IAEA
Atoms for Peace: The First Half Century
1957 - 2007

Board of Governors
General Conference

GOV/2006/47-GC(50)/14
Date: 16 August 2006

General Distribution
Original: English

For official use only

Item 7 of the Board's provisional agenda
(GOV/2006/50)
Item 17 of the Conference's provisional agenda
(GC(50)/1)

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(48)/RES/13 and GC(49)/RES/12, this document contains progress reports on the development of the sterile insect technique for the control or eradication of malaria-transmitting mosquitoes (Annex 1); support to the African Union's Pan African Tsetse and Trypanosomosis Eradication Campaign (AU-PATTEC) (Annex 2); Programme of Action for Cancer Therapy – PACT (Annex 3); Agency activities in the development of innovative nuclear technology (Annex 4); approaches to supporting nuclear power infrastructure development (Annex 5); and nuclear knowledge (Annex 6).

- Further information on the Agency's activities related to nuclear science, technology and applications can be found in the *Nuclear Technology Review 2006* (document GC(50)/INF/3), the Agency's *Annual Report 2005* (GC(50)/4), in particular the Technology section, and the *Technical Cooperation Report for 2005* (GC(50)/INF/4).

Recommended Action

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

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, transmitted by female mosquitoes of the genus *Anopheles*. It causes approximately 2 million deaths and about 300–500 million cases of clinical malaria a year. The disease constitutes a major obstacle to poverty reduction in Africa and causes an estimated slowdown of economic growth in some countries by 1.3% per year.

2. Malaria vaccines have not currently proved sufficiently protective to warrant use in malaria control, leading to renewed interest by Member States in the potential of the sterile insect technique (SIT) for the suppression of malaria-transmitting mosquitoes in suitable areas. It is envisaged that SIT would be used under specific conditions as an adjunct to more orthodox technologies, conforming to the WHO's Roll Back Malaria strategy of not relying on any single approach to control.

3. At its forty-eighth session in September 2004, the General Conference, through resolution GC(48)/RES/13.C requested the Agency to continue and strengthen the research required to use SIT for the control and eradication of malaria-transmitting mosquitoes, and to increasingly involve African and other developing Member States' scientific and research institutes in the research programme in order to ensure their participation, leading to ownership by the 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 the implementation of this resolution at the 50th session of the General Conference.

B. Developments since the General Conference's 2004 session

B.1. Research and Development based on Sudan

4. The Agency continued to focus its support on Sudan under the Regular Budget programme and the technical cooperation programme through regional project RAF/5/052, Sterile Insect Technique for Control of Anopheles Mosquito. A national steering committee for the project was formed and has met regularly since 2004, and a coordination meeting has been held annually in Vienna to review progress and plan future activities.

5. Two field sites, Merowe and Dongola, are currently under study in the Northern State of Sudan. Research and development on mosquito population genetics has been carried out during 2004–2005 in these potential field sites in order to assess their suitability for an SIT feasibility study. Field laboratories were established in these two sites, and a larval surveillance system has been in operation

since March 2005. Two automatic weather stations have been operational since 2004 at each site and satellite imagery data for the two sites has been obtained. Global Positioning System (GPS) based data loggers have been programmed for these surveys and field validation and training started in 2005. A population genetic survey in the two project areas and adjacent areas has been carried out for mosquito analysis with the scientific support of Queen Mary's College, United Kingdom. Sudanese project counterpart staff were trained in the relevant techniques. Results indicate sufficient isolation of the mosquito populations to allow furtherance of an SIT based approach.

6. Colonies of the mosquito type *Anopheles arabiensis* from both Dongola and Merowe have been established at the Tropical Medicine Research Institute in Khartoum. Eggs from the Dongola colony were transferred to the Agency's Laboratories at Seibersdorf and a sub-colony established. Colonies for research have also been established in Atlanta, USA, and at Queen Mary's College. The biological characteristics of these colonies have been under investigation both in Khartoum and at the Agency's Laboratories at Seibersdorf since mid-2004.

7. The Government of Sudan has provided staff, facilities, infrastructure and logistics for field work, including recruitment of enumerators, and ensured the participation of communities in socio-economic data collection. Results from national field surveys, aerial photographs, and existing data covering geology, soil, land use, drainage, vegetation and settlements have been made available through collaboration with the Remote Sensing Authority in Khartoum. A facility for an intermediate scale production insectary has been allocated in Soba. It is expected that mosquito rearing could begin in Soba in August 2006 followed by field cage studies in the field site in October–November 2006.

B.2. Research and Development based on the Île de la Réunion

8. The mosquito control authorities on the Île de la Réunion have already obtained detailed information on mosquito larval breeding sites, and so initial project activities have focused on the establishment of mosquito colonies, supported by extrabudgetary contributions from France. Research is aimed at understanding mosquito population distribution and isolation as a basis for better strategic planning of malaria intervention. As yet, two attempts to produce colonies of *Anopheles arabiensis* from the island, undertaken through expert missions, have not been successful. Further colonization efforts are planned.

B.3. Research and Development in the Agency's Laboratories at Seibersdorf

9. In the Agency's Laboratories at Seibersdorf, research on sterilization, mass rearing and sexing intensified during 2004–2005. Research on radiation-induced sterility has been undertaken since mid-2004 and dose-sterility curves have been developed and published. Current experimentation focuses on the effects of irradiation on mosquito competitiveness. Mass rearing experimentation has focused on the development of adult resting cages with semi-automated sugar and blood feeding systems. Blood diets have been studied extensively, in particular the influence of various anti-coagulants on mosquito fecundity. Sexing studies have focused on traditional approaches using an insecticide resistant strain of *Anopheles arabiensis* from Sudan. Additionally, modern biotechnological approaches have been engaged to develop transgenic sexing strains, with a successful transformation of the target species at the end of 2005.

10. Two coordinated research projects (CRPs) were approved in the reporting period. One focuses on the colonization and mass rearing aspects of mosquitoes, and the first Research Coordination Meeting was held in Vienna in November 2005. The second CRP was approved early 2006 and focuses on adult male biology post-release (dispersal, resting, feeding etc.); it is scheduled to be initiated in 2007.

B.4. Support to Capacity Building and Planning

11. Under TC project RAF/5/052, training of nine fellows from malaria-endemic countries (Cameroon, Kenya, Sudan, United Republic of Tanzania) has been carried out. Of these, one received training in Egypt, two received training in the United Kingdom, one in the USA, and five received training at the Agency's Laboratories at Seibersdorf. Furthermore, an expert mission was implemented in Nigeria in April 2006 to assess the technical feasibility of an SIT programme for the control of malaria vectors at specific sites.

12. Laboratory research into the effective use of SIT, particularly radiation sterilization, blood feeding and genetic sexing, coupled with the development of a potential field site, continue with promising results. Expectations are that this progress, both in the laboratory and in the field, will continue so that a meaningful feasibility study of SIT for malaria transmitting mosquitoes can be implemented.

