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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(52)/RES/12 and GC(53)/RES/13, this document contains progress reports on the support to the African Union's Pan African Tsetse and Trypanosomosis Eradication Campaign (AU-PATTEC) (Annex 1); development of the sterile insect technique for the control or eradication of malaria-transmitting mosquitoes (Annex 2); strengthening support to Member States in food and agriculture (Annex 3); Agency activities in the area of nuclear energy (Annex 4); supporting infrastructure development for nuclear power (Annex 5); Agency activities in the development of innovative nuclear technology (Annex 6); and nuclear knowledge management (Annex 7).
- Further information on the Agency's activities related to nuclear science, technology and applications can be found in the *Nuclear Technology Review 2010* (document GC(54)/INF/3), the Agency's *Annual Report 2009* (GC(54)/4), in particular the Technology section, and the *Technical Cooperation Report for 2009* (GC(54)/INF/4).

### Recommended Action

- It is recommended that the Board take note of Annexes 1–7 of this report and authorize the Director General to submit the report to the General Conference at its fifty-fourth session.



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

## A. Background

1. At its fifty-third session in September 2009, the General Conference, in its resolution GC(53)/RES/13, expressed its appreciation for the continued high priority assigned by the Agency to agricultural development in Member States. It welcomed the initiative taken by the Agency and the African Union (AU) Commission to strengthen their partnership within their respective mandates, in support of the overall objectives of the AU-PATTEC Plan of Action. The General Conference requested the Secretariat, in cooperation with Member States, to maintain funding – through the Regular Budget, the Technical Cooperation Fund and other partnerships – to strengthen its support for R&D in and technology transfer to African Member States 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 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-fourth (2010) regular session.

## B. Developments since the General Conference's 2009 session

2. A study presented in July 2010 by the EU-funded and FAO-executed Livestock Policy Initiative (LPI) under the Intergovernmental Authority on Development (IGAD) recognized the particular importance of livestock development as a pathway out of poverty and hunger and basis for food security. With regard to the tsetse and trypanosomosis (T&T) problem, the study concluded that in many T&T affected areas, an investment of US \$1500 – 3000 per km<sup>2</sup> for the elimination of the T&T problem could result in benefits from livestock development for the rural poor communities of US \$12 500–15 000 per km<sup>2</sup>.

3. On 16 July 2010 AU-PATTEC celebrated its 10<sup>th</sup> anniversary at the 7<sup>th</sup> meeting of national PATTEC coordinators and the 2<sup>nd</sup> PATTEC joint steering committee meeting, held in Munyonyo, Kampala, Uganda. One of six recommendations resulting from the meetings re-confirmed the continued high relevance of the sterile insect technique (SIT) and need for Agency support to AU-PATTEC. In particular, the meeting agreed that “in order to mop up residual tsetse populations in some areas, SIT remains the solution of choice, hence the mass rearing and back up facilities must be strengthened technically in order to be able to produce flies, when required on time.”

4. On 25 November 2009, the Agency and the AU Commission signed a Memorandum of Understanding in support of the Pan-African Tsetse and Trypanosomosis Eradication Campaign. Within their respective mandates, internal policies, procedures and resources, the AU and the Agency agreed to cooperate in the following areas: baseline data collection and feasibility assessment for area-

wide integrated pest management (AW-IPM) campaigns against the tsetse and trypanosomiasis (T&T) problem; development of project documents suitable to approach potential donors; capacity building; monitoring and evaluation of the implementation of AU-PATTEC projects; planning, funding and implementation of training courses; applied research, methods development and validation to address technical gaps; and; mutual support of each other's programmes at resource mobilisation events.

5. In the past year, the Agency supported the AU-PATTEC Plan of Action through two regional technical cooperation projects and six national tsetse TC projects. Assistance (in the form of training, expert services and equipment) was provided to 12 Member States affected by T&T for baseline data collection, feasibility assessment studies, capacity building and pre-operational support for the use of sterile insect techniques (SIT). Within their respective mandates, FAO, WHO and the Agency have continued to provide advisory support to the six national projects coordinated by AU-PATTEC in Burkina Faso, Ethiopia, Ghana, Kenya, Mali and Uganda, referred to as the "AU-PATTEC List-I" countries. The projects are implementing activities, making use of financial grants and loans received from the African Development Bank (AfDB) in 2004.

6. For the past 12 years the Agency, FAO, WHO and other partners have used the platform PAAT (Programme Against African Trypanosomiasis) to harmonise their efforts against the T&T problem. Tsetse-affected Member States continue to benefit from the PAAT information system (PAAT-IS), to which the Agency, FAO, WHO and other partners contribute relevant technical and policy guidelines, manuals, standard operational procedures, tsetse presence/absence risk prediction maps, and other outputs. The 15<sup>th</sup> meeting of the PAAT Advisory Group (PAG) coordinators was held in Mombasa, Kenya, 1-3 December 2009, with the participation of national PATTEC coordinators. FAO, with the technical concurrence of the Agency and WHO, organised an external review of PAAT in late 2009. The review team visited existing national PATTEC projects and interacted with various stakeholders, including AU, international and regional institutions and PATTEC. The external review team reported at the 15<sup>th</sup> meeting of the PAG coordinators that the stakeholders highly appreciate PAAT's role as a source of policy advice and information relevant to the T&T problem. The review team underlined that the working relationship between PATTEC and PAAT needs further harmonisation.

7. To foster relevant regional capacity building, the Agency has committed to work with the Centre International de Recherche-Développement sur l'Élevage en zone Sub-humide (CIRDES) in Bobo-Dioulasso, Burkina Faso, towards CIRDES becoming an IAEA Collaborating Centre in 'The Use of the Sterile Insect Technique for Area-wide Integrated Management of Tsetse Fly Populations'. The collaboration will promote joint regional efforts in (i) validating techniques and methods developed in support of SIT; (ii) providing tsetse seed materials of different species to African tsetse mass-rearing centres and of sterile male tsetse flies to SIT field projects; (iii) field sampling of tsetse flies from different areas for population genetic and ecological studies; (iv) tsetse strain competitiveness studies; and (v) hosting of individual and/or group fellowships and training courses. From 1-19 February 2010, the Agency organised and CIRDES hosted the FAO/IAEA/PATTEC Regional Training Course on "Standardised Collection and Processing of Entomological and other Relevant Baseline Data". Thirteen participants from eight T&T affected Member States attended the course. The collaboration between the Agency and Burkina Faso also includes the provision of advice for the establishment of a new tsetse mass rearing facility in Burkina Faso, which is expected to provide sterile male tsetse flies to selected SIT projects in Western Africa.

8. As reported at the 53<sup>rd</sup> session of the IAEA's General Conference, the caesium-137 irradiator at CIRDES, needed for SIT activities, is well beyond its intended life span. The Agency explored options for obtaining an X-ray irradiator for SIT operations, and the Government of the United States of America agreed to contribute US\$ 190 000 for this purpose. Action on the safe removal and disposal of the disused source has yet to be taken.

9. The Agency continued to provide technical assistance and guidance to Senegal under a national TC project on ‘Implementing the Pre-Operational Phase to Create a Zone Free of *Glossina palpalis gambiensis*<sup>1</sup> using the SIT’. Excellent progress has been made due to the strong support provided by the Government of Senegal and to the continuing 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. As reported last year, baseline data have been collected on the distribution of the target *Glossina palpalis gambiensis* population, on tsetse population genetics and on the prevalence of the disease nagana<sup>2</sup> in livestock. The collected data suggest that the total intervention zone in the Niayes area (north of Dakar) and La Petite Côte (south east of Dakar) is about 500 km<sup>2</sup>, which is substantially less than the initially estimated 1300 km<sup>2</sup>. Suppression activities on some commercial farms were initiated in late 2009, with trial releases of sterile male flies originating from CIRDES initiated in April 2010. The FAO/IAEA Insect Pest Control Laboratory (IPCL) in Seibersdorf and CIRDES have meanwhile started to develop and validate methods for the long-distance transport of chilled sterile male flies. Subject to the outcome of an external review of the project, it is anticipated that operational releases in the Senegal project area may be initiated in 2011, using sterile male flies supplied by CIRDES.

10. Some T&T affected Member States and other partners, including AfDB, PAAT, and the Agency, have expressed concern with the insufficient numbers of sterile male tsetse flies available for SIT applications as part of an AW-IPM, under national PATTEC projects. While Member States are primarily responsible for the funding and construction of tsetse mass rearing factories, the Agency continues to provide advice on selecting suitable locations for such facilities, as well as on their design, the necessary equipment and training. As the adaptation of tsetse fly strains to mass rearing conditions takes several years, the Agency has taken steps to secure the availability of small seed or back-up colonies of the most important tsetse fly species for Member States. Support to the actual mass-production of sterile tsetse fly males for use in SIT operations continues to be restricted – within available budget lines – to national or sub-regional tsetse rearing centres in T&T affected Member States in Africa.

11. The Agency continued implementing a regional TC project on T&T in the northeastern part of South Africa and southern Mozambique. While the feasibility of T&T intervention and the justification for the associated investments have been confirmed for South Africa, further baseline data need to be gathered in Mozambique and Swaziland, which borders into the tsetse zone that needs to be covered by this project and should be included for the project to be successful<sup>3</sup>. The Agency provided assistance in areas such as standardised baseline data collection, feasibility assessment, capacity building, provision of fly colony seed material and of sterile male tsetse flies. The Governments of South Africa and Mozambique have joined forces to address the T&T problem in Kwazulu Natal (KZN) in South Africa and the southern part of Mozambique. Whereas in KZN, all baseline data have been collected, this process has just started in Southern Mozambique. In June 2010, the Agency organised an IAEA/FAO regional training course on the ‘Collection of Baseline Data for the Planning and Implementing of Tsetse Area-wide Integrated Pest Management in Southern and Eastern Africa’ in Maputo, Mozambique.

12. In Ethiopia, the Agency continued to provide technical assistance to the Southern Tsetse Eradication Project (STEP) to control and eradicate T&T in the Southern Rift Valley through the TC

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<sup>1</sup> A species of tsetse flies occurring along riverine vegetations in West Africa.

<sup>2</sup> Tsetse-transmitted African animal trypanosomosis.

<sup>3</sup> Though not a Member State of the Agency, Swaziland will participate in the project using a combination of its own funds and some assistance provided by partners such as AU-PATTEC.

project, “Creating a Tsetse-Free Zone in the Southern Rift Valley”. Under this project, the Agency, together with FAO and other partners, continued to implement activities initiated under the Japanese-funded United Nations Trust Fund for Human Security (UNTFHS), which approved the utilisation of remaining funds through May 2010. A technical and a high level meeting between STEP representatives, the Ethiopian authorities, FAO, the IAEA as well as other national and regional stakeholders were held in Addis Ababa, Ethiopia, on 20–23 July 2010. An OIOS organised external review of STEP in late 2008 had arrived at the conclusion that, before STEP can enter the operational phase, and the Agency can provide support to, its operational phase, involving an SIT component, all shortcomings identified by Ethiopia and the Agency should be addressed in a satisfactory manner. Work between the Government of Ethiopia and the Agency in this regard is underway.

13. The Agency has assisted Kenya in building up a national capacity for tsetse SIT. Counterparts generated evidence through further population genetic studies that there are at least three well-confined populations of the target species *Glossina pallidipes* in Kenya, each of which is a good candidate for AW-IPM, possibly involving an SIT component. PATTEC-Kenya has reportedly succeeded in reducing the target *Glossina pallidipes* population in the Lambwe Valley to very low residual levels using insecticide impregnated fabric targets. With regard to the envisaged SIT ‘mopping-up’<sup>4</sup> phase in the Lambwe Valley, the Agency provided guidance and assistance to develop a project proposal and obtain additional bilateral funds from Slovakia to further expand existing fly colonies and to conduct pilot releases of sterile male flies in 2010 and 2011.

14. In recent years, Botswana has been the first T&T affected country which reintroduced the repeated aerial spraying of ultra-low volume formulations of non-persistent insecticides, also referred to as the sequential aerosol technique (SAT). Counterparts in Botswana pursued the regular entomological monitoring recommended by the Agency at identified sites and conducted the proposed probability calculations, thereby generating increasing evidence that *G. morsitans*<sup>5</sup> *centralis* has probably been eliminated from the Okavango delta. Similar surveys are underway for areas that were subjected to SAT operations in subsequent years. As the *G. m. centralis* elimination operations have meanwhile been shifted to areas in Angola and Zambia, the risk of active reinvasion of *G. m. centralis* into Botswana appears substantially reduced. However, the risk of a passive reintroduction of *G. m. centralis* by, for example, tourist aircraft landing on air strips in the Okavango delta, or via north-south road transport of goods, particularly from Zambia to Botswana, requires continued attention.

