant cancer organizations.

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<sup>4</sup> Best Medical International acquired the Theratronics radiotherapy product line from MDS Nordion in 2008. An expanded donor agreement is under negotiation with Best Medical.

## **E. PACT Model Demonstration Sites (PMDS)**

24. As noted above, the PACT Model Demonstration Sites (PMDS) were established in collaboration with WHO to place cancer on the global health agenda and to help low and middle income countries attract new resources. Through the PMDS, IAEA/PACT, WHO, IARC, UICC, INCTR and other partners are assisting national authorities in the design, funding and implementation of projects focusing on country-specific cancer control priorities. The organizations involved have provided technical expertise, each according to their mandates, on introducing, improving or expanding cancer registration; prevention and early detection; diagnosis and treatment; and palliative care capacity. They continue to facilitate the education and training of cancer personnel in all areas, and to support the government, NGOs and cancer societies in advocacy and resource mobilization for the implementation of the national cancer control programme. PMDS projects have demonstrated the progress that can be achieved by utilizing the synergies that exist among international partners in working together with national counterparts in low and middle-income nations. Most of the PMDS have established steering committees that are developing national cancer control strategies and action plans to be recommended for adoption and implementation by their governments. Specific project proposals have been developed for some components of the cancer control programmes in Albania, Nicaragua and Tanzania and have been partially funded via grants from the OPEC Fund for International Development and the United Nations Women's Guild. PMDS are already helping to raise donor and public awareness for future national/regional/global initiatives to be funded with larger donations. After the full assessment of the PMDS in the next 5 years, this model could be replicated successfully in other low-resource countries.

25. 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. The radiotherapy units donated by MDS Nordion/Best Medical through PACT were launched in the United Republic of Tanzania and in Nicaragua in May 2008 and March 2009, respectively. It is expected that the Bhabhatron radiotherapy unit donated by the Government of India, also through PACT, will be launched in Vietnam during the third quarter of 2009.

## **F. Funding and Resource Mobilization**

26. Since its inception, PACT's resource mobilization efforts have secured or facilitated the mobilization of voluntary contributions, pledges, grants, long-term loans and donations of cash, equipment and in-kind expertise and training valued in excess of US\$ 23 million. This includes extrabudgetary contributions received since September 2007 from 11 Member States. Internally, voluntary contributions and dedications of 2004 Budget Surplus funds by 56 Member States in late September 2007 provided the support critically needed to establish and operationalize the PACT Programme Office.

27. The remaining balance in the IAEA Nobel Cancer and Nutrition Fund was used to support PACT's regional training activities. The previously reported grants pledged by the OPEC Fund for International Development (OFID) amounting to US\$ 500 000 to support three PMDS projects, and US\$ 300 000 for a footnote a/ TC cancer therapy project in Uruguay, were transferred to the Agency in 2008 and 2009. As noted above, PACT's implementing partners, in particular ACS, UICC and US NCI, also helped finance activities through in-kind support for training, impACT missions and technical support to Member States. The value of such contributions is estimated to be over \$1 million since 2007. PACT programmatic initiatives also benefited from the expertise of a radiotherapist partially supported by the Government of Japan beginning in late 2007 and a cancer control specialist financed by the Government of Switzerland.

28. Bilateral resource mobilization has also been facilitated by PACT initiatives. For example, PPO coordination of Agency-wide support in the development of technical proposals based on the recommendations of the impACT report to strengthen Ghana's national cancer control programme resulted in long-term loans by OFID and the Arab Bank for Economic Development in Africa totalling US\$ 13.5 million. Similarly, PMDS counterparts in Vietnam have credited PACT initiatives as the catalyst for bilateral support by Australia and Austria to train up to 30 professionals and provide up to six radiotherapy machines. Encouraging and supporting bilateral efforts is an area which PACT will aim to emphasize in its resource mobilization strategy. The confidence of donors in supporting these projects has been enhanced by the strong technical backing of the IAEA and WHO.

29. The PPO continues to seek non-traditional sources of funds to support its activities. The recruitment of fundraising staff in 2009 has allowed for enhanced outreach efforts to smaller scale individual donors to maximize their potential support via the PACT website (<http://www.cancer.iaea.org/>), which is able to receive direct donations of up to €10 000. The Agency is finalizing a medium-term global fundraising strategy, which will target foundations, bilateral and multilateral donors, as well as the private sector and individual philanthropists. A study conducted in 2007–2008 by a professional fundraising firm has validated PACT's approach while concluding that PACT is well-positioned to mobilize the substantial resources required to address the cancer crisis in Member States. It should also be noted that well-known personalities and experts in cancer control have indicated their willingness to assist PACT in its resource mobilization efforts.

30. The resource mobilization plan for the PMDS reported in 2007 is well underway with approximately one-third of the required funding already made available through the various modalities described above. Current efforts for additional funding focus on contacting key bilateral and private donors that are already active in the PMDS in non-cancer related activities to raise their awareness about cancer in developing countries and to provide them with information on the PMDS projects for which funding is being sought. The PPO continues to pursue larger funding possibilities for the Africa region based on its original funding request to the European Union. This will be combined with the development of the Regional Cancer Training Network project referred to in paragraph 17 above. Funding proposals have already been developed and submitted to one potential donor and more are under preparation.

31. The establishment of an endowment fund -- the PACT Fund -- at the National Foundation for Cancer Research (NFCR) provided the framework for US-based donors, both individual and institutional, to support PACT initiatives. The private fundraising effort in the United

States was launched at the United Nations Headquarters in New York in October 2007 by the IAEA Director General and was attended by more than 80 leading cancer experts, activists and philanthropists. NFCR has provided several opportunities for PPO staff to develop potential donor relationships in the U.S., including through participation in a high-level oncology research and development meeting. In December 2008, in conjunction with a visit by the Director General to Monaco, His Serene Highness Prince Albert II of Monaco hosted a gala dinner in Monte Carlo to introduce PACT to potential donors. The PPO is further developing the contacts made on this occasion. A valuable source of support has been Korea's KONICOF, which has engaged in fundraising efforts on behalf of PACT since 2007 by seeking small, often monthly, donations from Korean citizens and businesses, and has already contributed US\$ 30 000 in cash to PACT projects. Finally, two new donors joined others in 2008 to support PACT, namely, the United Nations Women's Guild with €7 000, and the United Nations Federal Credit Union (UNFCU) with US\$5 000. These funds were assigned to specific proposals to address the palliative care needs of adults and children with cancer in Africa.

## **G. Raising Awareness and Outreach**

32. Raising awareness about the global cancer burden in low and middle income countries continues to be one of PACT's greatest challenges. The Lance Armstrong Foundation (LAF) approached PPO in 2008 for advice on organizing its global initiative and has since formalized a partnership with the Agency through a PACT Practical Arrangement. The LAF has achieved great success in the United States for cancer patient empowerment and resource mobilization, and PACT expects to benefit from cooperation with LAF's global efforts to fight cancer in developing countries. In 2009, PPO participated in the LIVESTRONG Global Cancer Summit in Dublin, Ireland. The Agency also concluded an agreement with an independent media and outreach firm, the *mondofragilis Group*, to make, together with IARC and UICC, the documentary titled, *Cancer is... 2008*, in order to raise awareness about cancer and the status of the international fight against it. Further, PACT is providing input to the UN Economic and Social Council's 2009 discussion to review the Millennium Development Goals and is encouraging the inclusion of cancer as a priority for developing countries. PACT has also conducted briefings and meetings with bilateral development agencies to increase awareness and build support for cancer control initiatives.

33. PACT continues to devote resources to conducting outreach via its website, which is continuously updated with news, information and descriptions of regional and project activities, and provides access to resources and publications. The website is receiving a growing number of visitors and is expected eventually to become an important platform for fundraising. In addition, PACT brochure, posters, and informational materials have been developed and are available in several official IAEA languages. Collaboration with the Agency's Division of Public Information (MTPI) has resulted in the development of human and public interest stories and multi-media presentations and press releases, as well as in the production of a second Public Service Announcement aired regularly on CNN International. Together with the VIC Medical Services and NAHU, PPO organized Cancer Day events at

the Vienna International Centre in 2008 and 2009 to raise awareness about cancer and its impact on developing countries among VIC-based staff, the diplomatic corps and visitors.

## **H. Achieving the Cancer Mandate: 2010 and beyond**

34. While progress has been achieved on a number of fronts, as described above, much remains to be done in all areas of PACT's work. During the remainder of 2009 and through the 2010–2011 biennium, a key priority will be to bring the WHO-IAEA Joint Programme on Cancer Control to fully operational status and to maximize its benefits in terms of accelerated programmatic delivery to Member States and enhanced resource mobilization potential. PPO will continue to coordinate the Agency's contributions to the Joint Programme with an initial focus on the PMDS. Later, these activities may be expanded to additional Member States within each region, in particular by meeting requests for imPACT reviews using available extrabudgetary funding.