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

A. Background

1. At its forty-ninth session in September 2005, the General Conference, through resolution GC(49)/RES/12.D, appreciated the continued support of the Agency to Member States in their efforts to build capacity and further develop the techniques for applying the sterile insect technique (SIT) in creating tsetse-free zones in Africa and called upon Member States to continue to provide technical, financial and material support to African States in their efforts to create tsetse free zones. It further requested the Secretariat to continue to support R&D and technology transfer, and stressed the need for continued cooperation with the Commission of the African Union and other regional and international partners with the aim of harmonizing efforts in line with the AU-PATTEC Plan of Action. It requested the Director General to report on the progress made in the implementation of resolution GC(49)/RES/12.D to the Board of Governors and to the General Conference at its fiftieth (2006) regular session.

B. Developments since the General Conference's 2005 session

2. The Agency continued to contribute to the implementation of the PATTEC Plan of Action through one regional, and nine national technical cooperation projects in Botswana, Burkina Faso, Ethiopia, Kenya, Mali, Senegal, South Africa, Uganda and the United Republic of Tanzania. Under these projects, the Agency implemented technology transfer to the Member States concerned on feasibility assessment, capacity building and pre-operational support on tsetse SIT, largely through provision of training to Member State personnel, expert services and equipment. Coordinated through AU-PATTEC, the tsetse and trypanosomosis (T&T) affected Member States Burkina Faso, Ethiopia, Ghana, Kenya, Mali and Uganda (referred to as the six "PATTEC phase-I" countries) secured loans and grants in 2004–2005 (in total about $ 80 million) from the African Development Bank (AfDB) in support of national efforts to create T&T-free zones and for related agricultural development. Subsequently, in international meetings, the assistance of the Agency, FAO and WHO was sought in implementing specific components of the country plans to eradicate the T&T problem in the context of overall sustainable agriculture, livestock and rural development. In this connection, at a regional PATTEC meeting in Nairobi in October 2005, the Agency, FAO and WHO presented a draft proposal containing the terms of reference for possible coordinated technical assistance to the six AfDB-supported national PATTEC projects. AU-PATTEC is now pursuing further loans and grants for an additional number of T&T affected 'PATTEC phase-II' Member States.

3. The major ongoing undertaking in the region with which the Agency is associated is the Southern Rift Valley Tsetse Eradication Project (STEP) in Ethiopia which aims to create a T&T-free

zone in an area of 25 000 km², thereby generating an environment conducive to livestock development and improved agricultural production. The Agency continued to support STEP under TC project ETH/5/012 — Integrating Sterile Insect Technique for Tsetse Eradication.

4. The Agency was represented at meetings of the STEP Technical Advisory Committee and its Steering Committee and took part in the Government-organized STEP External Partners Consultative Meeting, held in Addis Ababa, 12–16 June 2006. The latter meeting brought together stakeholders and donors who have already been assisting and supporting STEP and aimed at encouraging new partners to join the group by sharing information on the progress made to date, the future work plans, the current financial situation and future budget requirements.

5. STEP received $ 1,712 million from the Japan-funded United Nations Trust Fund for Human Security (UNTFHS) for a two year project entitled "Establishing a Zone Free of the Tsetse and Trypanosomosis Problem in the Southern Rift Valley, Ethiopia, and Assisting Rural Communities in Agricultural and Livestock Development" which will be jointly implemented by the Agency and the FAO in support of STEP. Furthermore, the US Government contributed $1.6 million to the Agency's technical cooperation project ETH/5/012 mainly to cover the procurement, manufacture, shipping and installation of mass rearing equipment for the Kaliti Tsetse Rearing and Irradiation Centre, the mass-rearing facility being constructed by the Government of Ethiopia.

6. The first two modules of the Kaliti Tsetse Rearing and Irradiation Centre, the mass-rearing facility being constructed by the Government of Ethiopia, have been completed and it is expected that large scale tsetse rearing will start in August 2006. Special efforts are being deployed by project counterparts, with Agency assistance, to address several aspects, including technical, logistical and managerial issues, relevant to STEP laboratory and field activities to ensure efficient implementation of the operational T&T intervention phase.

7. A coordination meeting of national counterparts of Agency-supported TC projects was held in Vienna from 7–9 December 2005 within the framework of the regional project RAF/5/051 — Sterile Insect Technique for Area-wide Tsetse and Trypanosomosis Management. Counterparts from eleven T&T affected Member States and also representatives from AU-PATTEC, the Programme Against African Trypanosomiasis (PAAT), FAO and WHO attended. The meeting aimed at identifying specific support that FAO, WHO and the Agency could provide following a phased and conditional approach based on a thorough assessment of the status of country T&T programmes.

8. The Agency continued fostering partnerships for PATTEC through its representation on the PATTEC Policy and Mobilization Committee and through the interaction — alongside other mandated United Nations organizations (notably FAO and WHO) and other stakeholders — in the Programme Against African Trypanosomiasis (PAAT). Agency staff used several occasions to inform counterparts, collaborators and partner institutions about the revised and focused contributions of the Agency to the Member States' efforts against the T&T problem, as it resulted from the Agency's "Tsetse - The Way Forward" review process. These occasions included the above-mentioned regional coordination meeting, the 11th meeting of the PAAT Advisory Group (Addis Ababa, 21–22 September 2005), the 30th meeting of the Executive Committee of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC; Addis Ababa, 25 September 2005) and the 28th meeting of the ISCTRC (Addis Ababa, 26–30 September 2005). As a result, the focused, phased and conditional approach for Agency assistance to Member States' efforts against the T&T problem taking into consideration the actual status of country programmes is increasingly accepted and understood. In this context a resolution was passed at a major international conference on T&T research and control organized by the African Union in September 2005, proposing to the national PATTEC projects the adoption of a phased, conditional planning and implementation approach. With regard to international

support by FAO and WHO to Member States' efforts against the T&T problem, both UN sister agencies also intend to adopt this approach in their assistance to AfDB funded countries.

9. Some laborious, time-consuming and quality-sensitive steps of tsetse mass-production were streamlined and standardized through research and development activities at the FAO/IAEA Agriculture and Biotechnology Laboratory at Seibersdorf, and through a coordinated research project (CRP) on "Improved and Harmonized Quality Control for Expanded Tsetse Production, Sterilization and Field Application". A new CRP on "Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens" has been designed and will be initiated in early 2007.

10. A draft of the document *FAO/IAEA Guidelines for Conducting Baseline Tsetse Surveys for Area-Wide Integrated Pest Management Programmes* was circulated for comment to national counterparts in T&T affected Member States. The draft guidelines, which will be finalized in 2006, served as a basis for a regional training course on the "Principles of Baseline Data Collection for Integrated Area-Wide Tsetse and Trypanosomosis Intervention Projects with a Sterile Insect Technique Component" that was organized by the Agency in collaboration with the FAO from 13 March to 7 April 2006 in Nairobi, Kenya, and hosted by the Government of Kenya and the International Centre of Insect Physiology and Ecology (ICIPE). Subsequently the Agency also assisted with the organization of a workshop to generate a detailed action plan for the collection of entomological base line data in the Lake Victoria Basin in Uganda.