15. There is no tsetse mass-rearing facility in Southern Africa with the capacity to supply large amounts of sterile male tsetse flies (of several species occurring in the sub-region) for operational SIT. If T&T affected Agency Member States in southern Africa want to use tsetse SIT as part of their national tsetse control efforts, the establishment of a sub-regional tsetse mass-rearing centre, possibly by the Southern African Development Community (SADC), needs to be considered. The expertise developed in Botswana in standardised entomological monitoring, in probability calculations of fly absence, in eco-technical and environmental monitoring, and in planning for and implementing SAT operations, represents a valuable resource for fostering relevant capacity building in other T&T affected FAO and Agency Member States. Some national PATTEC projects in Eastern and Western Africa are already benefiting from this expertise.

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<sup>4</sup> The phase of releasing sterile insects is the last phase on an integrated campaign, which is preceded by area-wide, usually insecticide-based, efforts of intensive tsetse fly suppression.

<sup>5</sup> *Glossina morsitans* is a savannah species of tsetse flies with several sub-species, including *G. m. morsitans* and *G. m. centralis*.

16. In Uganda, the refurbishment of a temporary tsetse rearing facility at the National Livestock Resource Research Institute (NaLIRRI) in Tororo is still in progress. However, the *G. f. fuscipes*<sup>6</sup> colony did not survive the period of being in a temporary state, while the insectary was under construction. Efforts are being made to re-establish the colony. Collection of entomological baseline data has been initiated. The work is supported through expert services to select trap deployment sites, using satellite imagery that is processed through standardised (UNEP/FAO) habitat classification. The geographic information system (GIS) unit was strengthened through the provision of equipment, software and training, to enable the counterparts to analyse the collated baseline data.

17. The Insect Pest Control Laboratory (ICPL) in Seibersdorf is continuing with demand-driven, applied research and methods development and refinement. Emphasis is on further developing an integrated management approach for the tsetse salivary gland (SG) virus that is hampering the mass-rearing of *Glossina pallidipes*. This approach involves blocking viral replication with commercial antiviral drugs and neutralizing the virus using virus-specific antibodies. Additional efforts have focussed on sex determination of tsetse flies in the late pupal stage and the development of standardised methods for long-distance bulk shipment and aerial release of chilled tsetse males.

18. The second Research Coordination Meeting (RCM) under the Coordinated Research Project (CRP) entitled ‘Applying GIS and Population Genetics for Managing Livestock Insect Pests’ was held in Nusa Dua, Bali, Indonesia, 22–26 February 2010. The meeting concluded that tsetse research and control activities involving field collection and processing of fly materials are benefiting from newly available GIS-aided processing of geo-referenced information, particularly when using the new FAO-UNEP standardised Land Cover Classification System (LCCS). In addition to generation and evaluation of population genetic information, also advanced techniques of geometric morphometrics deserve to be considered to analyse tsetse materials of different origin. While some progress has been made on computer simulation modelling for tsetse flies, this work should be pursued further, in an effort to eventually advance the model for use in operational decision making.

19. The Agency organised a workshop on “Genotyping Analysis of Tsetse Fly Symbionts and Pathogens” in Nairobi, Kenya, 20 – 24 July 2010. Subsequent to this workshop, the third RCM under the CRP entitled “Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens” was held from 26–30 July 2010. Both events were hosted by International Centre for Insect Physiology and Ecology.

20. The efforts initiated by the Agency in early 2009 – in close collaboration with a specialised partner from Mexico – on *Developing a Design Concept for a Tsetse Aerial Release System* have resulted in a prototype chilled adult release machine which is scheduled to be tested in 2010 in Senegal.

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<sup>6</sup> *Glossina fuscipes fuscipes* is a species of tsetse flies occurring in East and Central Africa along riverine forests and dense vegetation of lakes.



# Development of the Sterile Insect Technique for the Control or Eradication of Malaria-Transmitting Mosquitoes

## A. Background

1. Malaria is the most damaging insect-transmitted disease for human health. The causative agents are parasites of the genus *Plasmodium* that are transmitted by female mosquitoes of the genus *Anopheles*. It causes approximately 2 million deaths a year and there are about 300-500 million cases of clinical malaria annually. Over 90% of the world's malaria cases occur in Africa, and in many countries it consumes a major portion of the national health budget. The disease constitutes a major obstacle to poverty reduction in Africa; according to some estimates, it has slowed down economic growth in African countries by 1.3% per year.

2. Treatment of malaria requires affordable and effective drugs but the growing problem of drug resistance will necessitate a switch to more expensive alternatives. Malaria vaccines have not currently proved sufficiently protective to warrant use in malaria control. These limitations of current interventions have led to interest by Member States in the potential of the Sterile Insect Technique (SIT) for the suppression of malaria-transmitting mosquitoes in suitable areas.

3. In light of this interest in the potential of the SIT, at its fifty second session in September 2008, the General Conference, through resolution GC(52)/RES/12, requested the Agency to continue to strengthen its research activities in this area. The resolution also called for greater involvement of African and other developing Member States' scientific and research institutes to ensure their participation leading to increased ownership by affected countries. It further requested the Agency to increase its efforts to raise funds for the research programme, and invited donors to continue with their financial support, and other Member States to make financial contributions to the research programme. It requested the Director General to report on the progress made in implementing this resolution to the General Conference at its fifty-fourth session.

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

### B.1. Research and Development in the FAO/IAEA Agriculture and Biotechnology Laboratories at Seibersdorf

4. During the 2008-2009 biennium, the United States Government contributed US\$ 120 000 for the development of a mass rearing module capable of producing 100 000 mosquitoes per day. This module was needed to test systems and management procedures at the FAO/IAEA Insect Pest Control Laboratory (IPCL) in Seibersdorf as a precursor to the training of Member State production facility personnel and the transfer of this technology to national programmes. In addition, the US Government has provided a cost-free expert in 2010 to carry out R&D on mosquito genetics and sterile male behaviour. The French Government has supported a PhD student to conduct research in the IPCL on

radiation biology and the competitiveness of mosquitoes, which will be of great relevance to the SIT feasibility project on La Réunion (France).

5. Work during this biennium continued at the IPCL in Seibersdorf, with research on the development of the SIT package for *Anopheles* mosquitoes. The IPCL continues to maintain cultures of *Anopheles arabiensis* strains from Sudan and Zimbabwe, as well as a Genetic Sexing Strain (GSS) created for sex separation. The GSS was transferred to the mosquito project in Sudan for rearing and possible trial releases in 2010-2011. The strains were also distributed to other Member States (e.g. Belgium, Denmark, Italy, USA, etc.), upon request, for research purposes and training. The species *Aedes albopictus* (carrier of dengue and chikungunya) was introduced into the laboratory in early 2010, with one strain originating from Italy and one from La Réunion.

6. A new larval diet was developed at the IPCL that is optimal for all growth parameters of *An. arabiensis* and uses only ingredients that are widely available and cost-effective for mass-rearing. Preliminary tests showed good results for both *An. arabiensis* and *Ae. albopictus*. This new diet has been transferred to Italy, Sudan and La Réunion for use in their SIT projects, as well as to research institutes in France, Trinidad & Tobago, the United Kingdom, and French Polynesia.

7. Prototype larval holding trays and a rack system to hold 50 trays were designed, produced, and tested for mass-rearing *An. arabiensis* larvae and pupae. The production of larvae in these newly developed trays using the new larval diet showed very promising results. The trays have been transferred to Sudan for additional testing, validation and up-scaling of mosquito production for pilot field releases. The trays have also been transferred to Italy and La Réunion to conduct additional tests on *Ae. albopictus*.

8. A larva-pupa separator has been designed and developed to mechanically separate both stages. This system, which combines cold temperatures with water swirling effects, allowed the efficient separation of a 30 000 larvae-pupae mixture in 2 minutes without affecting survival. The system is now being produced for transfer to Sudan and La Réunion. Following feedback received from different research laboratories (Ghana, Italy, and French Polynesia) the adult oviposition cage (for the laying and care of eggs) has been modified and improved.

9. In addition to the work done on the sterilisation and male competitiveness of the wild-type strain from Sudan, experiments with the *An. arabiensis* GSS have resulted in a new radiation protocol for effective sterilization. Mating competitiveness studies with irradiated males of the GSS, non-irradiated males and laboratory-reared wild-type strain males are being carried out in the laboratory and in a simulated semi-field setting. Upon completion, the protocol will be transferred to Sudan and La Réunion. Radiation protecting chemicals have been tested which reduce the radiation-induced damages when added to the mosquito larval diet and therefore improve the competitiveness of the sterile males, which is a crucial factor for release in an SIT programme.

10. The flight performance of the sterile male mosquitoes is an important quality factor. To assess this parameter in the laboratory, a flight tube has been developed to assess the effects of irradiation, composition of larval diets, larval density and other factors on male flight performance. Preliminary results showed that adult male mosquito flight performance was affected by high irradiation doses administered to pupa. Investigations on the correlation between flight ability and male competitiveness are continuing.

11. The use of low temperatures as an anesthetizing method of pupae and adult mosquitoes was studied with the aim to facilitate transport and to improve irradiation procedures. Initial results showed that short periods of chilling have only small effects on the survival of adult mosquitoes. In addition, work was done on the development of suitable markers to tag the released insects. It was shown that different colours (black versus white) of the larval rearing containers influence the pigmentation of

mosquito larvae and adults. A very good separation of adult mosquitoes reared in black or white larval trays was obtained using picture analysis. Wild mosquito samples from La Réunion showed great similarity with the adults reared in black containers, suggesting that rearing of mosquitoes in white trays could be used as a cheap and efficient marker for released mosquitoes in Île de la Réunion.

12. The insect greenhouse in Seibersdorf that simulates semi-field conditions has been partially completed, except for internal climate control equipment. It can be used under ambient conditions in spring and fall and will allow the testing of, *inter alia*, competitiveness, mating behaviour, mating compatibility and dispersal of sterile males. An adequate environmental control system (at a cost of approximately € 175 000) is needed to enable year-round use.

## **B.2. Coordinated Research and Capacity Building**

13. The third Research Coordination Meeting (RCM) of the Coordinated Research Project (CRP) on “Development of Standardised Mass Rearing Systems for Male *An. arabiensis* Mosquitoes” was held in Italy in September 2009. Representatives of nine Member States attended the meeting and significant progress was reported particularly on mass-rearing of the immature stages (larva to pupa) based on innovations such as the larval trays and racks, a re-circulating water system and the new larval diet.

14. The second RCM of the CRP on “Male Biology of Mosquitoes in Relation to Genetic Control” was held in Austria in February 2010 with the participation of scientists and observers from 14 Member States. Many of the research activities are being expanded from the laboratory to the field. Significant progress was reported on mosquito male pre-mating conditions, mosquito mating systems and on the contribution of molecular/chemical approaches to the understanding of male mosquito mating behaviour.

15. Since 2008, five fellows from Indonesia, Pakistan, Sri Lanka, Sudan and Syria have received a total of 18 months of training at the IPCL under the Agency’s technical cooperation (TC) programme covering topics such as mass-rearing of mosquitoes, the use of the GSS, the use of the new larval diet, mating studies and flight tube tests.

## **B.3. Preparatory Activities for Field Pilot in Sudan**

16. The Agency continued its support to its technical cooperation project in Sudan that aims at assessing the feasibility of integrating the SIT against *An. arabiensis*. The collaboration between Sudan and the Agency was strengthened by the visit of Sudanese representatives to the IPCL (April 2010) and by the visit of IPCL staff to Sudan (February and June 2010). In addition, four expert missions were conducted in Sudan.

17. The larval diet for the mass-rearing of *An. arabiensis* developed at the IPCL was transferred to Sudan and is being distributed to the different laboratories (Dongola, Khartoum, Soba). The diet will be tested locally in Sudan for its effect on various developmental parameters and male competitiveness in order to assess its use for up-scaled production.

18. The project has so far focused on the collection of baseline data on *An. arabiensis* larval breeding sites in two representative locations (Dongola and Merowe) in the project area along the Nile river in the Northern State of Sudan. Sudanese counterparts, in collaboration with Agency staff and outside experts, have published the results of a two-year intensive survey of larval breeding sites in a peer-reviewed journal. This survey provides data on larval population dynamics that is contributing to a feasibility study for the SIT mosquito project and, in collaboration with the Institut National de Recherche en Informatique et en Automatique (INRIA) in France, to the development of a model that aims to predict temporal and spatial fluctuations of adult populations of *An. arabiensis* in northern

Sudan. This data will assist with the planning of a strategy to reduce malaria risks by the area-wide management of the vector.

19. In addition to baseline data collection, three small release trials with sterile male mosquitoes were carried out during the reporting period in the target area. Recapture rates were very low, but the data indicates that the sterile males dispersed up to 250 meters from the release point and could survive for up to 10 days. There is an urgent need to develop adequate sampling devices that will enable the trapping of both wild and sterile male mosquitoes to allow monitoring of mosquito populations.