35. The most vital issue for PACT during the next 3–5 years will be to deliver concrete benefits to the citizens of all the PMDS countries and to successfully demonstrate that international agencies can cooperate and extract synergies to maximize their individual and collective impact. Also, it will seek to further acquire field experience and an understanding of cancer capacity building in low income nations. When this phase is considered by the IAEA, WHO and other key players to be progressing successfully, subject to evaluation by independent experts, PACT will be able to expand its fundraising efforts to other developing countries by presenting the results achieved to major donors for larger scale resource mobilization efforts. As PACT's current demonstration sites near completion, significant attention will need to be paid to training and, in particular, to the establishment of *Regional Cancer Training Networks* and a *Virtual University for Cancer Control* to train staff in all areas of cancer care. While PACT is planning to devote substantial resources to these activities, it will continue, to the extent feasible, to offer imPACT reviews to all countries requesting assistance. It will also continue to work with WHO and other partners towards a global programme to fight cancer in the developing world in an effective and sustainable manner.



# Use of Isotope Hydrology for Water Resources Management

## A. Background

1. At its fifty-first session in September 2007, the General Conference, through resolution GC(51)/RES/14.A.4, requested the Director General to strengthen the efforts directed towards fuller utilization of isotope and nuclear techniques for water resources development and management in interested countries through appropriate programmes, by increased collaboration with national and other international organizations; to help Member States obtain easy access to isotopic analysis; to continue work on groundwater management; to strengthen activities which contribute to the understanding of the climate and its impact on the water cycle; and to continue to develop human resources in isotope hydrology. It further requested the Director General to report on achievements in implementing resolution GC(51)/RES/14.A.4 to the Board of Governors and to the General Conference at its fifty-third session.

## B. Developments since the General Conference's 2007 session

2. The United Nations' Commission on Sustainable Development (CSD) in its 16<sup>th</sup> and 17<sup>th</sup> sessions focused on the thematic areas of agriculture, rural development, land, drought, desertification, and Africa, where water was a critical and cross-cutting issue. The CSD sessions provided a platform for Governments, the UN and other important actors, including the private sector, to reinvigorate their resolve to tackle the global food price crisis, meet the hunger and malnutrition challenge and contribute to the achievement of the Millennium Development Goals (MDGs) and the Johannesburg targets and commitments. The goals of poverty eradication, food security and sustainable natural resource management, particularly water resources, were emphasized as inter-linked and to be addressed in a coherent and integrated manner.

3. The 5<sup>th</sup> World Water Forum and Ministerial Conference was held in March 2009 in Istanbul, Turkey. Ministers of water from nearly one hundred countries considered the following, among others, as important aspects of the international water agenda: i) strengthening the understanding of the impacts of global climate and land use changes on water resources, natural hydrological processes and ecosystems; ii) assessment of varying hydrological conditions, extreme water events and the shape and functionality of existing infrastructure in the context of understanding the impacts of global climate and land use

changes on water resources; iii) support of scientific research, education, development and adoption of new technologies in the field of water and promotion of their utilization for the sustainable use and management of water resources.

## **B.1. Raising Awareness of the Agency's Work and the Role of Isotope Hydrology in Water Resource Management**

4. A number of activities were implemented by the IAEA Water Resources Programme at the international water events mentioned above to raise awareness of the Agency's work and of the role of isotope hydrology in water resources management. Two "learning centres" were organized as a part of the 16<sup>th</sup> and 17<sup>th</sup> sessions of the CSD at UN Headquarters. These learning centres, entitled *Innovative Technologies for Sound Decision-making in Water Resources Management* and *Increasing Water Availability and Sustainable Use by Comprehensive Assessment of Water Resources*, were well attended by a diverse group of participants. In addition, two side events on combined energy, water and land-use planning were also organized and were well attended.

5. The Water Resources Programme developed information materials and scientific data aimed at disseminating the results of the Agency's work to the public at large and to experts in Member States. Information booths were established at the Water Expo held in Zaragoza, Spain, in August 2008; at the 5<sup>th</sup> World Water Forum in Istanbul, Turkey in March 2009; and at the meeting of the European Geophysical Union, which was held in Vienna in April 2009. An Agency-produced film entitled *Search for Water*, was screened at all of these events. The film, which is currently available on the Agency's website, describes the challenges in water resources management and introduces the topic of isotope hydrology in a manner that is targeted both at scientists and non-scientists. The Agency exhibit at Zaragoza also included displays, posters and other reading material related to the use of isotopes for water resources management. The Agency's exhibit in Zaragoza had more than 15 000 visitors, and was highly rated both by the organizers and the visitors. Large numbers of visitors were also present at the other information booths of the Agency.

6. The Agency co-sponsored an international conference in Kampala, Uganda, on *Groundwater and Climate in Africa*. The Agency's contributions brought about an increased awareness of the use of isotopes for understanding the impact of climate change on groundwater recharge. The conference was the first to discuss the role of groundwater in improving livelihoods in Africa under conditions of rapid development and climate change. The outcome of the conference was a road-map for policy makers for adapting to the impacts of climate change on water resources. In addition, it emphasized the need for increased regional cooperation in water resources assessment.

## **B.2. Expanding Access to Isotope Techniques and Information**

7. The Agency achieved a milestone in providing easier access to Member States for stable isotope analysis of water samples: a new instrument for isotope analysis that uses a laser spectroscopy technique was tested and adapted for Member State use. This instrument costs about 75 percent less than existing mass spectrometers, and performs equivalent analyses with very low operation and maintenance costs. The Agency is assisting Member States, where appropriate, to obtain this instrument within the framework of their technical cooperation projects. About twenty Member States are expected to have installed and begun operation of this instrument by the end of 2009.

8. Scientists/technicians from Member States were trained in the operation of the laser isotope analysis instrument, in the evaluation of results and in quality control procedures at several IAEA training events. In addition, an audio-visual guide to assemble, operate and use the laser instrument has been developed by the IAEA, and will soon be available to Member States.

9. During 2008, the Agency completed a CRP on the application of isotopes to understand water and carbon cycle dynamics in the atmosphere. Nine countries participated in the collection of over 10 000 samples of atmospheric moisture and plant water at 51 field sites. The results helped to improve the understanding of water and carbon cycle processes, particularly to quantify carbon and evaporation fluxes from land surfaces. Quantification of these fluxes provides a means to validate general circulation models used for simulating the impact of climate change on the water cycle.

10. Following the publication of the *Atlas of Isotope Hydrology - Africa* in 2007, the second Atlas of Isotope Hydrology was published in 2008. This atlas includes approximately 16 000 isotope records from Agency projects carried out between 1973 and 2007 in 16 Member States in Asia and the Pacific. The atlases of isotope hydrology provide easy access to historical data that can be used for water resources management at local and regional scales, as well as in formulating future TC projects.

11. The French translation of a widely used IAEA/UNESCO publication titled *Environmental Isotopes in the Hydrological Cycle* was published in 2008 to facilitate the training and practice of isotope hydrology in Francophone countries. With this translation, the original publication is now available in English, French and Spanish.

## **B.3. Capacity Building and Human Resource Development through Technical Cooperation**

12. The Inception Meeting of a regional technical cooperation project on *Mainstreaming Groundwater Considerations into the Integrated Management of the Nile River System*, which was approved for the 2009-2011 TC cycle and is being implemented in partnership with the Global Environmental Facility (GEF) and UNDP, took place in Vienna in January 2009. The project aims to provide the scientific basis and necessary institutional and policy support for incorporating a groundwater dimension into the planning and management of the Nile ecosystem as an essential component of sustainable development of the Nile basin. The following countries participate in the project: Burundi, Democratic Republic of Congo, Egypt,

Ethiopia, Kenya, Rwanda, Sudan, Uganda and the United Republic of Tanzania. Under the same IAEA/GEF/UNDP partnership another regional project involving Eritrea, Ethiopia, Kenya, Uganda and the United Republic of Tanzania, *Introducing Isotope Hydrology for Exploration and Management of Geothermal Resources in the African Rift System*, is also being implemented.

13. A technical cooperation project on the Nubian Sandstone Aquifer System (NSAS), which was approved in 2006, and is also being jointly implemented together with GEF and UNDP with the participation of Chad, Egypt, Libya and Sudan, is making progress. The project so far has resulted in: (i) the development of a regional stakeholders analysis, causal chain analysis and governance analysis for all countries; (ii) the first ever stakeholders meeting on the Nubian Aquifer in Egypt and Sudan; (iii) the hiring of a dedicated team to work on the modelling of the Nubian Aquifer in 2009; and (iv) the second Steering Committee Meeting, held in January 2009.

14. In 2009, a regional project on *Building Capacity in Support of Regional and Sub-regional Water Resources Planning, Development and Management* was launched under AFRA, with Agency support. The overall objective of the project, which attracted 15 Member States, is to build Africa's capacity to integrate isotope techniques in the planning, development and sustained management of water resources of the region. The project will achieve this by supporting and enhancing regional training centres and providing analytical services. During the first Coordination Meeting of the project, held in April 2009 in Kampala, Uganda, participants shared their experiences in the use of isotope hydrology techniques in water resources management, and identified areas where this can be enhanced. Based on a review of earlier efforts, Member States have learned how they can coordinate their efforts in mainstreaming the use of isotope techniques, in combination with conventional techniques, in the development of the water sector. The establishment of Regional Designated Centres under AFRA for analytical services and training is facilitating regional cooperation, capacity building and the increased use of isotope methods.