11. The Agency has been instrumental in the development of a document, summarizing the results of a feasibility study for the creation of a zone free of the remaining two tsetse fly species in KwaZulu Natal, South Africa. The document includes a comprehensive cost benefit analysis.

12. The Agency supplemented the earlier FAO/IAEA consultants' report on *Generic Design, Technical Guidelines and Optimal Location of Tsetse Fly Mass-Rearing Facilities* with a draft computerized spreadsheet, to facilitate Member States' efforts in identifying dimensions of the tsetse factories, specifying equipment needed and providing cost estimates. Furthermore, the Agency provided advice on the development of blueprints for national and sub-regional tsetse mass-rearing facilities

13. The Agency drafted detailed standard operational procedures (SOPs) for advanced mass-rearing of tsetse flies, with particular reference to the specific needs of operational TC projects, and major progress has been achieved on the development of two e-learning modules on SIT-relevant irradiation dosimetry and on procedures for strain compatibility testing in tsetse, which is an important component for quality assurance in tsetse SIT. The development of a mathematical model has been initiated, which aims at assisting Member States in planning and efficiency-assessment of different options of integrated area-wide tsetse control strategies. A meeting was organized for consultants to identify parameters to assess the minimal size of area-wide integrated pest management programmes that include an SIT component.

Programme of Action for Cancer Therapy

A. Background

1. At its forty-ninth session in September 2005, the General Conference requested in resolution GC(49)/RES/12.C, that the Director General continue to advocate, build support and allocate and mobilize resources for the implementation of the Programme of Action for Cancer Therapy (PACT) as one of the priorities of the Agency, and urged him to seek and strengthen the Agency's involvement in international partnerships with non-traditional donors to pursue, develop and implement PACT. It further encouraged the Director General to explore, together with the Director General of WHO, the feasibility of a joint programme of the Agency with WHO for cancer prevention, control, treatment and research, as well as the best means to partner in the implementation of PACT. The General Conference stressed the importance of developing an Agency-wide strategy for the implementation of PACT, making use - inter alia – of available Agency information, identified resources, and of synergies and interactions across all relevant departments, as well as raising funds from extrabudgetary sources. It recommended that, at an early stage, the PACT Programme Office, in consultation with relevant Agency departments and WHO, as appropriate, develop tools to assist developing Member States in establishing national plans and strengthening their capabilities to enhance the benefits to be achieved as the implementation of PACT proceeds. Member States, interested organizations and other non-traditional donors were invited to contribute to PACT and the Director General was requested to report on progress made in the implementation of this resolution at its fiftieth regular session.

B. Developments since the General Conference's 2005 session

B.1. Building partnerships

2. In May 2005, the World Health Assembly in its resolution WHA58.22 on cancer prevention and control, had requested the Director-General of WHO to explore the feasibility of initiating the development of a joint programme between WHO and IAEA for cancer prevention, control, treatment and research. In response to this, the PACT Programme Office (PPO) held discussions with concerned officials at WHO Headquarters in Geneva, the WHO's International Agency for Research on Cancer (IARC), and with WHO regional offices on cooperation in the field of cancer. IARC is providing technical expertise and has a technical and scientific coordination role in PACT. A Memorandum of Understanding was signed in April 2006 with the WHO Regional Office for the Eastern Mediterranean (EMRO) to support the advancement of cancer prevention and treatment in the region. A proposal for joint action for enhancing cancer control is currently being considered by EMRO.

3. The Secretariat has developed relationships with leading organizations[1] in the field of cancer control and research in order to assist Member States in developing their comprehensive cancer control programmes. Following a meeting of these organizations hosted by the Agency in April 2006, they agreed to work together, with a commitment to collaborate in cancer care capacity building at demonstration sites in the six regions of WHO. They have also agreed to work jointly with the PPO on integrated missions of PACT (imPACT) to assist countries in developing national cancer strategies and plans, to work together on fundraising and to prepare a concept paper focusing on cervical cancer with a view to approaching potential donors.

B.2. Assisting Member States in strengthening their capabilities to fight cancer

4. In collaboration with other parts of the Secretariat the PPO has developed the imPACT review process to assess the national burden posed by cancer and the status of national plans and infrastructure related to cancer. Subject to the availability of funds, imPACT reviews are conducted upon request and are intended to identify and respond to cancer control and treatment needs in critical policy and strategic areas. With the assistance of partner organizations, including the regional offices of WHO, imPACT reviews were conducted in Albania, Ghana, Nicaragua, Sri Lanka, the United Republic of Tanzania, Vietnam, and Yemen. Several of these reviews were conducted in conjunction with the Agency's technical cooperation programme. Requests for further imPACT reviews have been received from 25 Member States.

5. The PPO has developed the concept of Model Demonstration Sites, which are designed to demonstrate to potential donors that international agencies can successfully work together and acquire field experience and understanding of comprehensive and multidisciplinary cancer capacity building in low and middle income countries. Following the imPACT reviews, suitable sites for the development of Model Demonstration Sites have been identified in Albania, Nicaragua, Sri Lanka, Tanzania Vietnam and Yemen.

B.3. Funding and fundraising

6. From the total requirement of €2.4 million for 2006-2007, €460 000 have been funded in the interim by re-prioritisation of existing regular budget resources of Major Programme 2, and approximately $900 000 have been received in cash (Hungary €40 000, New Zealand NSD 25 000, Spain €20 000 and the USA $800 000). The USA has provided in-kind contributions through the provision of cost-free expertise. Albania has provided $100 000 as a cost-sharing donation for its Model Demonstration Site. Despite the Secretariat's efforts to bridge the funding requirement of PACT, additional funding in 2006 and 2007 is required to move PACT forward in meeting Member States' requests for assistance.

7. Funding proposals for the Model Demonstration Sites have been submitted to potential donor Member States and international cancer funding bodies for consideration. IARC is also providing expertise for the Model Demonstration Sites in Albania and Tanzania.

8. Training of cancer care professionals is one of the key requirements for effective national and regional cancer control programmes. Existing institutions have been identified as regional leaders,

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[1] These include, among others, the International Union Against Cancer (UICC), the International Network for Cancer Treatment and Research (INCTR), the US National Cancer Institute (NCI), the Open Society Institute (OSI), the American Cancer Society (ACS) and the Oxford University Department of Clinical Pharmacology.

particularly in Africa (United Republic of Tanzania) that could become centres for regional training in all aspects of cancer care, with the Agency focusing on radiotherapy, and the PACT partners providing expertise in their respective areas. The objective in the coming year is to prepare a detailed joint funding proposal, aiming at establishing regional networks of cancer training centres in three regions over the next three to five years.