20. A technical review of the SIT feasibility project in the Northern State of Sudan was carried out by a group of experts in February 2010. The expert report emphasised that area-wide integrated pest management projects with an SIT component are very complex and can only be successful when all steps are taken in a timely manner and in the proper sequence. The report identified a number of critical issues (e.g. development of an adult male trapping device, collection of data on wild male ecology and behaviour, data on sterile male performance and competitiveness, up-scaling of the rearing in the current facility) that need to be resolved before the project can enter its operational phase. The experts recommended that the project adhere to the “phased conditional approach” as was developed for tsetse and fruit fly SIT programmes.

#### **B.4. Preparatory Activities for Feasibility Project on Réunion Island**

21. Practical Arrangements were signed in September 2008 between the Institut de Recherche pour le Développement (IRD), based in France, and the Agency in order to formalize the roles of both organizations for collaborative work on mosquito SIT.

22. In February 2009, the IRD hosted a meeting in Vienna where the Centre de Recherche et de Veille sur les Maladies Émergentes dans l'Océan Indien (CRVOI) in La Réunion, the IRD and the Agency agreed on their respective roles in the feasibility phase of the SIT project in La Réunion. In March 2009, Agency staff attended the “kick-off” meeting of the 4-year feasibility phase of the SIT project in La Réunion. The project is entitled “Technique de l’Insecte Stérile (TIS) appliquée à la lutte contre les moustiques *An. arabiensis*, vecteur de paludisme à L’île de La Réunion et *Ae. albopictus*, vecteur de la dengue et du chikungunya”. Together with the IRD, the IPCL is responsible for the development of mass-rearing technologies, sex separation methods, sterilization and release procedures for *An. arabiensis* and *Ae. albopictus*. The project involves French and international institutions and is co-funded by the French Ministry of Health, the Regional Council of La Réunion and IRD. The Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), the University of La Réunion, and the Agency are contributing in kind.

23. In December 2009, the Indian Ocean Commission, IRD, CRVOI and the countries in the West Indian Ocean area (Comoros, Madagascar, Mauritius and the Seychelles) participated in a meeting to review progress during the first year of the Réunion project. The project generated great interest among the representatives of the countries in the area. As a result, they are planning to submit concepts for national TC projects and one regional TC project for the 2012-2013 cycle, aimed at developing the SIT as an additional control tactic for mosquitoes in the region.

#### **B.5. Support to a Pilot Field Programme in Bologna, Italy**

24. In 2009, several meetings were organised between representatives of the "Centro Agricoltura Ambiente G. Nicoli" (CAA) from Crevalcore/Bologna in Italy and Agency staff. Data collected during a 3-year SIT trial conducted by CAA staff on a small pilot scale demonstrated that the sterile mosquitoes were effective and the *Ae. albopictus* population could be significantly reduced.

25. The Agency hosted a consultants meeting on "the Development of Generic Design for a Mosquito Mass-Rearing Facility" in May 2010 in Austria. The meeting was co-funded by the CAA and the Agency and attended by representatives of recipient Member States<sup>1</sup>. As a result of this mutually beneficial collaboration with CAA, steps are being undertaken for the CAA to become an IAEA Collaborating Centre, where fellows could be trained and scientists working on *Aedes* mosquito control can study and participate in pilot operations.

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<sup>1</sup> Argentina, France, Guatemala, Italy, South Africa, Spain, Sudan, USA and French Polynesia.



# Strengthening Support to Member States in Food and Agriculture

## A. Background

1. At its fifty-second session in October 2008, the General Conference, through resolution GC(52)/RES/12.A.1.9, urged the strengthening of FAO/IAEA partnership activities in order to enhance the continuing efforts in support of Member States, particularly in the areas of inter-regional and national capacity building, policy advice, establishment of standards and guidelines, and need-driven research and development.

2. Specifically, under its resolution on “Strengthening the support to Member States in food and agriculture”, the General Conference requested the Secretariat to expand efforts to address, inter alia, food insecurity in Member States, to increase its contribution to raise agricultural productivity and sustainability through the development and integrated application of nuclear science and technology; and to continue developing and applying nuclear techniques, inter alia, in areas of food and agriculture using an integrated and holistic approach – namely, land and water management, plant breeding and crop production, insect pest control, animal production and health, and food safety. The General Conference further encouraged the Secretariat to pursue the consultations with FAO to continue their partnership, which should be further strengthened through a joint review of the activities and achievements, and to continue adjusting and adapting its technology development, capacity building and technology transfer and services in response to Member States’ demands and needs in food and agriculture; and it requested the Director General to report on the progress made in the implementation of this resolution to the Board of Governors and the General Conference at its fifty-fourth (2010) regular session (GC(52)/RES/12.A.5.).

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

### B.1. Strengthening the FAO/IAEA partnership

3. As part of FAO’s reform, the Arrangements for the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture were reviewed by the Member States of FAO. FAO renewed its commitment to these Arrangements through, inter alia, the Special Session of the FAO Conference in November 2009, which approved the new structure of FAO including the Joint FAO/IAEA Division under the Agriculture and Consumer Protection Department. In addition, the FAO Conference observed that FAO’s new Strategic Framework for 2010-2019 provides a solid foundation for the further strengthening and broadening collaboration with other UN system organizations including the IAEA.

4. The Joint FAO/IAEA Programme is expected to make important contributions to FAO’s Programme of Work and Budget (PWB) for 2010-2011 in four of the 13 specific strategic objectives as follows: sustainable intensification of crop production; increased sustainable livestock production; improved quality and safety of foods at all stages of the food production chain; and sustainable

management of land, water and genetic resources and improved responses to global environmental challenges affecting food and agriculture.

5. The Joint FAO/IAEA Division actively contributed to the development of the PWB 2010-2011, whereby the Joint Division will be able to fully capitalize on synergies and to better link the programmatic goals of FAO and the Agency.

6. Since 2009, efforts have been made to streamline, simplify and harmonize lines of authority and accountability by fully aligning the Seibersdorf laboratory management and staff with their respective programmes. With this re-alignment, the food and agriculture programme will now be able to attain greater synergy and react more quickly to the multiple and diverse requests of Member States.

## **B.2. Recent activities of the Joint FAO/IAEA Programme**

7. The renewed commitment by FAO to its partnership with the IAEA has helped the Joint FAO/IAEA Division in continuing the successful delivery of the Joint FAO/IAEA Programme during the past biennium. Activities have included, among others, mutation breeding of salinity and drought tolerant crops and numerous applications in conservation agriculture, animal and plant pest and disease control, food safety, facilitation of trade, mitigation of climate change, and sustainable use of natural resources. The Joint FAO/IAEA Division is currently coordinating 41 Coordinated Research Projects in approximately 600 research institutions and experimental stations in Member States, and is responsible for providing scientific and technical support to more than 240 national and regional Agency Technical Cooperation Projects. Some 50 workshops, seminars and training courses (train-the-trainer) were organized each year for about 500 trainees from developing countries, with more than 90 per cent being carried out on location in developing countries.

8. In the past biennium, Member States have achieved numerous successes using nuclear and related techniques, with support from the Joint FAO/IAEA Programme. These applications enable farmers, food manufacturers and government agencies to provide more, better and safer food, while conserving soil and water resources and the biodiversity on which these products depend. Through these successes the Joint FAO/IAEA Division continues to contribute to the Millennium Development Goals as well. Some of the most notable impacts achieved by stakeholders in Member States through nuclear and related applications and in partnership with the Joint FAO/IAEA Division are highlighted below.

9. The support to transboundary and regional programmes to control major insect pests through the sterile insect technique (SIT) has resulted, in 2008-2009, in the expansion of fruit fly free areas in Central and South America allowing the export of fresh fruits and vegetables and the eradication of pest fruit flies from southern Peru and of the invasive cactus moth from two islands in southern Mexico. The more effective management of major *anastrepha* and *ceratitis* fruit fly pests achieved through the integrated application of the SIT has opened lucrative export markets and has brought investments for the production of fruit and vegetables of over US \$185 million in Central America. Furthermore, a successful pilot project to suppress the false codling moth in South Africa has been expanded and privatized by the citrus industry.

10. China and some other Asian countries have introduced the use of nuclear tracer techniques as a successful measure aimed at soil conservation. Through regular programme and technical cooperation projects conducted in the Loess Plateau (Nianzhuang watershed) and in northern (Fengning) and north-eastern (Baiquan) China, substantial soil erosion rates were measured on cultivated land using the <sup>137</sup>Cs fallout radionuclide. These measurements subsequently enabled the development of remedial conservation measures that reduced soil erosion rates, again measured by <sup>137</sup>Cs fallout radionuclide, by up to 80 per cent.

11. Fertigation, the dual application of water and fertilizer to crops, which has been shown to significantly reduce both water and fertilizer use, has now been put into practice by more than 30 Member States. More than 95 countries now use isotopes and nuclear techniques to identify land and water management practices to improve nutrient and water use efficiency for crop productivity and environmental sustainability.

12. Worldwide, more than one hundred Member States are using mutation induction techniques to improve food and industrial crops, and the number of officially released mutant varieties now stands at 3088 (up from 2250 in 2000). About 69 mutant varieties with higher yields, quality, disease resistance, better adaptation to the environment and improved nutrition from 14 crop species were officially released in 13 countries during 2008-2009. Based on the Agency's support through Coordinated Research Projects and national and regional Technical Cooperation Projects, the national agriculture research institutes of Vietnam have developed and officially released to farmers in the Mekong Delta three improved rice mutant varieties that are known for both their high food quality and tolerance to salinity. By 2008, these varieties were worth US \$350 million per year in additional income to farmers, and one of these varieties is now among the top five export varieties in Vietnam.

13. The world is expected to be declared officially free of rinderpest, a virus responsible for severe losses of cattle on a global scale, particularly in Africa, at the end of this year. The Joint FAO/IAEA Division played a key role in the FAO Global Rinderpest Eradication Programme (GREP), initiated in 1994, which contributed to the transfer of technology, the improvement of laboratory infrastructure and staff capacity, as well as to the provision of methodology and operational guidance, in collaboration with its partners, such as the European Union (EU) and the African Union-Interafrican Bureau for Animal Resources (AU-IBAR). The economic significance of this achievement is considerable, as a major outbreak of rinderpest, typically lasting five years, could destroy more than 70 million (or 14 million per year) of the 220 million cattle in Africa. With an estimated value per head of US \$120, the cost of such an outbreak would be more than US \$1.6 billion per year and a total of US \$8.4 billion for the whole outbreak.

14. The bovine genome has been fully revealed after six years of international efforts in which the Joint Division actively participated through research work conducted at its laboratories in Seibersdorf. This is the first genome of mammalian domesticated livestock that has been studied. Sequencing of the bovine genome provides new information about mammalian evolution as well as cattle-specific biology and will enable new research that could result in more sustainable food production.

15. The establishment and enhancement of food safety laboratories and control systems for chemical residues in food help many countries safeguard consumer health and promote trade. For example, Nicaragua is using nuclear and complementary techniques to improve production, product quality and analytical techniques to control residues of veterinary drugs and hormonal growth promoters in bovine meat exports.

16. In 2009, the strengthening of the National Residues Laboratory of Nicaragua's Ministry of Agriculture and Forestry, including the introduction of new analytical techniques developed by the Joint FAO/IAEA Division, helped to increase the export of Nicaraguan meat, shrimp, peanuts and honey by an estimated US \$360 million.