15. In a similar effort at the sub-regional level, representatives from five French-speaking Member States in West Africa (Benin, Burkina Faso, Cameroon, the Central African Republic and Niger) participated in a Coordination Meeting in March 2009 on the introduction and harmonization of technical cooperation projects on water resources. The objective of the meeting was to review, optimize and finalize the work plans of respective projects to ensure the smooth implementation of planned inputs related to the development of human resources in isotope hydrology and Geographic Information Systems GIS and to the planning of field activities. Meeting participants reviewed the sites and timeframe identified for the collection of water samples for isotope analysis, as well as the requirements for data analysis. They were also introduced to the new laser spectroscopy instrument for isotope analysis.

16. The first project meeting under the RCA project titled *Assessing Trends in Freshwater Quality Using Environmental Isotopes and Chemical Techniques for Improved Resource Management* (approved for 2009-2011) was held in Kuala Lumpur, Malaysia, in April 2009. Participants discussed emerging issues and priority needs in water resource development and management and were sensitized to the advantages and cost-effectiveness of isotope techniques for understanding surface water-groundwater interactions and connections between aquifers, as well as the mechanisms of aquifer recharge and contaminant migration in groundwater. In addition, the meeting helped the Agency to better understand the most

pressing needs of Member States in the field and to define with them the most suitable solutions to address these needs under the project. As a result, capacity building in specific fields of isotope hydrology will receive particular emphasis together with regional cooperative initiatives.

17. The Middle East is an arid to semi-arid region and there is a need to explore the possibility to store water through artificial recharge in selected aquifers, and to make use of these aquifers during drought periods. Under an ARASIA project, *Use of Isotopes and Geochemical Techniques in the Study of Artificial Recharge in Groundwater*, approved in 2005, the Agency has been assisting participating countries in carrying out relevant studies and has contributed to human capacity building in data interpretation of chemical and isotopic data for artificial recharge studies, field sampling and laboratory analysis, and in the modelling of geochemical data. The results of these detailed geochemical and isotopic investigations have been used to characterize the studied sites and to provide criteria for the best locations to be selected for this purpose.

18. Agency technical cooperation activities in Latin America since 2007 have focused on the assessment of transboundary aquifers, thereby learning valuable lessons and achieving technical results that are necessary to consolidate scientific and technical knowledge in support of regional cooperation and national authorities' efforts to formulate strategic action plans. Two recently completed projects, one on *Sustainable Integrated Management of the Guarani Aquifer System*, and the second on *Sustainable Development of the Environment and Water Resources in the Upper Lempa River Basin*, underscore the transboundary approach. The projects were implemented with strong regional vision and leadership and were designed to support larger development programmes and policy making decisions. National technical capacity was enhanced, new tools were introduced, technical networks were established and new products such as hydrogeological maps were developed, which increased knowledge and facilitated sound transboundary policy making and cooperation.

#### **B.4. Developing Partnerships and Increasing Collaboration with Other UN Organizations**

19. To build new opportunities for cooperation in the area of river basin management, the IAEA Water Resources Programme participated in the second International Joint Danube Survey organized by the International Commission for the Protection of the Danube River (ICPDR). The survey was conducted in 2007 over the 2400 km course of the Danube River from its headwaters in Germany to the Black Sea. This was the first time isotope studies were implemented in the Danube survey. In addition to serving as a baseline for monitoring the impact of climate change on river hydrology, the isotope data improved the understanding of river hydrology and nutrient sources and contributed to more effective transboundary cooperation to meet the European Union Water Framework goals.

20. In collaboration with the Global Environment Facility (GEF) the Agency organized in 2008 an international study tour for three aquifer management teams: the Guarani in Latin America, and Northwest Sahara and Iullumedden in Africa. Conducted by the US Geological Survey (USGS) at various locations in the USA, the objective of the study tour was to enhance the management of transboundary aquifers in concerned Member States by sharing knowledge, experience and best practices. The study tour provided the basis for building a

network of groundwater professionals active in GEF-supported groundwater projects and to integrate isotope techniques in these projects.

21. The Agency developed a concept for an IAEA-led partnership to increase the availability of national water resources assessments in Member States. The concept was formulated in cooperation with UNDP, FAO, UNESCO, WMO, and other members of UN-Water, as well as the US Geological Survey. The partnership is expected to be initiated in 2010.

22. The Agency's Isotope Hydrology Analytical Network (IHAN), which supports the analytical needs of technical cooperation projects, CRPs and global isotope networks, was expanded and now includes 17 laboratories from 15 Member States: Argentina, Austria, Brazil, Chile, Egypt, El Salvador, France, Germany, Mexico, Morocco, the Netherlands, Pakistan, Poland, Tunisia and Vietnam.

# Nuclear Energy Activities

1. This annex summarizes highlights of Agency activities not covered in Annexes 5, 6, 7 and 8, which address potable water, innovative nuclear technology, small and medium sized reactors, and infrastructure development for nuclear power, respectively.
2. The Agency's 2009 updates of its own projections for global growth in nuclear power revised both the low and high projections upwards. In the updated low projection, global nuclear power capacity reaches 511 GW(e) and, in the updated high projection, 807 GW(e) for 2030, compared to 372 GW(e) at the end of 2008.
3. The Agency attended the 14th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP-14) in Poznan, Poland, in December 2008, and the 17th session of the Commission on Sustainable Development (CSD-17) in New York in May 2009. At COP-14, the Agency organized two side events with the Polish Nuclear Energy Agency and the OECD/NEA. The Agency also released a special publication, *Climate Change and Nuclear Power 2008*, which provides information on all aspects of nuclear power in the context of current climate change concerns and presents national perspectives from seven countries. The booklet confirms the diversity of reasons to introduce or expand nuclear power (including climate change mitigation, energy supply security, fossil energy price volatility and regional air pollution), as well as concerns that still exist (such as operational safety, proliferation and waste disposal). The Agency further raised its profile, as had been requested by Member States, by providing an on-site information centre, staffed throughout the conference, to distribute publications and answer questions. At CSD-17 the Agency organized a side event on the connection between climate, land-use, energy and water strategies, and presented results from a case study to develop an integrated quantitative tool for combined energy, water and land use planning.
4. The Agency organized an International Ministerial Conference on Nuclear Energy in the 21<sup>st</sup> Century in Beijing, China, in April 2009, hosted by the Government of China. The conference reviewed the status and prospects of nuclear power, including progress in the evolution of technology, and discussed actions necessary for further nuclear power expansion. The concluding statement by the President of the Conference, noted that, "(w)hile respecting the right of each State to define its national energy policy in accordance with its international obligations, the vast majority of participants affirmed that nuclear energy, as a proven, clean, safe, competitive technology, will make an increasing contribution to the sustainable development of humankind throughout the 21<sup>st</sup> century and beyond."
5. An increasing number of Member States have nuclear knowledge management programmes in place or are developing such programmes. The Agency provides assist visits, training and reference documents. It facilitates networking and helps directly to preserve nuclear knowledge. Since September 2008, the Agency published *Planning and Execution of Knowledge Management Assist Visits for Nuclear Organizations* (IAEA-TECDOC-1586), *Fast Reactor Knowledge Preservation System: Taxonomy and Basic Requirements* (Nuclear Energy Series No. NG-T-6.3) and *Development of Knowledge Portals for Nuclear Power Plants* (Nuclear Energy Series No. NG-T-6.2). It completed assist visits to Kazakhstan and Malaysia to provide assistance, education and advice on best practices and strategies in knowledge management, and conducted a regional training course in Vienna on the

development of the ANENT (Asian Network for Education in Nuclear Technology) cyber platform and distance learning, at which participants from Asia received training in operating the ANENT web portal and cyber platform. In April 2009, the Agency signed an agreement with the Korea Atomic Energy Research Institute to jointly maintain and operate the web system of ANENT. And in June 2009, it signed an agreement with the European Nuclear Education Network Association to jointly strengthen nuclear education worldwide, including through the development of new training materials, courses and curricula for ANENT.

6. Through peer reviews, databanks, training, CRPs and the publication of technical guidance and reference documents, the Agency supports interested Member States in improving the performance of operating nuclear power plants. Documents published since September 2008 cover on-line monitoring for improved performance (Nuclear Energy Series Nos. NP-T-1.1 and NP-T-1.2), heavy component replacement (Nuclear Energy Series No. NP-T-3.2), the role of instrumentation and control systems in power uprating projects (Nuclear Energy Series No. NP-T-1.3), introducing digital instrumentation and control systems (Nuclear Energy Series No. NP-T-1.4), irradiation embrittlement effects in reactor pressure vessel steels (Nuclear Energy Series No. NP-T-3.11) and reliability centered maintenance (TECDOC -1590). Two CRPs, carried out together with OECD-NEA and EC Joint Research Centre, were completed on detailed engineering analyses of the structural integrity of reactor pressure vessels.

7. Interest in uranium exploration, mining and production continues to rise. Since September 2008 meetings were organised in Vienna and Amman, Jordan, on uranium exploration, best practices in uranium mining and processing, advanced mining and milling methods and equipment, mine remediation and environmental issues. At the 52<sup>nd</sup> General Conference in 2008 the Agency also relaunched its UPSAT programme (Uranium Production Site Appraisal Team). UPSAT was originally created in 1996, but was never used given the decline at the time in the global uranium production industry. UPSAT reviews will be conducted at the request of Member States. They are peer reviews to exchange experience and work practices and provide independent, international expert advice.