9. Together with partner organizations, proposals are being developed for the funding of training, research, the development of a comprehensive cancer control strategy, and for expanding cancer care programmes building, where feasible, on established technical cooperation projects. These are currently at various stages of development and processing, and are aimed at Member States in Africa and in the Middle East.

10. Contacts have also been established with major foundations that fund international health projects and with the radiotherapy and medical equipment industries. A radiotherapy machine, donated by MDS Nordion (Canada), will be unveiled in Dar Es Salaam, Tanzania, in September 2006.

B.4. Public awareness

11. Cable News Network (CNN) aired a public service announcement for one year on the cancer epidemic, radiotherapy and the Agency's role in treating cancer. The Secretariat is currently working on a further public service announcement due to be released later in 2006. It will reflect PACT's successes to date in working with international partners on a comprehensive cancer strategy.

12. Various medical journals have published articles on PACT, and the Secretariat has received many letters sharing information, offering support and requesting assistance.

13. This year the PPO also launched a dedicated PACT website within the main Agency website (www.iaea.org). The PPO has prepared and disseminated almost 1000 media and information kits that include not only information on PACT and the Agency, but also cancer statistics from WHO, IARC and the UICC, which are intended to alert potential donors to the need to do more in this area.

Agency Activities in the Development of Innovative Nuclear Technology

A. Background

1. In September 2005, in resolution GC(49)/RES/12.F, the General Conference, conscious of the need for sustainable development and of the potential contribution of nuclear energy to meeting the growing energy needs in the 21st century, noted the progress achieved in a number of Member States in the development of innovative nuclear technology, and recognized the unique role which the Agency plays, and in particular the current role it is playing through the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), by bringing together all interested Member States to consider jointly innovations in nuclear reactors and fuel cycle systems. It invited all interested Member States to consider jointly innovations in nuclear reactors and fuel cycle systems, 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 fiftieth session.

B. Developments since the General Conference's 2005 Session

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

2. INPRO is an Agency-wide project, coordinated by the Department of Nuclear Energy with contributions from all relevant Agency Departments. Since 2004, INPRO has been partly implemented with Regular Budget funds, but it continues to be implemented using mostly extrabudgetary resources. INPRO became an Agency subprogramme in the 2006-2007 budget cycle.

3. The second part of INPRO's Phase-1B was started in January 2005 and completed in July 2006. It included (a) preparation of a user manual on all the areas covered by the INPRO methodology, to assist users in assessing innovative nuclear energy systems (INSs); (b) assessments of INSs by INPRO members through application of the methodology; and (c) the identification of possible frameworks and implementation options for collaborative projects for INS development and deployment.

4. Seven chapters of the user manual (Overview, Economics, Reactor Safety, Fuel Cycle Safety, Environment, Waste Management and Infrastructure) have been made available as a draft to INPRO members. Drafts of two other chapters (Proliferation Resistance and Physical Protection) will be available by the end of 2006.

5. By conducting assessments of INS it is intended to identify promising INSs, which can contribute to sustainable development. The assessments will also contribute to identifying the needs for international collaborative projects and also to providing valuable feedback for further improvement of the INPRO methodology. Assessments are currently being carried out by Argentina, Armenia, France, India, and the Republic of Korea. Also, a joint assessment based on a closed fuel

cycle with fast reactors is being conducted by Canada, China, India, Japan, Republic of Korea, the Russian Federation, and Ukraine. Further assessments will be initiated in Brazil, China, Morocco and Ukraine. Another joint assessment of INS to meet energy demand during periods of raw material insufficiency will be carried out by Bulgaria, the Czech Republic, Poland, the Russian Federation and Slovakia.

6. Various tools have been developed to support INPRO activities to facilitate the identification of collaborative projects by INPRO members, including an INPRO portal to enhance communications among INPRO members and to support the organizations doing INS assessments; and nuclear power development modelling tools to establish INS introduction scenarios and to define and assess INSs.

7. A technical meeting was held from 10 to 12 April 2006 to discuss the options for the implementation of collaborative projects during INPRO Phase-2. Consensus was reached on the framework, topics and guidelines for the implementation of collaborative projects in INPRO Phase-2, which will be performed by groups of interested INPRO members. INPRO will provide secretariat services to receive and process applications of the collaborative projects, to offer a forum for their discussion and to help INPRO members find partners and frameworks for their implementation.

8. Thirty-three participants from 28 countries and one international organization, including 10 non-INPRO members, were trained at a workshop in the application of the INPRO methodology, held in June 2006, at IAEA Headquarters in Vienna.

9. The ninth meeting of the INPRO Steering Committee in July 2006 endorsed the start of Phase-2 and the outline of the action plan for Phase-2. This allowed INPRO to initiate Phase-2 activities in accordance with its terms of reference: (a) methodology oriented activities, (b) institutional/infrastructure oriented activities, and (c) collaborative projects. The Steering Committee also endorsed the document defining the framework, options, topics and guidelines for the implementation of collaborative projects under INPRO Phase-2. The Steering Committee initiated the process for receiving Member State proposals for collaborative projects, with a plan to review proposals at the next meeting.

10. As of August 2006, the following 25 Member States and one international organization were INPRO members: Argentina, Armenia, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, France, Germany, India, Indonesia, Japan, Republic of Korea, Morocco, Netherlands, Pakistan, Russian Federation, Slovakia, South Africa, Spain, Switzerland, Turkey, Ukraine, USA and the European Commission.

11. In total, 29 cost-free experts have been nominated by INPRO members and have worked at the Agency as members of the INPRO International Coordinating Group.

12. A home page for INPRO (http://www.iaea.org/INPRO) provides periodically updated information to INPRO members and the public in general.

13. The Agency pursues increased cooperation with other international efforts targeted at innovative technology development, such as the Generation IV International Forum (GIF). In September 2005, a meeting took place between the INPRO and GIF secretariats, during which synergy between INPRO and GIF was reviewed. Constructive proposals on cooperation, such as the review by GIF working group of the INPRO manual chapter on economics, were made and are currently being implemented.

14. The work of INPRO has been presented in a number of important international conferences, such as the Conference on EU research and training in reactor systems (FISA, March 2006), the Topical Meeting on New Reactor Systems (TopNux) (March 2006), the International Congress on

Advances in Nuclear Power Plants (ICAPP06) (June 2006) and the International Conference on Nuclear Engineering (ICONE) (July 2006).

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

15. Through Major Programme 1, Nuclear Power, Fuel Cycle and Nuclear Science, the Agency continues to assist the innovative nuclear technology research and development efforts of interested Member States through scientific and technical information exchange and collaborative R&D.