# Nuclear Energy Activities

1. This annex summarizes highlights of Agency activities not covered in Annexes 5, 6 and 7, which address infrastructure development for nuclear power, innovative nuclear technology and nuclear knowledge management, respectively.
2. The Agency annually updates its low and high projections for global growth in nuclear power. In 2010, the low projection was revised upwards, and the high projection was essentially unchanged. In the updated low projection, global nuclear power capacity reaches 546 GW(e) in 2030, compared to 371 GW(e) at the end of 2009. In the updated high projection, it reaches 803 GW(e).
3. At the 15th Session of the Conference of the Parties (COP 15) to the United Nations Framework Convention on Climate Change (UNFCCC), held in December in Copenhagen, Denmark, the Agency maintained an information centre. Agency publications distributed at the centre included a brochure, *Climate Change and the Atom*, describing the Agency's activities related to the issue of climate change, and *Climate Change and Nuclear Power 2009*, which provides updated information on all aspects of nuclear power in the context of current climate change concerns and presents national perspectives from a number of countries.
4. There is broad interest in optimizing the lifecycles of operating nuclear power plants through plant life management (PLiM) for safe long term operation (LTO). The IAEA supports Member States' efforts to improve PLiM and LTO through publications, coordinated research projects (CRPs), workshops and missions to compile best practices, share information, coordinate research and provide advice. Two CRPs related to the integrity of reactor pressure vessels were completed since the 53<sup>rd</sup> General Conference and their final reports published: *Pressurized Thermal Shock in Nuclear Power Plants: Good Practices for Assessment* (IAEA-TECDOC-1627) and *Master Curve Approach to Monitor Fracture Toughness of Reactor Pressure Vessels in Nuclear Power Plants* (IAEA-TECDOC-1631).
5. The Agency established a new Network of Excellence for Supporting the Use of Instrumentation and Control (I&C) Technologies for the Safe and Effective Operation of Nuclear Power Plants (NE-ICT) in April 2010. This network supports the designing, testing, commissioning, and licensing of I&C technologies for nuclear power plants. The network builds on a large pool of international experts, which includes the members of the Agency's Technical Working Group on Nuclear Power Plant Instrumentation and Control. The main focuses of the network will be implementing and licensing digital I&C in safety systems, modernization of I&C systems and control rooms, monitoring and managing I&C cable ageing, and new sensing technologies. Since the 53<sup>rd</sup> General Conference, the Agency published *Protecting Against Common-Cause Failures in Digital I&C Systems of Nuclear Power Plants* (IAEA NE Series No. NP-T-1.5).
6. The Agency's Power Reactor Information System (PRIS) is a comprehensive data source on all nuclear power reactors in the world. It includes specification and performance history data of operating reactors as well as reactors under construction and reactors being decommissioned. All operating nuclear power plants provide data regularly. The PRIS website (<http://www.iaea.org/pris>) provides information for the public and is one of the most frequently used gateways to the Agency's website. Since the 53<sup>rd</sup> General Conference, the Agency has modernized PRIS. The complete database and all related communications are now web-based in order to make PRIS globally available. The interface provides end-users the possibility of easily generating both global and plant-specific reports and graphs on nuclear energy's status, performance and trends.

7. Of the 29 countries with operating nuclear power plants, 24 plan to expand nuclear capacity. The Agency held workshops in Argentina, Brazil, China, and Lithuania on different aspects of expansion. A guidance document on evaluating bids and construction management will be published in 2010. A Technical Meeting on Interfacing Nuclear Power Plants with the Electric Grid: the Need for Reliability amid Complexity, in August 2010, will lead to an additional guidance document on the grid – nuclear power plant interface.

8. The latest update of the biennial ‘Red Book’ — *Uranium 2009: Resources, Production and Demand* — was published jointly by the Agency and the OECD/NEA in July 2010. Identified conventional uranium resources, recoverable at a cost of less than \$130/kg U, are currently estimated at 5.7 million tonnes uranium (Mt U). This is an increase of over 0.2 Mt U, relative to the previous edition of the Red Book, due mainly to increases reported by Australia, Canada and Namibia. There are an additional 0.7 Mt U of identified conventional resources recoverable at costs between \$130/kg U and \$260/kg U. For reference, the spot price for uranium in 2009 fluctuated between \$110/kg U and \$135/kg U with a very gradual downward trend.

9. Following the relaunch of the Agency’s UPSAT (Uranium Production Site Appraisal Team) programme in 2008, an UPSAT peer review of the uranium mining and milling plant at Caetité, State of Bahia, Brazil, was carried out in February 2010. UPSAT peer reviews are organized on request and provide independent, international expert advice to promote best practices and safety in the uranium production cycle.

10. The Agency convened an international conference on the Management of Spent Fuel from Nuclear Power Reactors in June 2010.<sup>1</sup> The conference concluded that repositories for either spent nuclear fuel (SNF) or high level waste (HLW) from recycling facilities remain at least a decade away. This will necessitate an increase in both the amount of SNF in interim storage and the length of time for which SNF will be stored. Delegates felt that work was needed to ensure confidence in the integrity of SNF for these long storage durations. The conference also identified the need for additional work to be done on burn-up credit for spent fuel from power reactors, fuel behaviour in dry storage and the behaviour and safety of high burn-up fuels and MOX fuels in long term storage. It stressed the importance of greater international cooperation on research and development and progress towards harmonized safety regulations.

11. The Agency also published *Management of Damaged Spent Nuclear Fuel* (IAEA NE Series No. NF-T-3.6) and *Costing of Spent Nuclear Fuel Storage* (IAEA Nuclear Energy Series No. NF-T-3.5). It completed a CRP on Spent Fuel Performance Assessment and Research (SPAR-II), which evaluated the performance of spent fuel in wet and dry storage and concluded that current storage technology can accommodate the trend toward extended storage times.

12. The Agency operates site remediation, decommissioning and disposal networks to improve the flow of knowledge from those with more experience to those with less. The Network on Environmental Management and Remediation (ENVIRONET) was launched during the Agency’s General Conference in 2009. Four sections of the Waste Management Symposium 2010, held in March in Phoenix, Arizona, were dedicated to presenting ENVIRONET’s plans and activities and expanding the number of participants. In June 2010, a training course was held at the Argonne National Laboratory in the USA on Life-Cycle Planning of Environmental Remediation.

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<sup>1</sup> Safety issues addressed by the conference are summarized in the report entitled *Measures to strengthen international cooperation in nuclear, radiation, transport and waste safety* (GOV/2010/41-GC(54)/8 in Section J.2 on management of spent fuel.

13. The International Decommissioning Network (IDN) supports countries with small scale programmes with the objective of providing practical examples and demonstration exercises. In 2009, the UK hosted visits to the Sellafield and Dounreay nuclear installations for senior managers involved in the decommissioning of sites with multiple facilities. Two workshops were held in 2010. The first covered cost estimation for smaller facilities; characterization, dismantling and decontamination technologies; and material management and clearance. The second was a special 'hands-on' decommissioning course at Argonne National Laboratory.

14. The International Disposal Network (DISPONET) assists Member States in the disposal of low level radioactive waste. A workshop on post-operational environmental monitoring and surveillance of disposal facilities for radioactive waste was held in September and led to recommendations on the termination of control, facility performance, early planning and knowledge preservation. In cooperation with the TC programme, two regional courses on the disposal of low and intermediate radioactive waste were organized in Mumbai, India, and Cordoba, Spain.

15. In cooperation with the TC programme the Underground Research Facilities Network (URF) conducted two training courses. The first, in Peine, Germany, was entitled Fundamentals of Geological Disposal in Sedimentary Environments, and participants visited the Konrad and Gorleben disposal facilities in development. The second, entitled Advanced Conceptual and Numerical Methods for Modelling Subsurface Processes Regarding Nuclear Waste Repository Systems was held in Albuquerque, New Mexico, USA, and included a site visit to the Waste Isolation Pilot Plant.

16. Shutdowns and outage extensions of aged research reactors continued to affect global supplies of molybdenum-99. The Agency helped expand the number of research reactors involved in molybdenum-99 production by fostering the EurAsia Research Reactor Coalition (formed in 2008 and including Member States in Central Asia and Eastern Europe), encouraging existing reactors to offer irradiation services, and contributing to the High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR) initiated by the OECD/NEA. The Agency also held a workshop on enhancing molybdenum-99 production and availability, facilitated direct interactions among different stakeholders, and, through a CRP on production using low enriched uranium (LEU) targets or neutron activation, encouraged offers of additional irradiation services and feasibility studies. The Agency also contributed technical support and information to a number of international meetings. Currently, the Agency is working on a survey to gather information on non-HEU based Mo-99 and Tc-99m production for a comparative analysis of the various possibilities.

17. A number of Agency supported research reactor coalitions and networks (African Research Reactor Network, Baltic Research Reactor Network, Caribbean Research Reactor Coalition, Eurasia Research Reactor Coalition and Eastern European Research Reactor Initiative) shared research reactor facilities and expertise and secured entrepreneurial interest in upgraded and new facilities and improved access to countries without research reactors. In December 2009, the first sample of Mo-99 produced through activation of Mo-98 by the Eurasia Research Reactor Coalition was shipped to the USA for qualification tests. The Eastern European Research Reactor Initiative organized two group fellowship training courses for Member States interested in initiating research reactor projects.

18. Agency support continued for Member States participating in international programmes to return research reactor fuel to its country of origin. As part of the Russian Research Reactor Fuel Return (RRRFR) programme, 12.1 kg of fresh HEU fuel was moved from the Czech Republic to the Russian Federation under a contract arranged by the Agency. The Agency also assisted in the repatriation to the Russian Federation of 429 kg of spent HEU fuel from the Libyan Arab Jamahiriya, Poland and the Ukraine. The Agency published *Good Practices for Qualification of High Density Low Enriched Uranium Research Reactor Fuels* (IAEA NE Series No. NF-T-5.2), which provides guidance on ensuring acceptable performance of high density LEU fuels, and *Corrosion of Research Reactor*

*Aluminium Clad Spent Fuel in Water* (IAEA-TECDOC-1637), which describes ways to improve storage. The technical cooperation project on repatriating spent fuel from the RA research reactor at the Vinča Institute in Serbia is on schedule. A main milestone was the completion of spent fuel repackaging in May 2010. All the spent fuel will be transported to the Russian Federation in one shipment in late 2010.

# Supporting Infrastructure Development for Nuclear Power

## A. Background

1. In resolution GC(53)/RES/13.B.1, the General Conference requested the Secretariat to continue to pursue, in consultation with interested Member States, the Agency's activities in the areas of nuclear science and technology for nuclear power applications in Member States, with a view to strengthening infrastructures and fostering science, technology and engineering.
2. In resolution GC(53)/RES/13.B.2, the General Conference encouraged the Secretariat to undertake further assessments on approaches and options for addressing infrastructure requirements. It also encouraged Member States and the Secretariat to take the results of assessments of infrastructure requirements into account in optimizing the Agency's ongoing activities and commended the Secretariat for its internal coordination and holistic approach to nuclear infrastructure support. The General Conference called on the Secretariat, in particular, to continue to focus on activities aimed at helping interested Member States assess their human resource needs and identify ways to address those needs. The General Conference requested that the Director General report on the progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its fifty-fourth (2010) session. This report responds to that request.

## B. Work since the 53<sup>rd</sup> session of the General Conference

### B.1. General

3. The renewed interest in nuclear power has resulted in a significant increase in demand for Agency assistance from Member States considering or introducing nuclear power. Over 60 Member States have expressed interest in considering the introduction of nuclear power, and, in the past four years, the number of related technical cooperation (TC) projects has tripled, and extrabudgetary contributions for this purpose have also risen. Agency activities related to the introduction of nuclear power cover a wide range of technical topics, including workforce planning, human resource development and supporting the development of competent regulatory systems. The Agency's Secretariat has been involved in developing guidance and other documents, creating forums to share lessons learned and best practices, and providing technical assistance in the form of capacity building and review services.
4. Reflecting the Agency's holistic approach to infrastructure development, these activities continued to be implemented in a coordinated manner across all the relevant areas of the Agency's programme, using a matrix approach for the technical integration of activities. This includes the integration of information from various databases for more effective planning and delivery of support activities under TC projects, training in the use of energy planning tools, legislative assistance, guidance on ensuring beneficial, responsible and sustainable nuclear development, building capabilities — including self-assessment capabilities — among governmental and operating organizations, as well as the preparation and implementation of education and training materials. The

Nuclear Power Support Group (NPSG) continued to play the central role of coordinating the Secretariat's assistance in the area of nuclear power development while the technical cooperation programme is the main vehicle for responding to Member State requests.

## **B.2. Assessment of nuclear infrastructure**

5. In 2009, the Agency launched a new service, the Integrated Nuclear Infrastructure Review (INIR) missions, which are designed to assist countries in analysing their nuclear power infrastructure development, identify gaps and develop action plans. The work of the INIR missions, which are conducted by Agency staff and international experts, is based on the publication entitled *Evaluation of the Status of National Nuclear Infrastructure Development* (Nuclear Energy (NE) Series NG-T-3.2), and a brochure entitled *Guidance on Preparing and Conducting INIR Missions*, which was published in March 2009.

6. Three INIR missions were conducted in 2009, in Indonesia, Jordan and Vietnam. These missions assessed the status of the 19 infrastructure issues identified in the publication entitled *Milestones in the Development of a National Infrastructure for Nuclear Power* (NE Series NG-G-3.1). The INIR mission teams made suggestions and recommendations to enhance nuclear power infrastructure planning. Self-assessments were prepared and provided to the mission teams in advance, which greatly facilitated the outcomes. These missions were conducted in the context of national TC projects. The Member States who participated in these first three INIR missions found them to be useful and supportive of national efforts.