8. In 2009 new TC projects on the uranium production cycle started in Algeria, Argentina, Brazil, China, Egypt, Jordan and Venezuela, and regional projects started in Africa and Latin America. In June 2009, the Agency organized the *International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle: Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues (URAM-2009)*. It addressed all aspects of the uranium production cycle, from the availability of raw materials to the long-term sustainability of nuclear power.

9. In May 2009 the IAEA organized the *International Conference on Remediation of Land Contaminated by Radioactive Material Residues* in Astana, Kazakhstan. It addressed new technologies, life-cycle planning, financing mechanisms, regulatory issues, and stakeholder involvement (see also GC(53)/INF/2). In addition, the Agency extended a regional TC project, begun in 2005, involving all four Central Asian Member States in the remediation of uranium mining and milling sites. Its objectives include developing both a consistent regulatory framework throughout the region and an overall action plan for the full implementation of environmental programmes.

10. The global volume of stored spent fuel continues to increase, and expected storage periods continue to lengthen to as much as 100 years. Agency activities cover technology for spent fuel storage and the long term behaviour of spent fuel and storage components. Since

September 2008, the Agency has published *Spent Fuel Reprocessing Options* (IAEA-TECDOC-1587). Two documents have been approved for publication but not yet published: *Management of Damaged Nuclear Fuel* and *Costing of Spent Fuel Storage*. A CRP on spent fuel performance assessment and research (SPAR-II) held its final review of results on compiling and assessing the experience of different countries with both wet and dry spent fuel storage. The main focus was on degradation mechanisms affecting fuel element materials for both undamaged and damaged fuel. A new CRP, SPAR III, was begun in 2009. It continues work on the same topic but with a focus on long term storage. Preparations have begun for the International Conference on Management of Spent Nuclear Fuel from Power Reactors, which will be held from 3 May to 4 June 2010 in Vienna, Austria.

11. The International Decommissioning Network (IDN) was launched at the 51<sup>st</sup> General Conference in 2007 to improve the flow of knowledge and experience among those engaged in decommissioning and to encourage organizations in developed Member States to contribute to the activities of Member States requiring decommissioning assistance. It provides practical training for decommissioning planners and managers to speed decommissioning of disused nuclear facilities around the world. In 2008 it organized workshops on size reduction of components hosted by SCK/CEN, Belgium, and on materials management and clearance hosted by ENRESA, Spain. Efforts in 2009 are focussed on making the network fully self-sustaining and strengthen direct assistance among participants.

12. Following the successful start of the IDN, the Agency launched an international low-level waste disposal network (DISPONET) at a technical meeting in April 2009 with representatives from 21 Member States. DISPONET addresses the disposal of very low level waste, low- and intermediate level waste, and disused sealed radioactive sources using both surface and subsurface facilities, including borehole disposal. It seeks to coordinate support to Member States with less advanced programmes through organising training and demonstration activities. DISPONET members have offered to host eleven workshops and training courses in 2009 and 2010. Preparations are underway for an international workshop in France on post-operational environmental monitoring and surveillance of disposal facilities, and for regional training courses in Asia and Latin America on near surface repository development.

13. The year 2008 saw shortfalls in important medical and industrial radioisotopes, particularly molybdenum-99, due to the repeated unavailability of some of the few large ageing research reactors used for production. In this area, the Agency published in August 2008 a document on *Optimization of Research Reactor Availability and Reliability: Recommended Practices* (IAEA Nuclear Energy Series No. NP-T-5.4), which compiles lessons learned from operating diverse heavily utilized research reactors and recommends specific operations and maintenance practices to improve performance. The Agency also leads a CRP on molybdenum-99 production from low enriched uranium (LEU) targets.

14. The Agency promotes regional collaboration to improve the utilization of small and medium size research reactors. In 2008, the Agency organized a technical meeting on strategic planning for research reactor utilization in the Mediterranean region leading to the creation of a Mediterranean Research Reactor Users Network (M-RRUN). Research reactor coalitions were also formed in Eastern Europe, the Caribbean and Central Asia regions. In addition to these geographically defined coalitions, one topically oriented research reactor network was also begun, on Residual Stress and Texture Analysis for Industrial Partners (STRAINET).

15. The Agency continued to support Member States participating in international programmes to return research reactor fuel to its country of origin. At the request of Portugal and the US Foreign Research Reactor Spent Nuclear Fuel acceptance programme, the Agency contracted for the removal and repatriation of 7 kg of US origin spent high enriched uranium (HEU) fuel from Portugal, the first time the Agency played such a role in repatriating fuel to the United States. As part of the Russian Research Reactor Fuel Return Programme, the Agency assisted in the repatriation to the Russian Federation of spent HEU fuel from Bulgaria, Hungary and Latvia.

16. The technical cooperation project to repatriate spent fuel from the RA research reactor at the Vinča Institute in Serbia, continued on schedule. In June 2009, the Russian Federation agreed to receive all used fuel (2.5 tonnes of HEU and LEU) from the RA research reactor at Vinca. In 2008, manufacturing began on custom designed equipment to clean and prepare the water in the spent fuel pond for fuel repackaging. Repackaging is planned to start in autumn this year. All fuel is scheduled to be transported to the Russian Federation as a single shipment in 2010. It is currently stored inside the reactor building in a water pool, which was designed as a temporary storage.

# Producing Potable Water Economically Using Nuclear Reactors

## **A. Background**

1. In resolution GC(52)/RES/12.A.4, the General Conference noted that nuclear desalination using nuclear energy is technically feasible and generally cost-effective, and that it has been successfully demonstrated. It also noted that a number of Member States have expressed interest in seawater desalination using nuclear energy. The General Conference invited the Director General to continue activities to assist Member States interested in seawater desalination using nuclear energy and requested that he report on progress to the Board of Governors and to the General Conference at its 53<sup>rd</sup> session. This report responds to that request.

## **B. International Nuclear Desalination Advisory Group (INDAG)**

2. In resolution GC(52)/RES/12.A.4, the General Conference invited INDAG to continue its functions as a forum for advice and review on nuclear desalination activities. At the end of 2008, INDAG completed its third term of work. In line with the effort to harmonize the terms of reference for all technical working groups in the Department of Nuclear Energy, revised terms of reference were adopted for INDAG, which was renamed the Technical Working Group on Nuclear Desalination, TWG-ND.

3. The TWG-ND held its first meeting in July 2009. The eighth issue of the Nuclear Desalination newsletter will be published in September 2009.

## **C. Activities of the Agency**

4. In line with the INDAG recommendation noted in GC(52)/RES/12.A.4, the Agency is developing a 'nuclear desalination toolkit' aimed at providing guidelines on how to launch desalination programmes in Member States. The first version of the toolkit was released in July 2009. The Agency continues to update and revise the Agency's Desalination Economic Evaluation Program (DEEP) software with the help of external consultants. The new version, DEEP 3.2, was released in early 2009 and has undergone preliminary benchmarking. It has new templates to include Rankine cycles, a detailed water cost transport model, an improved

interface and more secure templates. Several Member States are supporting these efforts with cost-free experts.

5. With extrabudgetary support from the Abdus Salam International Centre for Theoretical Physics (ICTP), the Agency organized a Workshop on Technology and Performance of Desalination Systems, which was held in Trieste, Italy, from 11 to 15 May 2009. Scientists and engineers from several Member States were trained in evaluating the technology and performance of energy sources and water desalination systems. This covered alternative combinations of different desalination processes with various sources of energy such as combined cycles, gas turbines, coal combustion and nuclear reactors, and included economic evaluations using the DEEP software.

6. With extrabudgetary support from the USA, work began in 2009 on alternative and additional water sources (e.g. recycled or desalinated water) for water cooled nuclear power plants and on efficiency measures to decrease their water use. A technical document is being prepared with the objectives of evaluating current practices related to water use; identifying design and operational strategies to increase water efficiency; and suggesting ways to advance water management in nuclear power plants in the medium and long term.

7. The Agency completed and published an NE Series document on the environmental impacts of nuclear desalination. The report covers both adverse impacts, such as brine pollution, and beneficial impacts, such as the preservation of existing natural water resources. The report provides preliminary guidelines for assessing environmental and socio-economic impacts as part of an integrated feasibility study of nuclear desalination.

8. The Coordinated Research Project (CRP) on *Advances in Nuclear Power Process Heat Applications* is expected to be completed in 2009. The project's objective is to evaluate possible low and high temperature applications of high temperature reactors for nuclear hydrogen production and, in the case of waste heat, for seawater desalination. A technical document reporting the CRP's results is under preparation.

9. The Agency started a new CRP in 2009 on *New technologies for Seawater Desalination using Nuclear Energy*. The CRP focuses on new technologies to make nuclear desalination safer and more economical and supports R&D in nuclear desalination technologies for cost-effectively producing large volumes of desalted water in a sustainable manner. It is intended particularly for developing countries interested in nuclear energy for seawater desalination and cogeneration.

## **D. Information exchange**

10. The Agency continues to provide an international forum for exchanging information on nuclear desalination, including information on design, operation, coupling, safety, experience, socio-environmental impacts, and monitoring the water produced by desalination plants.