16. The expertise gained from a CRP on natural circulation phenomena, modelling and reliability of passive systems that utilize natural circulation, and contained in the report titled Natural circulation in water cooled nuclear power plants2 forms the basis of an intensive Agency training course on natural circulation in water cooled NPPs for scientists and engineers involved in the design, testing and analysis of natural circulation systems. The next course will be held at the International Centre for Theoretical Physics (ICTP) in Trieste, Italy, in 2007.

17. The web-based Thermo-Physical Materials Properties (THERPRO) Database (http://www.iaea.org/THERPRO) was established in 2005 as a result of a CRP on thermo-physical properties of LWR and HWR materials. This database provides materials properties data to registered, authorized users and contains over 13 000 files of data, descriptions of experiments and bibliographic information collected from the open literature. The report on Thermophysical properties database of materials for light water reactors and heavy water reactors3, published in June 2006 presents new data assessments conducted during the CRP. Use of accurate data can remove the need for excessive margins in new reactor designs.

18. A new CRP on heat transfer behaviour and thermal hydraulics code testing for supercritical water cooled reactors was initiated in 2006. This CRP is being coordinated with the OECD/NEA and the GIF supercritical water cooled reactor steering committee.

19. In the area of advanced fast reactors two technical meetings, held in Cadarache, France (26-30 September 2005), and in Kalpakkam, India (1-3 March 2006), provided a global forum for information exchange to Member States involved in fast reactor development activities. In Cadarache, decommissioning experience with fast reactors and active sodium loops, in particular with regard to the decommissioning of components after sodium draining, was addressed. In Kalpakkam, fast reactor fuel failure and failed fuel detection systems were considered with regard to the philosophy applied and the analyses carried out.

20. The Agency prepared a report providing a comprehensive summary of the status of lead and lead-alloy cooled fast reactors with regard to (a) the various concepts and designs that are being investigated, (b) the underlying research and technology development, and (c) impact on the fuel cycle. The report was peer reviewed by a group of international experts, and is currently being prepared for publication.

21. Two CRPs on the application of accelerator-driven systems (ADSs) for actinide utilization and long-lived nuclide transmutation are being implemented. One CRP aims at the comparative assessment of the dynamics of transmutation systems. A new CRP seeks to improve the present understanding of the coupling of the ADS spallation source with the multiplicative subcritical core. The Agency has prepared an ADS application cross section library that can be used in the simulation

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[2] IAEA-TECDOC-1474.

[3] IAEA-TECDOC-1496.

and design studies and is available for direct downloading from the internet and also as CD ROM. A review of the current status of ADS for energy production and transmutation of long-lived nuclides was performed at the 39th Meeting of the Technical Working Group on Fast Reactors (TWG-FR) held in Beijing, China (15–19 May 2006) by the TWG-FR representatives. The Agency continues to collaborate with OECD/NEA in the field of partitioning and transmutation. Both organizations sponsor the Information Exchange Meeting on Actinide and Fission Product Partitioning and Transmutation, which will be hosted by the CEA in Nîmes, France, in September 2006. A workshop on "ADS Technology and Applications" was held at the ICTP, Trieste, Italy, in October 2005.

22. Design studies and simulations required in the development of innovative nuclear technology systems are largely determined by the accuracy of the atomic and nuclear data. A CRP on nuclear data relevant for the thorium/uranium fuel cycle provided nuclear data files for design calculations of innovative fuel cycles, which can be used by designers of nuclear plants. Two initiatives to improve nuclear data on the structure and decay properties of minor actinides, and on neutron reaction properties of neptunium, americium and curium in addition to less abundant plutonium isotopes, have commenced in 2005 and 2006, respectively.

23. Research activities on high temperature gas cooled reactors (HTGRs) continued to focus on benchmarking core design codes and technology of coated fuel particles. A Research Coordination Meeting (RCM), held in September 2005 focused on core physics and thermal-hydraulics and reviewed results for benchmarks. A CRP was extended for two years to finalize tasks and publish a second TECDOC. In the area of fuel technology, an RCM in October 2005 reviewed the status of the project, including fuel performance models being benchmarked and compared for normal as well as accident conditions, and code predictions on the outcome of current and planned fuel irradiation tests.

24. The first meeting of a CRP on HTGR potential in process heat applications is planned for October 2006. The CRP will focus on nuclear hydrogen as well as low temperature process heat applications, such as seawater desalination.

25. In the area of educational training, a workshop on HTGR physics and applications was held in July 2006, hosted by the ICTP, in Trieste, Italy. About 20 participants, mostly from developing countries attended the workshop.

26. In the area of nuclear desalination, the Agency's Desalination Economic Evaluation Program (DEEP) software has been upgraded and was released in September 2005. More than one hundred copies were distributed to interested scientists and engineers from Member States. A technical meeting on integrated nuclear desalination systems was held in Vienna in December 2005, dealing with several innovative features related to new designs of seawater intake, pre-treatment systems, use of reject heat and cost reduction strategies. The 8th meeting of the International Nuclear Desalination Advisory Group (INDAG) meeting was held in Vienna in February 2006. INDAG assessed the performance of the activities in the Programme and Budget 2004-2005 and reviewed the activities in the Programme and Budget 2006-2007. A training course on the technology and economics of desalination system modelling was held in April 2006 at the ICTP in Trieste.

27. In the area of small and medium sized reactors (SMRs) a new CRP on small reactors without on-site refuelling was started with 18 organizations from 12 Member States, and the first RCM was convened in Vienna from 21 to 25 November 2005. Small reactors without on-site refuelling are reactors that can operate without reloading and shuffling of fuel for a reasonably long period. The CRP examines technological and regulatory options to reduce or eliminate emergency planning zones, supports design and technology development for small reactors without on-site refuelling of several different types and performs scenario studies for nuclear energy systems with such reactors.

28. An interregional workshop on design and application potential of integral type PWRs for developing countries was held in Argentina in November 2005. The workshop included lectures from technical directors of leading projects of such reactors and an overview lecture on the progress in design and technology development for advanced water cooled SMRs. A dialogue with the participants from developing countries was convened outlining the prospects of nuclear power and requirements to advanced nuclear power plants (NPPs).

29. Two new reports on Advanced nuclear plant design options to cope with external events and Status of innovative small and medium sized reactor designs 2005: Reactors with conventional refuelling schemes were published in 20064. They address different issues of plant design, siting, safety assessment and component qualification regarding extreme external events, and give balanced and objective information on important development trends and objectives of innovative SMRs for a variety of uses, on the achieved state-of-the-art in design and technology development and regulatory status.

30. Economies of scale for SMRs and their competitiveness will be addressed in a report on options to break the economies of scale for SMRs, expected to be submitted for publication in 2007, and in the context of a CRP dealing with the identification of competitive technological options for SMRs, planned for 2007. The CRP seeks to assist existing and potential stakeholders in the definition of a competitive strategy regarding design and deployment of SMRs, and to investigate the potential of SMR competitive applications.