7. The feedback and lessons learned on the implementation of the first three INIR missions were reviewed by a consultants group in February 2010. The consultants concluded that the *Guidance on Preparing and Conducting INIR Missions* was useful and suggested that it could be improved over time in light of the experience gained from implementation. The consultants also found that the publication entitled *Evaluation of the Status of National Nuclear Infrastructure Development* was also generally good and suggested that the Agency should continue to gain feedback from Member States' experience in using it to determine the appropriate time for reviewing and further improving the document.

## **B.3. Support for human resource development**

8. The International Conference on Human Resource Development for Introducing and Expanding Nuclear Power Programmes was held from 14 to 18 March 2010 in Abu Dhabi, United Arab Emirates (UAE).<sup>1</sup> The Conference was jointly hosted by the Government of the United Arab Emirates, the Emirates Nuclear Energy Corporation (ENEC), the Federal Authority for Nuclear Regulation (FANR) and the Khalifa University of Science, Technology and Research (KUSTAR).

9. The conference attracted 256 participants and 64 observers from 62 countries and 11 international organizations. In planning and implementing the conference, the Agency cooperated with the European Nuclear Education Network (ENEN) Association, the Abdus Salam International Centre for Theoretical Physics (ICTP), the Japan Atomic Energy Agency (JAEA), the Japan Atomic Industrial Forum (JAIF), the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (NEA/OECD), the Nuclear Energy Institute (NEI), the World Association of Nuclear Operators (WANO), and the World Nuclear Association (WNA).

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<sup>1</sup> Since the issue of human resource development cuts across several activities for which the General Conference has requested reports, this conference is also mentioned in Annex 7 of this report on nuclear knowledge management and in the report entitled *Measures to strengthen international cooperation in nuclear, radiation, transport and waste safety* (GOV/2010/41-GC(54)/8 in Section D on capacity building, knowledge networks, education and training.

10. The conference confirmed the importance of a balanced approach to human resource development that emphasizes building capacity and expertise in all, rather than only selected, relevant areas of the nuclear field. Particular emphasis was placed on attracting a younger, early-career workforce, recognizing that they are indispensable for future global nuclear success. For effective management of national nuclear power programmes, human resources with experience in different nuclear areas are needed, and programmes should encourage young staff to receive early experience in different areas associated with nuclear power. The importance of a strong safety culture was emphasized throughout the conference as being essential for the continued success of nuclear power programmes.

11. At the conference an initiative was announced by the Agency and the eight organizations listed in paragraph 9 to conduct a number of surveys of human resource needs and supplies, throughout the nuclear power field and to develop workforce planning tools for countries considering or launching new nuclear power programmes. The Agency will have a lead role in aspects of the surveys related to operating organizations, regulatory bodies, and staffing for new nuclear power programmes. The objectives of the surveys are:

- For those countries with existing nuclear power programmes, to provide decision-makers with information with which to improve planning for their nuclear industry workforce and to benchmark their efforts.
- For those countries considering nuclear power, to improve their understanding of the approaches needed to develop human resources for a sustainable nuclear power programme.
- For international organizations, to provide them with information to better serve their stakeholders.

12. A key aspect of the Agency's human resource development activities is to share experience and lessons learned. Under the Agency's TC programme, the Korea Hydro & Nuclear Power Company (KHNP) hosted a meeting in June 2009 with the participation of future leaders of new nuclear power programmes from 12 Member States. During a two-week period, each participant was assigned to work with a mentor from KHNP. Mentors were recent retirees from KHNP who had been senior managers responsible for commissioning nuclear power plants in the Republic of Korea. The meeting included visits to the corporate office of the nuclear power plant operating organization, an engineering company, an educational institute and training centre, research organizations, an operating nuclear power plant, a nuclear power plant under construction, a heavy component manufacturing company, government ministries, and the nuclear safety regulatory body. The mentors accompanied the participants on these visits and helped participants to gain the perspective of someone responsible for nuclear power programme implementation. The mentoring support for future leaders of new nuclear power programmes is planned to continue in 2010 in the Republic of Korea.

13. A report entitled *Workforce Planning for New Nuclear Power Programmes* (NE Series No. NG-T-3.10) was completed and approved for publication. The workforce planning approach recommended in this document is based on the Milestones publication<sup>2</sup>. Based on this approach, the Agency has developed a standard workshop on workforce planning concepts for Member States introducing nuclear power. In view of the strong demand for this support in the TC programme, 11 workshops have been conducted since 2009. Another 10 are planned through 2011.

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<sup>2</sup> *Milestones in the Development of a National Infrastructure for Nuclear Power*, (IAEA Nuclear Energy Series No. NG-G-3.1), 2007.

14. The Global Nuclear Energy Partnership (GNEP), which was renamed the International Framework for Nuclear Energy Cooperation (IFNEC) in June 2010, has supported the development of a workforce planning model for newcomers based on the Agency's workforce planning approach. The model was originally developed using data from the USA and Russian Federation, and discussions are underway to develop a project to further extend the model using data from a Member State introducing nuclear power.

#### **B.4. Workshops and training courses**

15. A workshop on nuclear power newcomers and international cooperative actions was organized by the Agency in November 2009 and attended by 105 representatives from 45 Member States and WANO. The workshop helped newcomers and vendor countries establish a common international understanding of the needs, responsibilities and ways to share experience in national infrastructure development.

16. The Agency held a workshop entitled "Topical Issues on Infrastructure Development: Managing the Development of a National Infrastructure for Nuclear Power" in February 2010. The meeting was attended by more than 100 representatives from 45 Member States, the European Commission (EC) and WANO. This was the fourth annual workshop conducted by the Agency since 2006 to provide a platform for sharing experience and lessons learned to facilitate the development and implementation of national infrastructure development. The main outcome of the workshop was recognition of the importance of having a national strategy in place that can provide a basis for workforce planning and other aspects of the national infrastructure.

17. Under the TC programme, an Interregional Training Course on Leadership and Management of Nuclear Power Infrastructure in Emerging Nuclear Power States was held at the Argonne National Laboratory (ANL), USA, in October–November 2009. The course was organized jointly by the Agency and the ANL of the US Department of Energy (DOE). It was attended by 28 participants at the decision-making level from 20 Member States from Africa, Asia, Europe and Latin America. The course activities revolved around three major inter-related objectives: i) providing knowledge connected to the 19 infrastructure issues, (ii) sensitizing participants to the specific processes, organization and management systems associated with nuclear power infrastructure, and (iii) further strengthening the networking and sharing of experience among newcomer countries. Based on the recommendations and lessons learned from the course the second training opportunity is planned for October 2010 in the USA.

#### **B.5. Databases and publications**

18. The Country Nuclear Power Profiles (CNPP) compile background information on the status and development of nuclear power programmes in Member States. The format was revised in 2009 to allow Member States introducing nuclear power to be included in the profiles. The new CNPP format contains additional information on nuclear power infrastructure development and presents factors related to effective planning, decision-making and implementation of nuclear power projects. The latest edition consists of 44 country profiles and is available on CD-ROM and on the web at [www.pub.iaea.org/MTCD/publications/PDF/cnpp2009](http://www.pub.iaea.org/MTCD/publications/PDF/cnpp2009). Participants include the 29 countries that have operating nuclear power plants, as well as 15 countries having past or planned nuclear power programmes. An additional six 'newcomer' countries have been invited to submit information for the 2010 edition.

19. Additional recent Nuclear Energy (NE) Series publications that are of interest to countries introducing nuclear power include:

- NE Series No. NG-G-2.1: Managing Human Resources in the Field of Nuclear Energy

- NE Series No. NG-T-4.1: Issues to Improve the Prospects of Financing Nuclear Power Plants
- NE Series No. NG-T-3.6: Responsibilities and Capabilities of a Nuclear Energy Programme Implementing Organization
- NE Series No. NG-T-3.1: Initiating Nuclear Power Programmes: Responsibilities and Capabilities of Owners and Operators
- NE Series No. NW-G-1.1: Policies and Strategies for Radioactive Waste Management

20. The Agency also completed a Safety Guide entitled *Establishing the Safety Infrastructure for a Nuclear Power Programme*. The publication provides a 'road map' of safety related actions to be taken in the first three phases of the development of a nuclear power programme in order to achieve a high level of safety during the lifetime of the nuclear power plant.

## **B.6. Documents in preparation**

21. A number of additional documents are now in various stages of preparation with continuing participation and contributions from Member States.

22. NE Series No. NG-T-3.7, entitled *Managing Siting Activities for Nuclear Power Plants*, is scheduled to be submitted for publication by the end of 2010. The integrated site selection and evaluation approach recommended in this document is based on the Milestones approach and takes into consideration the related Safety Guide mentioned above.

23. NE Series No. NG-T-3.4, entitled *Industrial Infrastructure to Support a National Nuclear Power Programme*, is under development and planned for publication in 2011.

24. An updated and integrated report, NE Series No. NG-T-3.9, entitled *Invitation and Evaluation of Bids for Nuclear Power Plants*, is planned for publication in 2010. This report will provide practical guidance on the establishment of the nuclear power plant bidding process including the preparation of bid invitation specifications, the technical and economic evaluation of bids, and the contract negotiation.

25. Four other NE Series documents are under development, entitled *Nuclear Power General Objectives*, *Radioactive Waste Management Objectives*, *Nuclear Fuel Cycle Objectives*, and *Stakeholder Involvement in the Lifecycle of Nuclear Facilities*. Both documents are planned for publication in 2010.

26. As part of its legislative assistance programme, which 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 Agency is also developing a new publication on legal aspects of the promotion of nuclear power.

## **C. Future events**

27. To strengthen the internal mechanisms for delivering the Agency's support to requesting Member States in an integrated manner, an Integrated Nuclear Infrastructure Group has been established within the Division of Nuclear Power. The group will be responsible for facilitating and ensuring effective coordination and integrated implementation of the Agency's activities related to the introduction of nuclear power. While the Nuclear Power Support Group (NPSG) will continue to be a forum for

coordination, the new group will be in charge of operationalizing the technical activities at the working level.

28. The feedback from the results of assessments of infrastructure requirements received through the performance of INIR missions will be used in 2010 for preparing a revision of the current *Guidance on Preparing and Conducting INIR Missions*. The main aims are to improve the preparation and overall effectiveness of the review teams, and to standardize reporting in order to expedite the delivery of assessment results.

29. A workshop on management and evaluation of national nuclear infrastructure planning and building will be organized by the Agency in February 2011. This follows the series of workshops conducted since 2006 regarding national infrastructure to support the introduction of nuclear power. This workshop will focus on leadership and coordination of nuclear infrastructure planning and development, and on the self-evaluation process.

30. A workshop on common challenges on site selection for nuclear power plants will be organized by the Agency in 2010. This follows the previous workshop related to siting conducted in 2009. The second workshop will focus on siting planning and development and the adequate application of the relevant Agency safety standards to the site selection process.

31. A workshop on industrial involvement and technology transfer for nuclear power plant projects will be organized by the Agency later in 2010. This workshop will focus on integrated and updated practical guidance on what are the considerations and issues that need to be addressed in planning, preparing and building (i) a sustainable industrial capacity within the nuclear power programme lifecycle, and (ii) technology transfer mechanisms, including the management of intellectual property rights in newcomer States.

32. Several Member States are interested in conducting their bilateral and multilateral support for infrastructure development in a more coordinated manner with due regard to other ongoing support activities in specific areas. For example, France and Jordan are engaged in cooperation for infrastructure development under a memorandum of understanding and have indicated to the Agency their interest in sharing information to foster better coordination.

# Agency Activities in the Development of Innovative Nuclear Technology

## A. Background

1. In resolution GC(53)/RES/13.B.4, the General Conference emphasized the important role that the Agency could play in assisting interested Member States with the planning and development of their nuclear power programmes with innovative nuclear energy systems, and requested the Director General to strengthen the Agency's efforts related to the development of innovative nuclear technology by further enhancing the effective use of available resources in support of related activities of the technical working groups (TWGs) and the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO). The General Conference recommended that the Secretariat continue to explore opportunities for synergy between the Agency's activities, in particular INPRO, and those pursued under other international initiatives in areas related to international cooperation in peaceful uses of nuclear energy, safety, proliferation resistance and other security issues. It requested the Secretariat to promote the exchange of relevant technical information among interested Member States and to foster human resource training on innovative nuclear technologies. 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-fourth regular session.

2. This report responds to that request and summarizes Agency activities related to innovative nuclear technology, in particular those carried out under INPRO.

## B. INPRO Activities

### B.1. Overall project status

3. As of June 2010, INPRO had increased its membership by one country (Algeria), and had 31 members, representing 75 per cent of the world's gross domestic product and 65 per cent of the world population: Algeria, Argentina, Armenia, Belarus, Belgium, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, France, Germany, India, Indonesia, Italy, Japan, Kazakhstan, Republic of Korea, Morocco, Netherlands, Pakistan, Russian Federation, Slovakia, South Africa, Spain, Switzerland, Turkey, Ukraine, USA and the European Commission (EC).