11. In March 2009, in cooperation with the Korea Atomic Energy Research Institute, the Agency organized a technical meeting on 'Non-electric Applications of Nuclear Energy' in Daejeon, Republic of Korea. The meeting focused on nuclear desalination and hydrogen

production and recommended, *inter alia*, that the Agency should promote greater collaboration among Member States on non-electric nuclear energy applications.

12. The Agency's website for nuclear desalination ([www.iaea.org/NuclearPower/Desalination](http://www.iaea.org/NuclearPower/Desalination)) continues to provide access to all relevant Agency publications on the status of nuclear seawater desalination technology, as well as to the Agency's current and planned activities.

## E. Activities of the Member States

13. Algeria plans to assess nuclear energy potential for producing electricity and desalinated water. It completed a preliminary feasibility study on seawater desalination using nuclear reactors at two potential sites, Mostaganem and La Macta. The study concluded that nuclear desalination is more competitive than conventional desalination using fossil energy.

14. In 2007, China started the construction of the Hongyanhe nuclear power plant (NPP), which is expected to begin operation in 2012. This NPP is expected to generate power and 100 000 m<sup>3</sup>/day of desalinated water. The desalinated water is to be used both on site and to provide potable water for residential use. The Ningde NPP is also expected to include nuclear desalination. Construction started in early 2008, and the NPP is expected to begin operation in 2013. Its desalination capacity is 11 000 m<sup>3</sup>/d, which will be used as make-up water for the NPP. A feasibility study was completed on the Shandong nuclear desalination plant. It confirmed the feasibility of using the NHR-200 nuclear heating reactor to produce 120 000 m<sup>3</sup>/d using multi-effect distillation – thermal vapour compression (MED-TVC) and 250 000 m<sup>3</sup>/d using hybrid reverse osmosis/MED (RO/MED).

15. In 2008, Cuba completed a feasibility project on seawater desalination that used the IAEA DEEP software to evaluate small-scale desalination of brackish water for thinly populated small islands. Although the results of the feasibility study did not include the use of nuclear power, DEEP, in particular, identified the variables that most influenced the total specific water cost for different alternatives.

16. France continues to develop engineering support systems for nuclear desalination studies and collaborates with India on the validation and application of process models and recovery of valuable elements (e.g. uranium, germanium, magnesium and rubidium) from the brine of seawater desalination. France is also exploring with Libya the possible coupling of the Tajoura nuclear research reactor to an experimental desalination unit, as well as the feasibility of producing desalinated water using a PWR.

17. Japan continues to operate desalination plants at ten nuclear power reactors for the production of make-up water.

18. In April 2009, India successfully commissioned the 4500 m<sup>3</sup>/day multi-stage flash (MSF) desalination unit at the Nuclear Desalination Demonstration Plant (NDDP) at Kalpakkam. The NDDP is coupled to the Madras Atomic Power Station. This is the latest of three successful nuclear desalination demonstration projects in India, including the first nuclear desalination plant based on low temperature evaporation coupled to a research reactor, CIRUS. India continues to investigate the possibility of coupling a nuclear

desalination plant to the nuclear research reactor Dhruva at Trombay and integrating a large desalination plant with India's Advanced Heavy Water Reactor (AHWR).

19. Studies carried out in Indonesia indicate that the share of nuclear power in 2025 could be as high as 4% of total electricity production. Indonesia is planning to use nuclear power in cogeneration mode for electricity generation and seawater desalination.

20. Pakistan is constructing a demonstration plant for desalination using MED (multi-effect distillation), which is to be coupled to the Karachi Nuclear Power Plant. The project is scheduled for completion and commissioning by the end of 2009.

21. The Russian Federation continues construction work of a floating barge-mounted heat and power cogeneration nuclear plant. It is based on the small PWR-type reactor KLT-40S, which could also be used for desalination.

22. The Republic of Korea is evaluating plans for the next phase of the SMART project, which will seek a standard design approval from the licensing authority.

23. In addition to its cooperation with France described above, Libya is using APROS, a commercial process simulation software package procured through an IAEA technical cooperation project, to model and analyze the coupling of thermal desalination plants with nuclear reactors. APROS was used earlier to assess the design data of the 1200 m<sup>3</sup>/day thermal desalination plants available at the industrial desalination fabrication facility in Tripoli, Libya.

24. In the USA, within the context of the Global Nuclear Energy Partnership (GNEP), the Argonne National Laboratory completed an economic assessment for a GNEP partner country in early 2009. The study concluded not only that cogeneration for electricity and freshwater using a pressurized water reactor-type plant was a viable reason for nuclear energy development, but also that it could generate substantial revenue.

25. Several other countries are considering launching programmes for nuclear desalination demonstration or for desalination as part of cogeneration on either a national or multilateral basis. These countries include Egypt, Jordan, Kuwait, Saudi Arabia, Syrian Arab Republic, the United Arab Emirates and other countries of the Gulf Cooperation Council (Bahrain, Oman and Qatar).

# Agency Activities in the Development of Innovative Nuclear Technology

## A. Background

1. In resolution GC(52)/RES/12.B.3, the General Conference encouraged interested Member States to jointly consider developing and deploying innovative nuclear power systems, recommended continued work to this end by the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), asked the Secretariat to address the 2007 Programme Evaluation Report recommendations regarding INPRO, and requested the Director General to strengthen the Agency's efforts related to the development of innovative technology, in particular by better coordinating activities of the Technical Working Groups (TWGs) and INPRO. The General Conference further requested that the Director General report on the progress made to the Board of Governors and the General Conference at its fifty-third (2009) regular session.
2. This report responds to that request, it summarizes activities carried out under INPRO and other Agency activities related to innovative nuclear technology.

## B. INPRO Activities

### B.1. Overall Project Status

3. In response to eleven recommendations in the 2007 Programme Evaluation Report (GOV/INF/2008/3), INPRO's organizational structure was streamlined to increase flexibility, and a joint action plan was established that identifies the work scope and inputs required from all relevant Agency Departments. In the Agency's draft Programme & Budget for 2010–2011 the interlinking of INPRO with other Agency programmes was described. Although INPRO is still largely funded by extrabudgetary contributions, in 2008 one Member State committed to provide resources to INPRO for five years, which added stability and, for the first time, allowed for longer term planning.
4. The Agency published its first comprehensive INPRO progress report at the end of 2008. The report provides a detailed account of the status of all INPRO activities in 2008, highlights and outputs delivered. It has been made available to all IAEA Member States.
5. At the beginning of 2009, INPRO activities were consolidated into five substantive areas, which also form the basis for the INPRO action plan for 2010–2011:
  - (a) Nuclear energy system assessments (NESAs) using the INPRO methodology developed in Phase 1.
  - (b) Establishment of a global vision on sustainable nuclear energy.

- (c) Promotion of innovations in nuclear technology.
- (d) Promotion of innovations in institutional arrangements.
- (e) The INPRO Dialogue Forum, a cross-cutting area to foster information exchange between nuclear technology holders and technology users.

6. Since September 2008, INPRO's membership has increased with the addition of Italy and Kazakhstan. Total membership is now 30: Argentina, Armenia, Belarus, Belgium, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, France, Germany, India, Indonesia, Italy, Kazakhstan, Republic of Korea, Japan, Morocco, Netherlands, Pakistan, Russian Federation, Slovakia, South Africa, Spain, Switzerland, Turkey, Ukraine, USA and the European Commission (EC).

## **B.2. Nuclear energy system assessments (NESA) using the INPRO methodology**

7. The nine-volume user manual for the INPRO methodology, Guidance for the Application of an Assessment Methodology for Innovative Nuclear Energy Systems (IAEA-TECDOC-1575), was published in February 2009. The manual includes an overview volume and topical volumes on economics, reactor safety, fuel cycle safety, environment, waste management, proliferation resistance, physical protection and infrastructure. The INPRO methodology is available to be used for nuclear energy system assessments (NESAs) in support of long term planning and decision making on nuclear power programmes at a national, regional or global level. It is suitable both for countries with established nuclear programmes wishing to assess existing or future nuclear energy systems, and for countries wishing to embark on new nuclear programmes. The Agency also offers a 'NESA support package' including training, support missions to Member States, and help with implementation, analysis and the evaluation of results. Currently, seven countries have expressed interest in undertaking new national NESAs using the INPRO methodology: Belarus, China, Indonesia, Israel, Japan, Mexico and South Africa.

8. A Technical Cooperation workshop dealing with IAEA Tools for Nuclear Energy System Assessment for Long Term Planning and Development was held in July 2009 in support of training activities in the use of the INPRO methodology. The workshop was attended by 46 scientists from 41 IAEA Member States.

9. Two INPRO Collaborative Projects (CPs), through which INPRO members collaborate on specific technical issues, are in progress, both feeding into the development and application of the INPRO methodology. The first is on Proliferation Resistance: Acquisition/Diversion Pathway Analysis (PRADA), and the second on Performance Assessment of Passive Gaseous Provisions (PGAP). PRADA enables an analysis of acquisition and diversion pathways and contributes to enhancing the robustness of its proliferation barriers. PGAP's objective is to propose an internationally accepted definition for the reliability of thermohydraulic passive systems and a method for assessing that reliability.