31. A new project on nuclear hydrogen production was included, together with a project in support of demonstration of nuclear seawater desalination, in a subprogramme on support of non-electric applications of nuclear energy that started in early 2006. The hydrogen production project seeks to facilitate information exchange and coordinate research and development work in the area of nuclear hydrogen production. A tool for the economic evaluation of nuclear and non-nuclear hydrogen production methods is also being explored.

32. Some of the Agency's activities in catalysing innovations in nuclear fuel cycle in the front- and back-end are as follows:

a) Uranium production cycle and environment

The rising expectation for nuclear power has led to a revival of the uranium raw material industry after a slump of nearly two decades. The increased demand for uranium has led to a near tripling of uranium prices over the past three years. As a result, new exploration and mining activities have been initiated and the major uranium producers have increased their annual production. The Agency has reoriented its programme for 2006 and 2007 to meet the needs of Member States in increasing the uranium raw material base and augmenting mining and milling activities, while protecting the environment. A Technical Meeting at Singhbhum, India in March 2006, focused on innovative airborne and ground geophysical techniques for uranium exploration to discover deep and obscure unconformity related uranium deposits that do not have a surface expression. Another Technical Meeting held in Almaty, Kazakhstan, in August 2006 covered in situ leach (ISL) mining, which is very environment-friendly and is suitable to sandstone-based deposits where the ore body is in porous rock. Innovations in ISL with respect to uranium recovery and remediation and reclamation after ISL mining were the highlights of this meeting. The reports resulting from these meetings will outline the best practices in uranium exploration and production cycle.

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[4] IAEA-TECDOC-1487 and -1485.

b) Power reactor fuel performance and technology

The present generation of nuclear power reactors are mostly water cooled. The trend of increasing fuel burnup, with higher ratings and longer dwell time in these power plants requires improved modelling of the fuel behaviour. A CRP which studied fuel modelling at extended burnup (FUMEX-2) was concluded in July 2006. Its central accomplishment was to significantly extend the capability of fuel codes used in Member States to accurately predict fuel performance at high burnups, both for normal operation and under transient conditions. Another CRP, "Data Processing Technologies and Diagnostics for Water Chemistry Control in Nuclear Power Plants", provided a better understanding of water chemistry control for efficient and safe plant operation with increased fuel burnup, longer fuel residence times and fewer failures. The results of the CRP, published in 2006[5], summarized the improvements in both analytical models and operational practice using the information developed on water chemistry control techniques, plant chemistry, corrosion diagnostics and plant monitoring of corrosion, chemistry and coolant activity.

c) Management of spent fuel from power reactors

The Agency contributes to building up the technical knowledge base and helps to introduce innovations in Member States for managing spent fuel from power reactors from long term storage to reprocessing and recycling. This is being achieved through a series of CRPs on spent fuel performance assessment and research with regard to advances in applications of burnup credit to enhance spent fuel transport, storage, reprocessing and disposition, and the handling of damaged fuel. Innovative techniques in handling damaged spent fuel and spent fuel treatment options were reviewed in meetings organized in Daejeon, Republic of Korea and Vienna, in October and December 2005, respectively. A new report titled *Technical, economic and institutional aspects of regional spent fuel storage facilities*, published in November 2005,[6] elaborates on multinational approaches to the nuclear fuel cycle. According to the report, countries that have small nuclear power programmes or only research reactors, and hence no possibility for early disposal, face the challenge of arranging for extended interim storage of their spent nuclear fuel. Access to an interim storage facility provided by a third country would be a desirable solution. The report concludes that the regional concept is technically feasible and economically viable, although the political, social, and public acceptance challenges are required to be addressed.

d) Innovations in fissile and fertile materials utilization

The Agency organized several technical meetings and published several TECDOCs in recent years on the status of highly enriched uranium, reprocessed uranium, plutonium, thorium, uranium-233 and minor actinides and their use in innovative nuclear energy systems:

- A technical meeting on "Fissile Material Management Strategies for Sustainable Nuclear Energy" was held in Vienna in September 2005. A fully edited proceedings series is expected to be published in the last quarter of 2006. The report will contain the uranium demand and supply through 2050, fissile material management strategies for sustainable nuclear energy, including back end fuel cycle options; and sustainable nuclear energy beyond 2050.

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[5] IAEA-TECDOC-1505.

[6] IAEA-TECDOC-1482.

- The reprocessing of spent fuel in several countries has generated large inventories of reprocessed uranium and plutonium. In August 2006, the Agency has published a report on the *Viability of Inert Matrix Fuels (IMF) in reducing plutonium amounts in reactors*[7].

- Liquid metal fast reactors (LMFR) and their fuel cycle are being actively considered by several Member States for the efficient use of uranium and thorium raw materials and in reducing volume, decay heat and radiotoxicity in the final waste for geological disposal. To promote information exchange and collaboration, the Agency organized a meeting at Obninsk, Russian Federation, on LMFR fuels and fuel cycle options. The status of mixed uranium plutonium oxide conventional fuel and advanced LMFR fuels, namely mixed uranium plutonium monocarbide, mononitride and metallic fuels, and their reprocessing by aqueous and pyro-routes were discussed.

e) Proliferation resistance in fuel cycles

The Agency organized a technical meeting on "Increasing Proliferation Resistance of Nuclear Energy System and Fuel Cycles" in June 2006, which provided a forum to Member States to share state-of-the-art information on the proliferation resistance of different nuclear energy systems and their fuel cycle options, including LWRs, pressurized heavy water reactors (PHWRs), HTGRs, gas cooled fast reactors (GFRs) and uranium and thorium fuel cycles.

As part of an INPRO activity, the study on the Proliferation Resistance of the fuel cycle DUPIC (Direct Utilisation of Spent PWR fuel in CANDU) was completed and an IAEA-TECDOC will be published soon.

The Agency also initiated an activity on "Protected Plutonium Production (P3) and Utilization" in collaboration with the Tokyo Institute of Technology, Japan. The P3 concept aims at the dual objectives of producing plutonium with higher proliferation resistance, and the incineration of minor actinides. In this concept, a small addition (<1%) of neptunium, americium or curium to low enriched uranium oxide fuel for LWRs and depleted uranium and thorium blanket materials for fast reactors, ensures sufficient production of plutonium-238 in the spent fuel or irradiated blanket (the plutonium-238 emits spontaneous neutrons and has high decay heat, which increases proliferation resistance).

[7] IAEA-TECDOC-1516.

Approaches to supporting nuclear power infrastructure development

A. Background

1. In September 2005, in resolution GC(49)/RES/12.G, the General Conference recognized that the development and implementation of an appropriate infrastructure to support the safe and efficient introduction of nuclear power is an important issue for the countries concerned.

2. The General Conference requested the Director General to report on the progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its fiftieth session under an appropriate agenda item. This document is prepared in response to this request.

3. Also in 2005, the importance of infrastructure for the Agency's programme was reflected in the Agency's Medium Term Strategy for 2006–2011 through the inclusion of the objective to "advance nuclear science and technology and catalyse innovation" by assisting Member States with future infrastructure development.