4. The INPRO Action Plan for 2010–2011, was approved at the 15th meeting of the INPRO Steering Committee in November 2009 and implementation began in January 2010. The plan comprises activities and collaborative projects in five substantive areas:

- (a) Nuclear Energy System Assessments (NESAs) using the INPRO methodology.
- (b) Global visions, scenarios and pathways to sustainable nuclear development.
- (c) Innovations in nuclear technology.
- (d) Innovations in institutional arrangements.

(e) INPRO Dialogue Forum on Nuclear Energy Innovations.

5. Coordination with related activities throughout the Agency is effected through the INPRO Joint Action Plan, which was developed in 2009. Two INPRO collaborative projects (CPs), “Proliferation Resistance: Acquisition/Diversion Pathway Analysis” (PRADA) and “Environmental Impact Benchmarking Applicable for Nuclear Energy Systems under Normal Operation” (ENV), are examples of Agency-wide activities defined through the INPRO Joint Action Plan. PRADA is implemented in cooperation with Major Programme 4 (Nuclear Verification) and ENV in cooperation with Major Programme 2 (Nuclear Techniques for Development and Environmental Protection). This approach makes best use of available expertise and achieves good overall synergy and coordination within the Agency.

6. In 2009 and 2010, INPRO’s communication activities were intensified to enhance cooperation with INPRO’s stakeholders in Member States and at the Agency and to keep them abreast of ongoing activities. In May 2010, the 2009 INPRO Progress Report was published. It summarizes progress made in the course of 2009, highlights achievements and provides an outlook for 2010.

7. The INPRO work programme reflects the interests and priorities of its members which are in line with the Agency’s regular programme. It continues to rely mainly on in-kind and extrabudgetary contributions from its members. Results obtained under INPRO are in turn available to all IAEA Member States. As of June 2010, ten cost-free experts worked in the INPRO group at the Agency, bringing the total since INPRO’s establishment to 40. Two more are scheduled to join the group before the end of 2010.

## **B.2. Nuclear energy system assessment**

8. In 2009, the Agency published *Lessons Learned from Nuclear Energy System Assessment (NESA) using the INPRO Methodology* (IAEA-TECDOC-1636). This publication compiled lessons learned from the seven completed NESAs, which involved 11 countries<sup>1</sup>. Also included were proposals for improving the INPRO methodology to facilitate its use for comparative assessments. Complete reports of all seven assessment studies were compiled on a CD-ROM for distribution upon request.

9. In 2010, the *Assessment of Nuclear Energy Systems Based on a Closed Nuclear Fuel Cycle with Fast Reactors* (IAEA-TECDOC-1639) was published. It summarizes the results of a joint study by eight INPRO members. A full report is available on CD-ROM. It was concluded that the fast reactor systems that were modelled could meet INPRO requirements and therefore provide a sustainable energy supply option. The economics of fast reactors need to improve for them to be competitive with thermal reactors.

10. The NESA support package was further developed in 2010 and now includes a user’s guide on how to apply the INPRO methodology and perform a NESA, differentiating between three types of assessors: a nuclear technology developer, an experienced user of nuclear technology, and a prospective first time user of nuclear power. The Agency can provide assistance in a preparatory pre-NESA meeting to define the scope, depth and required national technical expertise, full documentation of the INPRO methodology, training workshops and access to Agency expertise in all assessment areas.

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<sup>1</sup> Argentina, Armenia, Brazil, Canada, China, France, India, Japan, the Republic of Korea, the Russian Federation and Ukraine.

11. In 2009, a new NESAs in Belarus was initiated with support from the Russian Federation and the Agency. A training workshop was held in Belarus in September 2009, followed in May 2010 by four scientific visits by Belarusian experts to Russian institutions. In 2010, preparations have begun for a NESAs to be performed by Kazakhstan. Morocco and South Africa have expressed interest in having NESAs as well.

12. A brochure was published entitled *Sustainable Energy for the 21st Century: IAEA Tools and Methodologies for Energy System Planning and Nuclear Energy System Assessments*. The brochure offers a unified description of the Agency's activity in the area of energy system analysis and planning, the INPRO methodology and its use in NESAs. A workshop on long range nuclear energy programme planning and strategy development was held in June 2010. It provided an integrated presentation of the Agency's tools, methods and case studies for long term planning of energy systems and nuclear energy systems.

### **B.3. Global vision and scenarios**

13. In this area, INPRO investigates scenarios on the opportunities and challenges for nuclear energy in the 21st century. A publication entitled *Global Scenarios and Regional Trends of Nuclear Energy Development in the 21st Century* will be published in 2010. It analyses the possible contribution of nuclear energy systems to meeting the energy needs of different regions, alternative institutional and technological approaches, and their effects on the implementation of required innovations.

14. Work continued from last year on four collaborative projects in this area: "Global Architecture of Innovative Nuclear Systems based on Thermal and Fast Reactors including Closed Fuel Cycles" (GAINS), "Innovative Fuel Cycles for Nuclear Energy Systems based on Integrated Technologies" (FINITE), "Investigations of the 233U/Th Fuel Cycle" (ThFC) and "Meeting Energy Needs in the Period of Raw Materials Insufficiency during the 21st Century" (RMI).

15. INPRO cooperated in the development of a user's manual for the Dynamics of Energy System of Atomic Energy (DESAE) code, which is a system research model designed for developing nuclear energy scenarios on a regional or global scale and analysing detailed material flows. It allows users to obtain data on key indicators for several INPRO assessment areas. In 2009, the DESAE 2.2 code was disseminated by INPRO and used in the collaborative projects RMI and FINITE.

### **B.4. Innovations in nuclear technology and institutional arrangements**

16. Activities in this area foster collaboration among INPRO members on selected innovative nuclear technologies and related R&D that contributes to sustainable nuclear energy.

17. The Agency published *Status and Trends of Nuclear Technologies* (IAEA-TECDOC-1622), which provides an overview of the history, current situation and future prospects of nuclear fuel cycle technologies. The report focuses on technical issues and covers all types of reactor and nuclear fuel cycle options with special emphasis on innovative nuclear fuel cycle technologies.

18. Four collaborative projects continue to be implemented in this area: "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), "Decay Heat Removal System for Liquid Metal Cooled Reactors" (DHR), "Advanced Water Cooled Reactors" (AWCR), and "Performance Assessment of Passive Gaseous Provisions" (PGAP). All are scheduled for completion in 2011.

19. With respect to institutional innovations that might facilitate the deployment of new reactor designs, a study on legal and institutional issues of transportable nuclear power plants was completed, and the full report will be published later in 2010. The study reviewed safety, security, safeguards,

nuclear liability and infrastructure issues for reactors which are fabricated at one location and then transported to the sites where they will be operated.

20. One collaborative project is under way, entitled “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.5. INPRO Dialogue Forum**

21. In 2010, the INPRO Dialogue Forum on Nuclear Energy Innovations was established to foster information exchange between technology holders and technology users to ensure that future technical and institutional innovations meet the expectations of both. The Forum also addresses national long term nuclear energy planning strategies and approaches and, on the highest level, the global nuclear energy system.

22. The Dialogue Forum’s first workshop on nuclear energy innovations was held in Vienna in February 2010 and focused on three topics: socio- and macroeconomic factors that influence decisions regarding deployment of nuclear systems; proven technology, i.e. technology in an innovative nuclear power plant system which should be ‘proven’ or ‘mature’ before it is included in a proposed design; and safety approaches for innovative nuclear systems. The workshop was attended by 47 participants from 33 Member States. A summary report was issued in 2010.

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

23. The Agency continuously monitors worldwide activities on advanced and innovative technology development and 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, the organization of international conferences, and coordinated research projects (CRPs).

24. The Agency organized the International Conference on Fast Reactors and Related Fuel Cycles: Challenges and Opportunities (FR09), hosted by the Japan Atomic Energy Agency in Kyoto in December 2009. The conference underlined that fast reactor and associated fuel cycle research and technology development was, in many countries, back on the agenda of research and industrial organizations, as well as academia. While reported results were encouraging, a number of remaining issues were identified and R&D programmes to resolve them were outlined. The current focus is on the commissioning of experimental fast reactors (including the Chinese experimental fast reactor in 2010), the restart of the Monju industrial prototype reactor in Japan in May 2010, the commissioning of power fast reactors in India and the Russian Federation in 2011–2013, the planned construction of the French prototype Advanced Sodium Technological Reactor for Industrial Demonstration (Astrid), and further construction projects in India, Japan, the Republic of Korea and the Russian Federation. The importance of international collaboration and establishing international fast reactor safety standards was also highlighted.

25. The International Conference on Opportunities and Challenges for Water Cooled Reactors in the 21st Century, held in Vienna in October 2009, contributed to the exchange of lessons learned from operational and regulatory experience among participants. The conference identified the need for

additional efforts to develop advanced materials and reliable components for longer plant lifetimes and more demanding conditions, to clarify the optimal balance between active and passive safety systems, to make more effective use of alternative fuels and advanced fuel designs, and to attain higher conversion rates.

26. In the area of water cooled reactors, a new CRP entitled “Benchmarking Severe Accident Computer Codes for Heavy Water Reactor Applications” was started in 2009 to establish a method for analysing such accidents. The Agency also launched a new International Collaborative Standard Problem (ICSP) on Integral Pressurized Water Reactor (PWR) Design Natural Circulation Flow Stability and Thermo-Hydraulic Coupling of Containment and Primary System During Accidents. The Agency published a report entitled *Passive Safety Systems and Natural Circulation in Water Cooled Nuclear Power Plants* (IAEA-TECDOC-1624), which investigated the thermal-hydraulic phenomena associated with the passive safety systems adopted in 20 advanced water cooled reactors. Training courses on natural circulation phenomena and passive safety systems in water cooled reactors were organized in June 2009 and in May 2010, and a course on PC-based advanced reactor simulators was organized in October 2009.

27. In the area of fast reactors, the Agency is conducting two CRPs on the verification, validation and qualification of fast reactor physics and engineering data and codes based on experimental benchmarks. One is entitled “Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the Monju Reactor Vessel”, and the other entitled “Control Rod Withdrawal and Sodium Natural Circulation Tests Performed During the PHENIX End-of-Life Experiments”. A third CRP, which started in 2005 and will conclude in 2010, is entitled “Analytical and Experimental Benchmark Analyses of Accelerator Driven Systems” (ADS), with the objective of better understanding the coupling of the ADS spallation source with the multiplicative subcritical core. A fourth CRP, initiated in 2007 and also scheduled for completion in 2010, is entitled “Analyses of and Lessons Learned from the Operational Experience with Fast Reactor Equipment and Systems”. Its results will also provide input to the Agency’s project on fast reactor knowledge preservation. The Agency published *Advanced Reactor Technology Options for Utilization and Transmutation of Actinides in Spent Nuclear Fuel* (IAEA-TECDOC-1626) in November 2009, *Decommissioning of Fast Reactors after Sodium Draining* (IAEA-TECDOC-1633) in January 2010 and *BN-600 Hybrid Core Benchmark Analyses* (IAEA-TECDOC-1623) in March 2010.

28. In the area of high temperature gas cooled reactors (HTGCRs), two CRPs related to HTGR technology development were completed in 2009 and 2010, respectively. The first, on the evaluation of high temperature gas cooled reactor performance related to the HTR-10, HTTR, PBMR 400, GT-MHR and the ASTRA critical facility, demonstrated the capabilities of current computational tools for analysing these reactors and highlighted further development needs. The second CRP, which dealt with advances in HTGR fuel technology, examined the use of current know-how in coated fuel particle manufacturing processes by using different characterization techniques to investigate the quality of the fuel at different stages. A new CRP was begun in 2010 on the improved understanding of the creep phenomenon in irradiated graphite. Its objective is to better understand graphite properties under irradiation and to subsequently develop improved models to predict the creep phenomenon. The outcomes of this CRP will assist operators of today’s low temperature gas cooled reactors in their life extension safety cases and also help the designers of new HTGRs that will use graphite as both a moderator and structural material in their designs.

29. A Technical Meeting on Options to Enhance Proliferation Resistance and Security of Nuclear Power Plants with Innovative Small and Medium Sized Reactors (SMRs) was held in June 2010 in Vienna to identify more viable technological options to enhance the proliferation resistance and security features of SMRs, to assess their validity, and to make recommendations for the advancement of national and international regulations in relevant fields. The meeting was part of an effort to publish

a document to provide a framework for applying proliferation-resistance and physical-protection assessment methods to evaluate innovative SMRs and associated fuel cycles at all stages of their design.