## **B.3. Global vision**

10. In the area of "Global Vision", scenarios on the opportunities and challenges for nuclear energy in the 21st century are being investigated and formulated. A publication on Global Scenarios and Regional Trends of Nuclear Energy Development in the 21st Century is under preparation for publication later in 2009. It analyses the possible contribution of nuclear energy systems to meet the energy needs of different regions and options of institutional and technological approaches and their effect on the implementation of required innovations.

11. Four CPs are underway in this area. The CP entitled Global Architecture of Innovative Nuclear Systems based on Thermal and Fast Reactors including Closed Fuel Cycles (GAINS) uses existing projections of global and regional energy needs through 2100 and analyses alternative nuclear energy systems including synergies among different technologies and stages of the fuel cycle; assesses possible supply options for meeting projected demand; and, subsequently, evaluates the methods used in the analysis and identifies needed improvements. INPRO members participating in the CP on Fuel Cycles for Innovative Nuclear Systems through Integration of Technologies (FINITE) will jointly select a specific innovative nuclear fuel cycle to study; assess it using the INPRO methodology; identify critical safety, waste, proliferation and economic issues; and identify the institutional and technical developments that would be necessary to implement the selected fuel cycle. The CP on Meeting Energy Needs in the Period of Raw Materials Insufficiency during the 21st Century (RMI) analyses long term energy demand and supply scenarios, but with a particular focus on the sustainability of the raw materials required by different energy supply options, including nuclear power, non-electrical nuclear applications, and non-nuclear options. The fourth CP on Investigations of the  $^{233}\text{U}/\text{Th}$  Fuel Cycle (ThFC) explores fuel cycle options based on thorium.

#### **B.4. Innovations in nuclear technology**

12. The objective of activities in this area is to foster collaboration among INPRO members on selected innovative nuclear technologies and related R&D that contribute to sustainable nuclear energy. There are three CPs currently underway. Under the CP on Advanced Water Cooled Reactors (AWR) studies, both experimental and theoretical, on natural circulation in reactor systems, mixing and stratification in large pools of water, the reliability of passive systems, and certain features of annular fuel rods are being conducted. Countries participating in the CP on Investigation of Technological Challenges related to the Removal of Heat by Liquid Metal and Molten Salt Coolants from Reactor Cores operating at High Temperatures (COOL) establish the properties of high temperature coolants, assess problems associated with handling such coolants, establish guidelines for designing components that will be in contact with high temperature coolants, and develop methods for on-line monitoring and control of high temperature coolant chemistry. The objective of the CP on Decay Heat Removal System for Liquid Metal Cooled Reactors (DHR) is to develop and benchmark computer codes for analysing decay heat removal in liquid metal cooled reactors.

#### **B.5. Innovations in institutional arrangements**

13. In addition to technological innovations, innovative approaches in institutional areas might be essential for the deployment of new reactor designs, in particular, of non-stationary small and medium sized reactors. A draft publication on Legal and Institutional Issues of Transportable Nuclear Installations was prepared in 2009. It addresses specific challenges including a review of safety, security, safeguards, nuclear liability and infrastructure issues for reactors which are fabricated at a plant and then transported to the user site. Under the CP on Implementation Issues for the Use of Nuclear Power in Small Countries (SMALL), participating countries identify waste management options applicable to small countries, evaluate the options, and identify any new institutional and technical measures that would be needed in each case.

#### **B.6. INPRO Dialogue Forum**

14. The INPRO Dialogue Forum is a continuation in a broadened form of the former INPRO activity on common user considerations. Its objective is to bring together technology holders and technology users to discuss and share information on desirable innovations, both technical and institutional, on national long term nuclear planning and on the global nuclear energy system.

15. INPRO's work on common user considerations was completed in 2008, and a final report was published in May 2009, Common User Considerations (CUC) by Developing Countries for Future Nuclear Energy Systems: Report of Stage 1 (Nuclear Energy Series No. NP-T-2.1). This publication presents the conclusions of experts from developing countries that are considering deployment of nuclear power plants. A second report is being prepared that will provide background information and greater detail.

### **C. Other Agency Activities related to Innovative Nuclear Technology**

16. The Agency fosters collaboration among Member States on selected innovative nuclear technologies and related R&D. Collaboration is developed through several Technical Working Groups (TWGs), e.g. on advanced water reactors, fast reactors, and nuclear fuel cycle options, and through Coordinated Research Projects (CRPs). Coordination of these activities with INPRO is achieved through the Agency-wide Joint Action Plan.

17. Two CRPs related to innovations in nuclear technology were completed in 2008. A CRP on Process Losses in Separation Processes in Partitioning and Transmutation (P&T) Systems to Minimize Long Term Environmental Impacts established a quantitative relationship between the environmental impact of disposed waste and the reduction of transuranic elements in the waste, taking separation losses into account. Based on this, target values were set for reduction of transuranic elements that are in line with current process losses. A CRP on Natural Circulation Phenomena, Modelling and Reliability of Passive Systems examined the use of natural circulation and passive systems in 20 reference advanced water cooled reactor designs. It characterized twelve phenomena influencing natural circulation, including liquid behaviour in large pools, the effect of non-condensable gasses on condensation heat transfer, condensation on containment structures, and steam-liquid interactions.

18. Four CRPs related to innovative nuclear technology were started in 2008. Two of them, in the area of fast reactors, are linked to experimental programmes at Japan's MONJU reactor and France's PHÉNIX reactor within the framework of the former reactor's restart and the latter's end of life studies. These CRPs will address natural convection in the coolant in the upper plenum of the reactor vessel of a sodium cooled fast reactor, temperature and power distributions in off balance situations, and sodium natural circulation phenomena in fast reactor cores.

19. The third new CRP is on the use of accelerators to simulate radiation effects in materials. Its objective is to combine accelerator simulation with theoretical modelling of radiation effects to help develop new radiation resistant structural materials for advanced nuclear systems, and its first phase comprises radiation damage studies on oxide dispersion strengthened steel, a candidate advanced structural material for sodium cooled fast reactor fuel assembly and nuclear fusion.

20. The fourth new CRP, on fuel modelling at extended burnup, addresses light water reactor (LWR) fuel performance issues at very high burnup (i.e. more than 65 000 MW-days/tonne) in terms of fission gas release and pellet-cladding mechanical interactions. The data to be modelled are provided by the OECD Nuclear Energy Agency and the Halden Reactor Project.

21. A joint study is being carried out with the Tokyo Institute of Technology on protected plutonium production. The study looks at intrinsic proliferation resistance, specifically a proposal to mix ~1% minor actinides (e.g. neptunium) with low enriched uranium oxide fuel for LWRs so that the spent fuel

will contain enough plutonium-238 to make it unattractive for weapons use because of the resulting high decay heat and spontaneous neutron emission.

22. Agency activities on accelerators cover both accelerator driven systems (ADS) and the use of accelerators for research on advanced materials and other topics pertinent to innovative nuclear technology. In May 2009, the Agency organized, in cooperation with the American Nuclear Society, the International Topical Meeting on Nuclear Research Applications and Utilization of Accelerators. It addressed new trends in accelerator applications including nuclear materials research, ADS for utilization and transmutation of minor actinides and some long-lived fission products, and accelerator technology. A special ‘satellite meeting’, titled European Fast Neutron Transmutation Reactor Projects (MYRRHA/XT-ADS), focused on fast fission reactor concepts and fuel cycles that could reduce spent fuel inventories and the volume of high level waste by utilizing fissionable isotopes. The Agency collaborates with the International Centre for Theoretical Physics (ICTP) in Trieste on training and education related to ADS. Two recent instances are an Advanced Workshop on Model Codes for Spallation Reactions and a Workshop on Nuclear Reaction Data for Advanced Reactor Technologies.

23. Since September 2008 the Agency has published reports on Spent Fuel Reprocessing Options (IAEA-TECDOC-1587) and Advanced Applications of Water Cooled Nuclear Power Plants (IAEA-TECDOC-1584). The latter examines the potential of water cooled reactors to expand into seawater desalination, district heating, heat for industrial processes, and electricity and heat for hydrogen production by presenting an overview of example applications, their opportunities, challenges and potential solutions.

24. Preparations are also underway for two forthcoming Agency conferences, the International Conference on Opportunities and Challenges for Water Cooled Reactors in the 21st Century in Vienna in October 2009 and the International Conference on Fast Reactors and Related Fuel Cycles — Challenges and Opportunities (FR09), in Kyoto, Japan, in December 2009.

## **D. Coordination with GIF**

25. The Agency continues to participate in Generation IV International Forum (GIF) working groups and as an observer in the Policy Group. The complementary relationship of INPRO and GIF has been jointly defined and details have been made available through respective websites. A joint action plan with GIF, developed in February 2008, is being implemented, and additional synergy areas are being discussed through the GIF Policy Group and the INPRO Steering Committee.

26. Cooperation with GIF includes the use of GIF’s economic evaluation model ECONS by the Agency to estimate the costs of gas cooled reactors and the possible application of the Agency’s safety standards to review selected GIF reactor systems. The Agency has provided training to several Member States in the use of ECONS and a workshop was held to that end in October 2008. The workshop identified improvements needed in the software to better analyse multi-unit, modular and cogeneration designs.