4. Topics relating to the nuclear power infrastructure are addressed by different parts of the Agency and require close coordination among relevant Agency activities. An inter-Departmental group, established in the Secretariat to develop a coordinated approach to providing support to interested Member States, has identified several policy issues that need to be considered, and has proposed means of improving coordination within the Agency of the required actions.

B. Work completed or ongoing since the 49th session of the General Conference

5. The infrastructure to support the implementation of a new nuclear power project has many components, ranging from the physical facilities and equipment associated with the delivery of the electricity, the transport of the material and supplies to the site, the site itself, and the facilities for handling radioactive waste, to the legal and regulatory framework within which all of the necessary activities are carried out, and the human and financial resources necessary to implement the required activities.

6. The Agency's Major Programme 1 project "Strengthening national and regional nuclear power infrastructures" was continued in 2006. As part of the work in this project, a report on the basic infrastructure for a nuclear power project was published as a TECDOC in June 2006[8]. This report provides initial guidance on the infrastructure that a country needs to develop to ensure that it is

[8] IAEA-TECDOC-1513.

prepared for the introduction of a nuclear power plant. This infrastructure is relevant whether the nuclear power plant is planned for the production of electricity or for seawater desalination.

7. In response to last year's General Conference resolution, Member States participated in a meeting to draft a document, which will define milestones for the development of the necessary infrastructure for Member States to plan, operate and maintain safe and reliable nuclear power plants, and to assist the Agency to prioritize its support to Member States. This document will supplement the TECDOC on the basic infrastructure for a nuclear power project (see para. 6 above), and will allow Member States to assess the level of their readiness to introduce nuclear power and to determine the magnitude of their required additional commitment. The assessment expected from the Agency will help Member States to prioritize their activities and achieve the use of nuclear power in a safe, secure and technically sound manner.

8. A document on the potential for sharing nuclear power infrastructure describes areas where countries may be able to achieve the required level of infrastructure by sharing resources and facilities. This is intended to enable countries to realize where they can be more effective by working with other countries, either in their region, or elsewhere. This document will be published as a TECDOC before the end of 2006.

9. An assessment of all previously developed Agency documentation in support of the planning for and the introduction of nuclear power has been performed. Work is ongoing to update these documents to reflect the changing social and commercial environment which must now be considered in the application of nuclear energy. The revised guidance will form part of the new Nuclear Energy Series of publications.

10. Within the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) a manual to enable a user to perform an assessment of the Innovative Nuclear Systems (INSs) was produced and circulated to INPRO Member States in 2006. This manual addresses long term national, regional and international potential developments and conditions that would facilitate the deployment of INSs, while the TECDOCs mentioned in paras 6 and 8 above give guidance on what can be achieved in the short term by Member States planning to introduce nuclear power.

11. Since the 49th session of the General Conference, there has been a significant increase in the number of Member States expressing interest in nuclear power. The Agency has been able to provide advice on what steps need to be taken to be ready to introduce nuclear power.

12. At present there are TC projects related directly to the development of nuclear power plants and associated infrastructure in six Member States, and related to preparations for the production of desalinated water from nuclear power plants for another six Member States. There are also 14 TC projects related to energy planning for countries which do not currently operate nuclear power plants. At the moment there are nine requests from other Member States for new TC projects in support of nuclear power applications. In addition, in 2007, two regional TC projects will commence to assist with infrastructure support for countries considering the introduction of nuclear power.

13. A workshop is planned for December 2006 to provide information on the infrastructure issues to be addressed during the planning phase of the introduction of nuclear power and to further identify Member States' concerns and needs in this area.

C. Future issues

14. The changing global environment is likely to influence the infrastructure necessary for construction and operation of nuclear power plants. Depending on the Member States' needs, issues such as financing arrangements for capital intensive nuclear power plants, international design approval, harmonization of codes and standards, and assurance of fuel cycle services would need to be addressed.

Nuclear Knowledge

1. In September 2004, in resolution GC(48)/RES/13.E, the General Conference recognized that preserving and enhancing nuclear knowledge and ensuring the availability of qualified manpower 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. The Secretariat was urged to continue to strengthen, subject to the availability of resources, its current and planned efforts in this area, recognizing the need for a focused and consolidated approach, to consult with Member States and other international organizations, to take into account the results of relevant international meetings in the ongoing development of a comprehensive Agency strategy for all aspects of nuclear education, training and qualification, as well as nuclear knowledge preservation and enhancement, and to further increase the level of awareness of its efforts in the preservation and enhancement of nuclear knowledge.

2. The General Conference further requested the Director General to report on progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its fiftieth (2006) session under an appropriate agenda item, and thereafter to continue to update the report to the General Conference on a biennial basis.

A. Strengthening nuclear knowledge management (NKM)

3. In 2005 the importance of nuclear knowledge management for the Agency's programme was reflected in the Agency's Medium Term Strategy for 2006–2011, through the inclusion of the objective to "sustain and build up the experience, expertise, knowledge base and capacity needed to support existing and expanded use of nuclear power and applications".

4. Subprogramme C.3, Nuclear Knowledge Management, was strengthened in the Agency's Programme and Budget 2006–2007 and is being implemented in synergy with Subprogramme C.4, International Nuclear Information System, and Subprogramme C.5, Library and Information Support. In the period 2004–2006, the general focus of Subprogramme C.3 was on the development of guidance for NKM, on networking nuclear education and training to link centres of competence with areas of growth for capacity building and on the preservation of nuclear knowledge. NKM continues to be a cross-cutting area for the Agency and is being coordinated on an Agency-wide basis.

5. The Agency adopted, also in 2005, an Agency-wide approach and strategy for NKM, laid down in the strategy paper *Role and Strategy of the International Atomic Energy Agency in Helping Member States to Manage Nuclear Knowledge*. The strategy paper identified the following areas as key for the Agency: providing guidance for policy formulation and implementation of nuclear knowledge management; strengthening the contribution of nuclear knowledge in solving development problems, based on needs and priorities of Member States; pooling, analysing and sharing nuclear information to facilitate knowledge creation and its utilization; implementing effective knowledge management systems; preserving and maintaining nuclear knowledge; securing sustainable human resources for the nuclear sector; and enhancing nuclear education and training.

6. In 2005, the Agency also adopted a Secretariat-wide approach and strategy for corporate, Secretariat-internal knowledge management. This strategy outlines how the Secretariat can best manage its corporate knowledge and establishes a corporate knowledge management implementation framework. These activities are not the subject of the present report.

7. Many elements of the Agency's programmes relate to nuclear knowledge management in a general manner including, for example, all Agency databases and training courses. They are reported to the Board of Governors and the General Conference through the Annual Report, the Nuclear Safety Review, the Nuclear Technology Review and the Technical Cooperation Report and other reports to the General Conference[9].