30. Non-power applications include industrial heat, desalination, district heating, tertiary oil recovery and hydrogen production. A new CRP on seawater desalination was started to propose methods and innovative technologies to make nuclear desalination more viable. *Environmental Impact Assessment of Nuclear Desalination* (IAEA-TECDOC-1642), published in February 2010, addresses both socio-economic and environmental impacts of nuclear desalination. A CRP on advances in nuclear power for process heat applications, which assessed heat utilization systems for hydrogen production, electricity generation, and waste heat for seawater desalination, was completed. A new computer code, the Hydrogen Economic Evaluation Program (HEEP), evaluates the economic aspects of hydrogen production using nuclear energy.

## **D. Coordination with GIF**

31. The Agency continues to participate in Generation IV International Forum (GIF) working groups and as an observer in the GIF Policy Group. The complementary relationship between INPRO and GIF has been jointly defined, and details are available from the websites of GIF and INPRO.

32. The fourth coordination meeting with GIF was held in March 2010. The joint action plan with GIF, developed initially in February 2008, was updated. It now includes agreements on coordination in the following areas: general information exchange, synergies in evaluation methods, cooperation in topical studies and global dialogue between nuclear technology holders and users.

33. A GIF/INPRO Workshop on Operational and Safety Aspects of Sodium Cooled Fast Reactors (SFRs) was held in June 2010 with contributions from GIF, INPRO and the Agency's fast reactor programme. There were 26 participants from nine Member States and two international organizations, including all key nuclear technology holders in that technical area. National experts presented the rationales for fast reactor designs based on accumulated operational and safety experience and discussed future R&D and deployment options, including safety aspects. Potential follow-up activities have been agreed upon and include topical workshops on sodium technology and decay heat removal in SFRs.

34. The Agency and GIF are also cooperating in meetings on methods to assess the proliferation resistance of innovative nuclear systems. These involve, in particular, the GIF working group on proliferation resistance and physical protection and the INPRO collaborative project PRADA (see para. 5 above). Progress has been made on comparing and harmonizing the respective methods, and the final report of PRADA is scheduled for publication in 2010.

35. INPRO also continues to coordinate with other international initiatives and institutions, including the European Sustainable Nuclear Energy Technology Platform and the European Commission.

# Nuclear Knowledge Management

1. In resolution GC(52)/RES/12.C (2008), the General Conference recognized that preserving and enhancing nuclear knowledge and ensuring the availability of qualified personnel are vital to all aspects of human activity related to the continued and expanded safe and secure utilization of all nuclear technologies for peaceful purposes, and noted existing concerns about a shortage of personnel in nuclear fields and a possible erosion of the nuclear knowledge base.
2. The Secretariat was urged to strengthen, subject to the availability of resources, its efforts in this area, recognizing the need for a focused and consolidated approach, to consult with Member States and other international organizations, and to take into account the results of relevant international meetings.
3. The General Conference requested the Director General to report on progress made to the Board of Governors and to the General Conference at its fifty-fourth session and every second year thereafter. This report responds to that request.

## A. Consolidating nuclear knowledge management

4. The Agency continues its nuclear knowledge management (NKM) activities focusing on formulating and providing guidance and services, facilitating knowledge sharing networks, developing pilot projects, and fostering and supporting nuclear education and training.
5. The past two years were characterized first, by an increased awareness of possible nuclear knowledge loss risk due to retirements and, second, by coordinated national and international efforts to strengthen nuclear education and training, to increase the availability of qualified personnel, and to make efficient use of available resources. An increasing number of Member States showed interest in developing new nuclear activities, and most of them are clearly aware of the necessity of long term human resource planning and capacity building. Several Member States have requested support to develop national policies and strategies for managing nuclear knowledge.
6. In March 2010, the Government of the United Arab Emirates hosted in Abu Dhabi the Agency's International Conference on Human Resource Development for Introducing and Expanding Nuclear Power Programmes.<sup>1</sup> Representatives from 62 Member States and 11 international organizations participated in the conference, which addressed current issues of education, training, human resource development and nuclear knowledge management.
7. The conference confirmed the importance of a balanced approach to human resource development that emphasizes building capacity and expertise in all, rather than only selected, relevant areas of the nuclear field. Strengthening existing educational networks and leveraging their respective advantages and achievements was recommended as an important path to increase efficiency.

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<sup>1</sup> Since the issue of human resource development cuts across several activities for which the General Conference has requested reports, this conference is also mentioned in Annex 5 of this report on infrastructure development for nuclear power and in the report entitled *Measures to strengthen international cooperation in nuclear, radiation, transport and waste safety* (GOV/2010/41-GC(54)/8) in Section D on capacity building, knowledge networks, education and training.

8. Participants in the conference supported the proposal of the Agency, together with the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (NEA/OECD), Nuclear Energy Institute (NEI), World Association of Nuclear Operators (WANO) and other international organizations, to conduct a global survey of human resources for nuclear power programmes in Member States. The Agency will have a lead role in the survey. The Agency was encouraged by the conference to reinforce its support to networking initiatives and to continue to provide guidance, assessment tools and best practices in knowledge management and nuclear education and training to Member States upon their request. The conference's conclusions also confirmed that the Agency's NKM activities have a sound foundation and are addressing priority issues faced by Member States at their current stages of nuclear development.

9. Within the Agency an Education and Training Support Group (ETSG) was created in 2008 to ensure that all Agency activities supporting education and training are provided to Member States in an integrated, consistent and optimized manner.

10. Overall, the value of a long term strategy on NKM within the framework of a sustainable nuclear development policy is now broadly recognized. There is a better understanding of the need for long term planning of human resource development. This has resulted in increased interactions between Member States and nuclear organizations and in a bigger demand for knowledge management services and support, as reflected below.

11. New technical reports entitled *Knowledge Management for Research and Development Organizations* and *Status and Trends in Nuclear Education* will be published in 2010.

## **B. Building capacity for nuclear knowledge management**

12. A number of Member States have emphasized the priority of building capacity in NKM, including knowledge management components in national and regional technical cooperation (TC) projects, and providing extrabudgetary funds to the Agency. An increasing number of Member States have initiated NKM programmes making use of the Agency's methodology and services.

13. The School of Nuclear Knowledge Management is held yearly at the International Centre for Theoretical Physics (ICTP), Trieste, Italy, and is now well established. In 2010 it received more than 120 applications from around the world for approximately 30 places. It provides a basic understanding of NKM tools and challenges as well as opportunities for sharing experiences and good practices among the participants and faculty. Similar courses were organized on a regional basis, specifically in Karlsruhe, Germany (in 2009 and 2010), Manila, Philippines (2009), Sevastopol, Ukraine, and Astana, Kazakhstan (both in 2010).

14. In 2010 the Agency, in cooperation with ICTP, will also conduct a three-week School on Nuclear Energy Management. Its purpose is to provide a unique international educational experience aimed at building future leadership in managing nuclear energy programmes among young professionals from developing countries, particularly countries considering or launching nuclear power programmes or other nuclear applications.

15. Multimedia software has been developed, some with TC support. Examples are an interactive training course on NKM, the multimedia textbook, *Nuclear Reactor Physics*, which is available in English, French, Russian and Spanish, and the Agency's nuclear power plant (NPP) simulators, which are available to Member States upon request. These will also be included in regional web-based

education portals in Africa, Asia, Latin America and the Middle East. In addition, an information and communication technology (ICT) multimedia safety project captures expert knowledge and experience from countries implementing the Agency's safety principles.

16. Regional workshops and technical meetings on NKM in Asia, Europe and Latin America provided training to more than 130 participants from 50 Member States. These workshops and meetings covered the status and trends in nuclear education, national approaches and strategies for NKM, web-based nuclear information management, process oriented knowledge management for NPPs in operation and construction phases, curricula in nuclear engineering teaching, and networking for nuclear education and training.

## **C. Nuclear knowledge management services**

17. The Agency conducted NKM assist visits to Bulgaria, Canada, Kazakhstan, Lithuania, Malaysia, Montenegro, Slovakia, the Russian Federation and Ukraine. The visits covered a wide spectrum of topics, including analyses of nuclear education activities, workforce planning, training systems for NPPs, the risk of knowledge loss and analyses of critical knowledge and positions. They were conducted by Agency personnel and outside experts based on the guidance documented in:

- *Planning and Execution of Knowledge Management Assist Missions for Nuclear Organizations* (IAEA-TECDOC-1586),
- *Knowledge Management for Nuclear Industry Operating Organizations* (IAEA-TECDOC-1510),
- *Risk Management of Knowledge Loss in Nuclear Industry Organizations* (STI/PUB/1248) and
- the forthcoming *Knowledge Management for Research and Development Organizations* noted in paragraph 11.

18. At the Moscow Engineering Physics Institute the assist visit provided advice on best practices in nuclear engineering education. In Kazakhstan, the advice focused on NKM systems and knowledge loss risk management. At the Ignalina NPP in Lithuania, the focus was on knowledge loss risk assessment. At the Zaporozhye NPP in Ukraine, the assist visit provided a training system for maintenance personnel and an NKM action plan. At the Kozloduy NPPs in Bulgaria, the assist visit provided advice on managing workforce flow and the risk of nuclear knowledge loss. In Montenegro, the assist visit discussed the creation of a centre for nuclear competence, and in Canada the benefits of a systematic knowledge management approach were demonstrated through presentations and practical exercises. In Malaysia, the assist visit assessed education and training programmes in three universities, the Atomic Energy Licensing Board and Nuclear Malaysia. In Slovakia, the visit supported development of a programme to identify and transfer critical knowledge in support of Slovenské elektrárne.

## **D. Applying nuclear knowledge management to development**

19. Many of the TC programme's regional and national projects in 2009 and 2010 supported directly or indirectly NKM activities, with much emphasis on networking, knowledge acquisition and

preservation, succession planning and the strengthening of institutional memory. In the four TC regions (Africa, Asia and the Pacific, Europe and Latin America), 12 national and regional projects were devoted to strengthening Member States' NKM capabilities and building awareness of the need for national NKM strategies, integrated with human resource development strategies.

20. In Europe, through three dedicated regional projects, the TC programme supported Member States in strengthening their NKM capabilities by training personnel and NKM managers. Eight training events and technical meetings were held to enhance national capacities in the field and to facilitate networking and knowledge sharing. Technical meetings and consultancies were also held to establish a network to review and improve nuclear science and engineering curricula. A curriculum on knowledge management is being developed, and educational organizations from Canada, Hungary and the Russian Federation have already expressed their interest in using it once it is completed.

21. In the Asia and the Pacific region, TC regional projects supported national nuclear power programmes on human resource development, NKM and skills retention. With the assistance of international experts and Agency staff, debates and mentoring programmes were carried out in Bangladesh, China, Malaysia, Republic of Korea, Thailand and Vietnam. The Asian Network for Education in Nuclear Technology (ANENT) continued its development also partially supported by the TC programme.

22. There was strong participation in networking activities. Examples include the "Safety Live Link Website" for the Asia and the Pacific region. The site allows Member States to access scientific information and provides the opportunity for knowledge sharing to those countries that recently joined in the region's activities. Also, at a regional meeting held in Dhaka, Bangladesh, about 20 NKM specialists from regulatory bodies shared practical experience in applying knowledge management methods for mapping core business processes for safety assessments of nuclear installations, the resolution of safety questions and competence building in nuclear safety.

23. Maintaining a high level of competence in radiation safety is essential and the goal of several dedicated regional projects. A project on radiation protection under the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific (RCA) is establishing networks for emergency response managers and for cardiologists using radiation technologies. These networks are designed to ensure the sustainability of activities initiated through current and past RCA projects.

24. The 'as low as reasonably achievable' (ALARA) network under the leadership of Japan held two technical meetings on improving radiation protection in industrial radiography and on radiation protection in industries that produce naturally occurring radioactive material (NORM). Exercises for emergency management decision makers were conducted at Chernobyl, Ukraine, and in Australia under the RCA within the framework of the Forum for Enhanced Decision Making for Radiation Emergency Management. The forum for cardiologists continued to use the Agency's website on the radiation protection of patients (<http://rpop.iaea.org>) and newsletters to exchange information.

25. Twenty-four nuclear regulatory bodies in the AFRA region founded the Forum for Nuclear Regulatory Bodies in Africa (FNRBA) in 2009 to advance regional cooperation, facilitate information exchange, and strengthen the radiation and nuclear safety infrastructure across the region. Also, in 2009, the Regional Advisory Safety Committee for Research Reactors in Africa (RASCA) was founded within the framework of a regional TC project. Participating Member States are Benin, Democratic Republic of the Congo, Egypt, Ghana, Kenya, Morocco, Niger, Nigeria and Sudan. Human resource development was also an important issue, especially in information and communication technologies (ICT). Tele-centres in 22 African countries are now operative, and more than 100 ICT developers were trained. Such centres collect, organize and share scientific and technical

information related to various nuclear technology applications, and support training activities on the use of ICT. A conference on ICT was held in Cape Town, South Africa, focused on the development and utilization of distance learning tools and tele-centres management. IT hardware was provided to Côte d'Ivoire, Mali, Sierra Leone and Uganda. Two regional designated educational centres were recognized, the University of Ghana and Alexandria University. An African conference on human resource development and knowledge management is now being planned.