# Small and Medium-sized Reactors (SMRs) – Development and Deployment

## A. Background

1. In resolution GC(51)/RES/14/B.2, the General Conference requested the Director General to continue encouraging the development of safe, secure, economically viable and proliferation-resistant SMRs, including with respect to nuclear desalination and hydrogen production; invited him to raise seed funds and other appropriate funding from extrabudgetary resources in order to contribute to the implementation of all Agency activities relating to the development and facilitating the deployment of innovative SMRs; and requested that he report on (i) the status of the programme initiated to assist developing countries interested in SMRs; (ii) the progress made in the research, development, demonstration and deployment of SMRs in interested Member States intending to introduce SMRs in the future; and (iii) the progress made in the implementation of the above to the Board of Governors and the General Conference. This report responds to that request.

## B. Activities of the Agency

2. The Agency continues to encourage the development and deployment of safe, secure, economically viable and proliferation resistant SMRs and to assist interested developing countries, including with respect to nuclear desalination and hydrogen production (see Annex 5), through the activities of the regular budget project “Common Technologies and Issues for SMRs”. These activities are designed to facilitate both the development of key enabling technologies and the resolution of key infrastructure issues for innovative SMRs of various types and are complementary to the extrabudgetary International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO).

3. Both of the above-mentioned activities provide assistance to developing countries interested in SMRs through fostering information exchange and conducting coordinated research on selected topics of technology development and assessment for such reactors. The activities involve active participation of experts from developing and developed countries.

4. The Agency prepared a report on “Design Features to Achieve Defence in Depth in Small and Medium Sized Reactors”, which will be published in 2009 as a new Nuclear Energy Series Report NP-T-2.2. The report presents approaches to implementing defence in

depth in SMRs in line with the definitions and recommendations of the IAEA safety standard NS-R-1 and thereby helps potential users of innovative SMRs evaluate the overall technical potential of SMRs with passive safety design features, including their possible impacts in areas other than safety. The report's annexes describe safety design concepts and features for 11 advanced SMR concepts, representing 5 reactor lines.

5. In 2009 the Agency will complete a Coordinated Research Project (CRP) on Small Reactors without On-site Refuelling, with 16 participating institutions from 9 IAEA Member States. The CRP has covered several topics. First, it has developed and tested a risk-informed method to justify reduced off-site emergency planning for innovative reactors. Second, it has completed inter-regional and intra-regional scenario studies for energy systems with small reactors. Third, under an arrangement with the OECD/NEA, several CRP participants took part in a benchmarking exercise for forced and natural circulation of lead-bismuth coolant based on tests performed in the HELIOS loop at the Seoul National University (Republic of Korea). The final report for the CRP is under preparation.

6. The Agency prepared a report on "Approaches to Assess Competitiveness of SMRs" that identified the approaches, models and tools for the assessment of competitive deployment of SMRs. It focuses on aspects that are important when comparing many small reactors to fewer large reactors. These include economies of scale, accelerated learning through multiple units, sharing of facilities at a site, unit timing, construction schedule, design simplification, and interest rate changes during construction.

7. The Agency initiated a series of case studies on competitive deployment of SMRs for different applications carried out by expert teams in Member States. These studies include software development for an 'open' (i.e. very flexible and adaptable) model to analyse the investment attractiveness of SMRs, compare SMRs to larger reactors, and evaluate at a national level the competitiveness of SMRs for various applications. The results will be summarized in a Nuclear Energy Series report, and the software that is developed will be available to Member States.

8. The Agency launched a new CRP on the Development of Methodologies for the Assessment of Passive Safety System Performance in Advanced Reactors with the participation of eight research institutions from Argentina, France, India, Italy, the Russian Federation and the USA. The main objective is to determine common analyses and tests to assess the reliability of passive safety systems. This would facilitate the use of risk-informed approaches in design optimization and safety qualification for future advanced reactors, including SMRs, thereby contributing to enhanced safety and improved economics. The CRP is being conducted in cooperation with the Department of Nuclear Safety and Security.

9. In addition to technological innovations, innovative approaches in institutional areas might be essential for the deployment of new reactor designs, in particular, of non-stationary small and medium sized reactors. A draft publication on *Legal and Institutional Issues of Transportable Nuclear Installations* was prepared in 2009. It addresses specific challenges including a review of safety, security, safeguards, nuclear liability and infrastructure issues for reactors which are fabricated on a plant and then transported to the user site.

10. The Agency has also begun work on new robust fuel development for SMRs with long life cores. Consultations with experts in Member States have identified several candidate fuel types to be considered for small long-life core reactors, as well as possibly for large reactors.

The candidate fuel types, such as CERMET and METMET, have the potential for very high fuel burn-ups and improved fuel utilization.

11. In response to the invitation “to raise seed funds and other appropriate funding from extrabudgetary resources” cited in paragraph 1 of this report, the Agency sent letters seeking voluntary contributions from Member States for Agency work on innovative SMRs. To date, no contributions have been received.

## C. Activities of the Member States

12. Several Member States have SMR designs ready for deployment. These include the pressurized heavy water reactors CANDU 6 (650 MW(e)) by AECL in Canada and PHWR-202 and PHWR-490 by NPCIL in India, and they include the 300 MW(e) and 610 MW(e) Chinese pressurized water reactor designs.

13. Recent construction of pressurized heavy water SMRs in India and Romania has been on schedule and on budget. Discussions for two additional CANDU 6 reactors in Romania are at an advanced stage.

14. Innovative SMRs are under development for all principal reactor lines and some non-conventional combinations. More than 45 innovative SMR concepts and designs are at different stages of development within national or international research and development (R&D) programmes, involving both developed and developing countries. Most allow for, or explicitly facilitate, non-electrical applications such as nuclear desalination or hydrogen production. The following paragraphs summarize the concepts and designs that have attracted most interest. Their target dates for being ready for deployment range from 2012 to 2030.

15. In Russia, construction of a pilot floating cogeneration plant of 300 MW(th)/70 MW(e) with two water cooled KLT-40S reactors began in June 2006. Its deployment date is 2012. Plans were announced to build five such plants and also two plants with 11 MW(e) ABV reactors for customers in the Russian Federation.

16. Several integral PWR designs are well advanced in their development, and some could be available for deployment around 2015–2020. The 335 MW(e) IRIS design developed by an international consortium led by Westinghouse Electric Company of USA is the furthest along in testing and development. Argentina has started licensing a 27 MW(e) prototype of the 150 to 300 MW(e) CAREM design. The 330 MW(th) SMART design developed in the Republic of Korea for a co-generation plant is at an earlier stage of development.

17. In India, construction is expected to start early in the next decade on the first 300 MW(e) advanced heavy water reactor, which has been developed for co-generation applications. The reactor is designed to operate with <sup>233</sup>U-Pu-Th fuel; it uses boiling light water as a coolant and heavy water as the moderator. The reactor designer, the Bhabha Atomic Research Centre, is in pre-licensing negotiations with the Atomic Energy Regulatory Body of India.

18. China is developing the modular HTR-PM, with each module having a capacity of 250 MW(th), or 100 MW(e). It is a high temperature gas cooled reactor with pebble bed fuel and an indirect supercritical steam energy conversion cycle. Demonstration of a full size module

is planned for 2013. A license application has been filed and is under review. A two-module plant configuration is foreseen for the commercial version of this reactor, yielding an electric output of 200 MW(e).

19. In South Africa, the 165 MW(e) pebble bed modular reactor (PBMR), a high temperature gas cooled reactor with pebble bed fuel originally employing a direct gas turbine Brayton cycle, has undergone a design strategy change. It will now be implemented first with an indirect steam power conversion cycle. Its demonstration at full size is scheduled by 2014, and future configurations will include 4 and 8-module plants.

20. In Japan, the Toshiba Corporation, in cooperation with the Central Research Institute of Electric Power Industry (CRIEPI) and Westinghouse Electric Company, is developing the 4S sodium cooled reactor. It has a design power of 10 MW(e) and a refuelling interval of 30 years. The US Nuclear Regulatory Commission began a pre-application review in 2007, and the formal licensing process is scheduled to start in October 2010. Construction of a demonstration reactor and safety tests are planned for the first half of the next decade.

21. In the USA, two private companies acquired the necessary intellectual property rights to proceed with the design development of two small reactors without on-site refuelling, a water-cooled NuScale and a heat-pipe based Hyperion Power Module employing uranium-hydride decomposable fuel.

# Supporting Infrastructure Development for Nuclear Power

## A. Background

1. In resolution GC(52)/RES/12.B.2, the General Conference recognized that the development and implementation of an appropriate infrastructure to support the successful introduction of nuclear power and its safe and efficient use is an issue of concern, especially for countries that are considering and planning for the introduction of nuclear power. The General Conference also recalled its resolutions GC(50)/RES/13.B.2 and GC(49)/RES/12.G on approaches to supporting nuclear power infrastructure development.

2. The General Conference encouraged the Secretariat to undertake assessments on approaches and options for addressing infrastructure requirements so as to support the introduction of nuclear energy technologies and their safe, secure and efficient use for those Member States that are considering or planning for the introduction of nuclear power; and requested that the Director General report to the Board of Governors and to the General Conference at its 53rd Session on developments that are relevant to this issue. This report responds to that request.