26. In Latin America, a NKM workshop and a technical meeting were held to exchange information and experience on NKM and best practices and to discuss implementation of a regional network for nuclear education and training (LANENT). Thirty-seven experts from eleven countries participated and agreed on the need for systematic integration of available resources and knowledge in the region.

27. The Agency also supported, through TC projects, the introduction and implementation of integrated management systems (IMSs) in Member States that have NPPs or are firmly embarking on nuclear power programmes. Training courses were organized under national and regional projects to help these countries prepare the introduction of Agency supported IMS approaches and standards.

28. In connection with human health, food, agriculture, physical chemistry and water hydrology, coordinated research projects helped create and share new knowledge, and technical cooperation projects helped implement activities and disseminate results and data to address Member State needs. Both were important tools for knowledge sharing between the Agency and Member States. Programme elements that relate to NKM in a general manner include 207 training courses at the Seibersdorf Laboratories, the Monaco Marine Environment Laboratories and in Member State laboratories, as well as the development of a laboratory information and quality assurance management system with 13 technology databases and in excess of 50 publications in both print and electronic forms including technical documents (TECDOCs) and peer reviewed journal articles. The Seibersdorf and Monaco laboratories are currently implementing laboratory information management systems (LIMS) which aim at improving laboratory management and laboratory performance. Distance-learning modules, web-based documents, and information and communication technology-based training materials are being developed and made available on CD and through the Internet.

## **E. Applying nuclear knowledge management to strengthen safety, security and safeguards**

29. Major NKM activities in nuclear safety and security are linked to the preparation and application of the Agency's safety standards and security guidelines. New training materials and video presentations in support of sharing knowledge and experience in the application of the Agency's safety standards were produced, thereby improving the web accessibility of this knowledge and these training resources. Tailored workshops and training events were conducted in several areas of nuclear and radiation safety. More practical and on the job training is supported through fellowships, extensions of basic courses and simulator based tools for safety assessment. The Agency continued to conduct security training courses and workshops to cover prevention, detection and response, with over 1500 participants per year.

30. The Agency's safety review services, which are based on the Agency's safety standards, have been redesigned, in particular the Integrated Regulatory Review Service (IRRS), which was successfully provided to 29 countries. An International Regulatory Network (RegNet) to share experience and good practices and discuss other regulatory issues is being set up. The Steering

Committee on Competence of Human Resources for Regulators held its first plenary meeting in December 2009 and approved revised Agency guidelines for the Systematic Assessment of Regulatory Competencies Needs (SARCoN).

31. The ICT multimedia project that was launched in 2007 to capture expert knowledge and experience from countries implementing the Agency's safety principles has made considerable progress with the production of new multimedia training material based on the Agency's safety standards. The project includes films of diverse training courses and workshops on the safety of nuclear installations, including courses on operational experience, and CDs containing presentations on Member States' experiences in implementing management systems. New multimedia training material was produced based on the Agency's safety standards. The Agency continued to maintain its nuclear safety and security knowledge management portal and launched a nuclear safety and security wiki.

32. The Global Nuclear Safety and Security Network (GNSSN), a framework for knowledge networks in the Global Nuclear Safety and Security Regime (GNSSR), was established to provide for the wide exchange of critical knowledge, experience, and lessons learned about nuclear safety and security.

33. Education and training in radiation protection were strongly supported through postgraduate educational courses (PGECs) in radiation protection and the safety of radiation sources. Four PGECs were held in the past two years. These are important in developing human resources for effective radiation, transport and waste safety infrastructure in Member States considering or launching nuclear power programmes or other nuclear applications. The course syllabus consists of theoretical lectures and practical sessions followed by research work.

34. The importance and use of regional safety networks is also increasing. The Asian Nuclear Safety Network (ANSN) is well established, and topical groups have been created to share experience and create new knowledge. They are used increasingly for managing regional activities and reviewing self-assessments on nuclear safety performed annually by each country in the programme. Recently a group for coordinating and monitoring topical groups' activities was established to develop detailed guidance documents for setting up national and regional capacity building centres in Asia.

35. The Ibero-American Radiation Safety Network is hosted by Brazil and fully operated by the Ibero-American Forum of Nuclear and Radiation Safety and Security Regulatory Agencies (FORO). FORO has a technical programme implemented through an extrabudgetary programme on nuclear and radiation safety. Under this programme, projects are being developed on safety assessment in radiotherapy, on the improvement of the regulatory framework for medical exposure, on evaluating and licensing the life extension of NPPs, and on the control of inadvertent radioactive material in the scrap metal and recycling industries. The outcome of the project on safety assessment in radiotherapy was submitted for joint Agency-FORO publication.

36. Approximately 200 new users registered with the Nuclear Events Web-based System (NEWS), bringing total registration to more than 1800. NEWS is used by the 65 States that are members of the International Nuclear and Radiological Event Scale (INES) network. It is used to make accurate and authoritative information about the safety significance of nuclear and radiation events broadly available to the international media and other interested parties.

37. As a cornerstone in building up sustainable human resources and supporting States in meeting obligations under international instruments related to nuclear security, the Agency supports States in their efforts to establish national Nuclear Security Support Centres (NSSCs). Such centres support the systematic development of nuclear security knowledge and skills at the national level in a State, as well as the exchange of expertise among national level stakeholders. NSSCs have fostered nuclear

security culture in States, improve national coordination and collaboration and lead to enhanced national nuclear security regimes. In some cases, NSSCs will offer services for maintenance and repair of nuclear security instruments. In the period covered by this report, the Agency developed a methodology to assist States to plan and establish such centres and assisted in the development of an NSSC in Ghana. The Agency is currently refining the methodology and is assisting the establishment of further centres in Colombia, Malaysia, Morocco and the United Republic of Tanzania.

38. The training of personnel from Member States in the application of safeguards continues to be an essential Agency nuclear knowledge management activity. Since September 2008, 14 national, regional and international training courses and workshops have been conducted to assist States in fulfilling their obligations under their safeguards agreements. The courses provide knowledge and enable participants to share experiences, capture lessons learned and build best practices.

39. Furthermore, to help individual States in establishing and strengthening their State systems of accounting for and control of nuclear material (SSACs), which are fundamental for efficient and effective safeguards implementation, the Agency conducted IAEA SSAC Advisory Service (ISSAS) missions in Georgia, Niger, Romania, and Saudi Arabia in 2008 and 2009. Missions to Azerbaijan and Turkey are in the preparatory stages and are anticipated before the end of 2010.

## **F. Strengthening nuclear knowledge sharing networks**

40. Important agreements were signed in the past two years to strengthen education and training networking, in particular one with the Korea Atomic Energy Research Institute, to jointly maintain and operate the web system of ANENT, and another with the European Nuclear Education Network Association, to jointly strengthen nuclear education worldwide including the development of new training material, courses and curricula to be included as a first stage in ANENT.

41. The Asian network ANENT increased its activities during this period. It provided the first distance learning courses on energy planning for 60 participants from 10 countries. An interactive course on nuclear reactor theory was developed by Catalunya University in Spain and made available to individuals and non-profit nuclear organizations through the Agency.

42. The Government of the United Arab Emirates requested the Agency to develop a nuclear education web-based platform to be installed in Kustar University, with the aim of providing easy and reliable access to high quality nuclear educational material for teachers and students from the region. The Agency is presently working on its development, and a similar concept will be replicated afterwards in Latin America and Africa.

43. Work continues on establishing basic competences for nuclear engineering curricula at the bachelor and master degree levels, taking into account the knowledge and experience of industry, academia and research and development organizations. The Agency is studying options for benchmarking the quality of nuclear education and training in order to provide self assessment tools to the many new organizations engaged in this activity. Documents on these topics are in preparation for publication in 2011.

44. Training centres for radiation, transport and waste safety were established with the support of the Agency. They offer comprehensive, well-equipped training facilities, including laboratories, and competent suitable personnel for regional safety needs. They are pro-active in the promotion and use of the Agency's safety standards and reference training material, and routinely deliver education and

training activities in radiation protection and waste safety, including specifically postgraduate educational courses (PGECs) in radiation protection and the safety of radiation sources, train-the-trainers courses and fellowships. In the period covered by the report, PGECs were organized in Argentina, Belarus, Malaysia and Syria with regional participation in all cases. Specialized training courses were also organized for specific target audiences, for example transport, individual monitoring, emergency response and regulators.

45. In the area of emergency preparedness and response the training was organised utilizing e-learning and portable tools, including “e-learning tools for the first response to a radiological emergency” and a “portable digital tool for assisting first responders to a radiological emergency”. The training also focused on training trainers, especially in regional level training activities, to ensure an efficient dissemination of the given specific technical knowledge.

46. The Agency’s networks in waste management — the International Decommissioning Network (IDN), the International Low-Level Waste Disposal Network (DISPONET), the Network of Underground Research Facilities (URF) and the Network on Environmental Management and Remediation (ENVIRONET) — have led to notable improvements in the delivery of Agency programmes in waste management and decommissioning. They have accelerated the transfer of relevant information at organizational and individual levels, the dissemination of knowledge and good practices, the identification and nomination of appropriate candidates for training activities, and they have increased the provision of experts and additional offers to host training activities.

47. These networks have conducted ten major training activities over the past year and have completed detailed plans for 2010-2011, in each case taking full advantage of generous hosting arrangements offered by network partners.

48. As a logical next step, these networks require a mechanism to facilitate direct communication amongst network participants and to make Agency training materials promptly available in a user friendly mode. In partnership with like-minded national and international organizations, a common web-based platform will be developed to facilitate interactions among network participants and to provide a library of audio-visual material and access to concise summaries of project experiences. Benefits to participants will include the efficient sharing of technical solutions to waste management challenges, the accelerated adoption of best practices and enhanced peer-to-peer contacts, especially between those with developed and those with less developed programmes.

## **G. Managing nuclear information**

49. The use of new web-based products has increased and the demand for innovative solutions is growing. Through several pilot projects, the Agency has provided a number of products in response, including the Fast Reactor Knowledge Organization System (FRKOS), ‘NuArch’ or free accessible web-based nuclear information, and the Nuclear Energy Handbook. The FRKOS, which was completed in 2008, has been improved based on positive feedback from Member States. NuArch is a product designed to web-harvest and preserve freely accessible nuclear-related information from the Internet. The development of NuArch started in 2008. It has harvested and incorporated more than 4.5 million documents in its data repository. The Nuclear Energy Handbook provides useful information about available nuclear resources. Also, the Agency maintains a database on nuclear related conferences and events, which is queried on average more than 70 000 times per month.

50. Since September 2008, the Agency has published *Development of Knowledge Portals for Nuclear Power Plants* (Nuclear Energy (NE) Series No. NG-T-6.2) and has posted on its website the proceedings of 15 workshops, schools and technical meetings (including *Nuclear Knowledge Preservation in CIS-Countries: Current Status and Relevant Suggestions* and *Managing Nuclear Knowledge: Proceedings of a 2008 Workshop, Trieste, Italy*). Ten further publications are in preparation.

51. The International Nuclear Information System (INIS) continued to play an important role in nuclear information management and knowledge preservation. It remains an important source of nuclear information for many Member States. The INIS membership continued to increase. Côte d'Ivoire, Mozambique, Sierra Leone and Zimbabwe recently joined, bringing the total number of INIS members to 147 (123 countries and 24 international organizations).

52. In April 2009 access to the INIS database was made free to all Internet users around the world. An Arabic interface was also introduced. Currently, INIS receives more than 70 000 searches per month. In the last two years 240 000 bibliographic records were added and 37 000 full text documents were prepared and uploaded, making a total of over 350 000 full text documents available. The Agency issued a new improved version of the joint INIS/Energy Technology Data Exchange (ETDE) thesaurus containing 30 835 terms. Digital preservation of the INIS microfiche collection continued. In close cooperation with Member States, over 4.4 million pages were digitized.

53. Capacity building continued with national INIS seminars and training courses organized in Uzbekistan for 40 participants, in South Africa for 23 participants from 21 Member States, and in Vienna for advanced users from 20 Member States. Representatives of 11 Member States, the ETDE and INIS participated in the 12th INIS/ETDE Joint Technical Committee Meeting.

54. The IAEA Library continued its important role in managing nuclear information and providing Member States and the Secretariat with access to authoritative information in all areas of Agency activities. Currently, it ties together databases, customer services and capacity building. Twenty-two new members joined the International Nuclear Library Network (INLN), bringing INLN membership from 12 libraries in 2008 to 34 in 2010.