## B. Work since the 52<sup>nd</sup> session of the General Conference

3. In the last three years, the number of Member States requesting Agency assistance to consider introducing nuclear power has grown to more than 60. Many of these countries are in the early stages of considering the issues associated with making an informed decision regarding nuclear power, and the number of countries projected by the IAEA to operate their first nuclear power plant in the next decades is more modest.<sup>5</sup> This report summarizes the Agency's efforts to respond to all Member States' requests regarding the introduction of nuclear power.

4. The Agency's approach to infrastructure building is integrated and comprehensive. It involves expertise from across the Agency's Departments, and mechanisms are in place to facilitate cross-departmental coordination, notably through the Nuclear Power Support Group (NPSG), which is an internal coordination group with representatives from across the Agency. (Section B.4, below, elaborates further.)

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<sup>5</sup> The *International Status and Prospects of Nuclear Power* (Gov/INF/2008/10-GC(52)/INF/6) indicated that in the IAEA's low and high projections the number of new countries operating nuclear power plants by 2030 would be approximately 5 and 20, respectively.

5. To promote information sharing among Member States, the Agency is expanding its Country Nuclear Power Profiles (CNPP) by inviting other countries in the process of introducing nuclear power, in addition to those countries already participating, to contribute. The CNPP format is being updated to accommodate information provided by countries in the planning stages of their nuclear power programme.

6. In order to increase the effectiveness of the assistance it provides Member States, the Agency is also considering how it can appropriately be involved in coordination in the area of infrastructure support for the introduction of nuclear power among multilateral organizations, as well as through bilateral cooperation with Member States.

### **B.1. Technical cooperation**

7. There are three times as many new technical cooperation (TC) projects related to the introduction of nuclear power in the 2009-2011 cycle as there were in the 2007-2008 cycle. As mentioned above, more than 60 Member States are receiving support via 38 national and 6 regional projects, including both on-going projects and projects started in the new cycle. In response to the increase in demand starting from 2009, the Agency has adjusted responsibilities so that more staff are devoting time as technical officers to support TC projects. The Agency also continues to expand its roster of international experts available for TC missions. It has also improved access to technical reports and standardized presentation materials to make it easier to plan and implement activities in the infrastructure area.

8. One of the priority issues identified by many countries considering introducing nuclear power is human resource development, and therefore human resource development and workforce planning are important components in many of the relevant TC projects. Because, more generally, the contents of the projects spans the breadth of the Agency's programmes across all nineteen infrastructure issues identified in the NE Series Guide *Milestones in the Introduction of a National Nuclear Power Programme* (NG-G-3.1), implementation of the projects necessitates an integrated approach to workplan development and to the conduct of missions.

### **B.2. Publications and workshops**

9. In late 2008, the Agency published *Evaluation of the Status of National Nuclear Infrastructure Development* (Nuclear Energy Series No. NG-T-3.2), which is closely related to *Milestones in the Development of a National Infrastructure for Nuclear Power* referred to above. *Evaluation of the Status of National Nuclear Infrastructure Development* provides the basis for conducting a self-evaluation or evaluation by external experts of the status of a country's infrastructure. Such an evaluation can be an effective means for a Member State to identify existing gaps and needs to more effectively plan its programme.

10. A brochure on a new Agency service, *INIR Integrated Nuclear Infrastructure Review Missions: Guidance on Preparing and Conducting INIR Missions*, was issued in 2009. INIR missions are IAEA-coordinated peer reviews conducted by teams of international experts on the basis of *Evaluation of the Status of National Nuclear Infrastructure Development*. The objective and scope of these reviews are tailor-made to the needs of the requesting Member State. As with a self-assessment, the INIR mission is intended to help a country identify gaps between the milestones and the current level of development of their programme and effectively address these gaps through, *inter alia*, international cooperation including the

Agency's technical cooperation programme. The first INIR missions are expected to take place in the second half of 2009.

11. Since the 52<sup>nd</sup> General Conference the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) published two documents in 2009 that would help Member States assess the long-term sustainability of their nuclear power programmes: the nine-volume user manual for the INPRO methodology and a publication on *Lessons Learned from Nuclear Energy System Assessments (NESA) using the INPRO Methodology* and a final report on the first activity on *Common User Considerations (CUC) by Developing Countries for Future Nuclear Energy Systems: Report of Stage 1*. This latter publication presents the conclusions of experts from developing countries which are considering deployment of nuclear power plants in the near term or are making projections up to 2050.

12. The Agency held a technical workshop in December 2008 which focused on the evaluation methodology, the INIR missions and on the functions of nuclear energy programme implementing organizations (NEPIOs). The workshop, which was co-sponsored by the Governments of Canada, China, France, India, Japan, the Republic of Korea, the Russian Federation and the United States of America, was attended by more than 40 Member States and confirmed the wide-spread use of the 'milestones approach' described in *Milestones in the Development of a National Infrastructure for Nuclear Power* and related documents.

### **B.3. Documents in preparation**

13. A new web-accessible database, which will be available by the end of 2009, will provide in-depth and up-to-date technical information about the status of the various nuclear technology options available and under development worldwide. It is directed primarily at countries that are considering the introduction of nuclear power, but it is also intended to be useful to vendors, suppliers and governments interested in the expansion of nuclear power.

14. Additional Nuclear Energy Series reports have been completed and are scheduled for publication in 2009 on improving prospects for financing nuclear power plants, the responsibilities and competencies of NEPIOs, the responsibilities and competencies of owner-operator organizations and workforce planning for new nuclear power programmes. This report focuses on the competencies and human resource requirements needed in key organizations during each of the three phases of infrastructure development, as well as on education and training programmes that can contribute to achieving these competencies. A new Nuclear Energy Series Guide on *Policies and Strategies for Radioactive Waste Management* has also been completed and is expected to be published later in 2009.

15. The Agency is also preparing a revised and expanded report on the evaluation of bids for nuclear power plants. This will provide practical guidance on the bidding process, including bid invitation specifications and on the technical and economic evaluation of bids.

16. A new Nuclear Energy Series report on stakeholder involvement will provide information on engaging stakeholders, including the public, in the planning process for a first nuclear power plant.

17. A new Nuclear Energy Series report on technology assessment will present tools to enable informed decision making when choosing among the various available reactor designs by providing technical guidance and a design-neutral systematic approach.

18. The Agency is also preparing a comprehensive study reviewing current conventional and advanced construction methods and their potential application to new nuclear power plant construction. The report will incorporate experiences and insights from recent nuclear construction projects and will provide a description of the advantages and disadvantages of each of these techniques from various perspectives, such as capital and construction costs, schedule and quality assurance.

19. Work has also begun on four additional reports scheduled for publication in 2010, covering:

- alternative contracting and ownership approaches for nuclear power plants, such as build-own-operate and regional ownership,
- industrial infrastructure to support national nuclear power programmes,
- managing siting activities for nuclear power plants, and
- interactions of electric grids and nuclear power plants.

#### **B.4. Holistic infrastructure support**

20. Reflecting the Agency's integrated approach to infrastructure development, the NPSG coordinates assistance in the area of nuclear power development across the Agency's Departments. To assemble the information from various databases across the Agency and for more effective planning and delivery of Agency activities, a country infrastructure profile database is under development under the auspices of the NPSG.

21. The Agency provides training in the use of energy planning tools to assist Member States in determining whether nuclear power is appropriate in their energy mixes. Of the 80 countries participating in energy planning capacity building through technical cooperation projects, 29 are evaluating nuclear power.

22. The legislative assistance programme offers annual nuclear law seminars, national and regional workshops and seminars, bilateral assistance in drafting and reviewing national laws, and the training of individuals. The programme covers all branches of nuclear law, namely nuclear safety, security, safeguards and liability for nuclear damage. In addition, the Office of Legal Affairs is preparing a second volume of the nuclear law handbook that will cover all the elements of a comprehensive national nuclear legal framework.

23. In the area of safety, the Agency is developing a new safety infrastructure guide which will provide a roadmap to safety standards for countries launching a first nuclear power plant. The draft will be reviewed by several safety committees in 2009 and 2010. Following two workshops held in July and December 2008 respectively, a workshop on nuclear power newcomers and international cooperative actions, to be held in November 2009, will focus on newcomer needs and ways of sharing experience and building cooperation between vendor countries and newcomers. An international topical conference was held in November 2008 in Mumbai, India, on ensuring safety for sustainable nuclear development, which included a special session on issues for countries considering the introduction of nuclear power.

24. In addition, the Agency's Education and Training Support Group (ETSG), which includes representation from all Major Programmes, is actively contributing to the harmonization of the preparation and implementation of education and training materials for the use of countries considering introducing nuclear power.

## **C. Future issues**

25. Taking into consideration that some Member States may plan to order their first nuclear power plants (NPPs) in the near future, special focus will be given to increasing advice on infrastructure preparation needs during the phase following agreement on a contract for a first NPP. Specific guidance based upon recent international experience will be developed to help a country to more effectively manage and implement the construction phase.

26. In response to concerns about assuring the human resources needed to support new and expanding nuclear power programmes, the Agency will organize an International Conference on Human Resource Development for Introducing and Expanding Nuclear Power Programmes in Abu Dhabi, United Arab Emirates, in March 2010. Its objective will be to contribute to new and strengthened strategies and policies for human resources for nuclear power.