B. Guidance for nuclear knowledge management

8. The Agency has contributed to increasing the level of awareness of the benefits of NKM through the development of guidance for the nuclear community as a whole on the application of NKM. This was done mainly through the organization of workshops and conferences on NKM and through publications. In 2004 and 2005, three workshops were held: two at the International Centre for Theoretical Physics (ICTP), Italy, in cooperation with the World Nuclear University (WNU)[10], and a third in Ukraine in June 2006, supported by the TC programme. A steering committee meeting for the International Conference on Knowledge Management in Nuclear Facilities was held in June 2006, in preparation for the conference in June 2007, which will specifically address the use of NKM in the context of the nuclear industry[11].

9. The Agency has provided organizations operating nuclear facilities with assistance and guidance in effective implementation of NKM programmes. In 2005, in cooperation with the World Association of Nuclear Operators (WANO), the Agency conducted two expert missions to advise on nuclear knowledge management at the Krško nuclear power plant in Slovenia. Lessons learned from these missions were then used to structure NKM expert missions in 2005 and 2006 to nuclear power plants in Kozloduy, Bulgaria and Paks, Hungary. An expert mission to Kazakhstan was conducted in April 2006 to develop an action plan for a new national TC project on managing and preserving nuclear knowledge. A guidance document on *Knowledge management for nuclear industry operating organizations* was then published in 2006, emphasizing that knowledge is a strategic resource and recommending the use of NKM to achieve competitive advantage. A second document on *Risk Management of Knowledge Loss in Nuclear Industry Organizations* was published in 2006. It seeks to assist Member States to develop a strategic approach to address the potential loss of critical knowledge and skills and to enable nuclear organizations to cope with that risk.

10. Decommissioning of nuclear facilities and the management of radioactive waste raise specific NKM issues, including the selection of information and knowledge to be preserved and the timescale

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[9] Including in particular GC(50) XXXX (2006) in response to GC(49)/RES/9 on activities in the area of education and training in nuclear, radiation, transport and waste safety.

[10] Proceedings for the workshop held in 2005 are under publication in 2006. Also in 2006, a glossary on NKM terminology and a resource material booklet containing relevant reference material since 2003 on CD-ROM were published.

[11] Proceedings of the International Conference on Nuclear Knowledge Management: Strategies, Information Management and Human Resource Development, held in France in 2004, were published in 2006.

to be considered. To assist the nuclear community in this regard, the Agency prepared several topical publications[12]. As a follow-up to the Technical Report *Record Keeping for the Decommissioning of Nuclear Facilities: Guidelines and Experience*, the Agency continued to provide practical guidance on long term preservation of information and technical knowledge in decommissioning projects. In August 2005, a workshop on waste inventory record keeping systems was held in connection with the annual conference of the Nuclear Information and Records Management Association.

11. The Agency's TC programme includes and supports various actions and initiatives in nuclear knowledge management which seek to respond to and address the priorities of developing Member States. Workshops have been organized for specific development issues in the four TC regions, including self-reliance and sustainability of national nuclear institutions. The workshops held in Africa under AFRA focused on strategies, approaches and practical activities to enhance the sustainability of national nuclear institutions through best practices at all levels of responsibility, and on enhanced management of quality and human resources, including knowledge management and succession planning.

C. Sharing nuclear knowledge

12. Tools and services have been developed for better access to existing knowledge. A new internet portal – Nucleus – is under development. It integrates the Secretariat's existing information resources on nuclear science and technology in one single portal. The portal contains approximately 130 information resources (databases and websites) of the Secretariat, including new features like the Ask-An-Expert and Find-An-Expert facilities. It will be further expanded to include all the Agency information resources. In the near future, it will also serve as the gateway for information exchange with Member States and other partner organizations.

13. In the field of nuclear safety and security, a knowledge portal for nuclear safety knowledge was established for the Secretariat. Based on this, a template for such systems has been made available to Member States. At present, eight Internet-based knowledge forums exist for the use of Member States, covering topics like regulatory activities, radiation protection and nuclear security. The entire Nuclear Security Plan of Action is being implemented with the support of a comprehensive information management system. The system bridges the gap between operational knowledge and administrative data and assists in the analysis and reporting of programme outputs. It is planned to evolve towards a more structured and searchable knowledge repository for nuclear security knowledge.

14. The Agency is promoting and facilitating the establishment of regional nuclear and radiation safety networks to share and create new knowledge. Under the Asian Nuclear Safety Network (ANSN), hubs and national centres have been established and put into operation. Five topical groups are currently active under ANSN: safety analysis of research reactors; education and training; operational safety; emergency preparedness and response; and radioactive waste management. In 2005, a prototype of the Ibero-American Radiation Safety Network was established in the frame of an extrabudgetary programme on nuclear and radiation safety in the Ibero-American region, under the

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[12] Published are: *Records for radioactive waste management up to repository closure: Managing the primary level information (PLI) set* and *Methods for Maintaining a Record of Waste Packages during Waste Processing and Storage*; a publication on *Preservation and Transfer to Future Generations of Information Important to the Safety of Waste Disposal Facilities* is in advanced preparation.

auspices of the Ibero-American Forum of Nuclear Regulators. A Radiation Safety Regulators Network (RaSaReN) has been established to facilitate worldwide exchange of knowledge and experience essential to establishing and maintaining effective and sustainable regulatory infrastructures for the control of radiation sources.

15. To enhance knowledge sharing for ageing and plant life management for long term operation, the Agency has been developing the Safety Knowledge-base on Ageing and Long Term Operation of Nuclear Power Plants (SKALTO, www-ns.iaea.org/tech-areas/engineering-safety/skalto/skalto.htm). SKALTO aims to identify and store relevant knowledge to facilitate its preservation, retrieval, updating, dissemination, and the creation of new knowledge.

D. Promoting and enhancing nuclear education and training

16. The Agency continued to support the enhancement and stabilization of nuclear education and training with the objective of securing the availability of qualified manpower for the nuclear sector. The most important approaches are networking of educational institutions, and fostering cooperation on the development of harmonized curricula and the preparation and dissemination of teaching materials. The Agency supported the World Nuclear University's (WNU) first Summer Institute (SI), held in 2005 in the USA, by providing lecturers and support for SI participants from developing countries under the TC programme. Based on the experience gained the second Summer Institute was conducted in Sweden and France with similar support from the Agency, and the third one is planned for 2007 in Republic or Korea.

17. The Asian Network for Education in Nuclear Technology (ANENT), established by the Agency in 2004, became operational in 2005. A website has been set up and is being expanded to include a long-distance learning platform for teachers and students. A reference curriculum for nuclear engineering is being developed in cooperation with partners outside Asia. Coordination of activities with the European Nuclear Education Network (ENEN) has continued, and the Agency supported ENEN Association training courses through the TC programme. The Agency also supported the International Youth Nuclear Congress in 2006, held in Sweden and Finland, both through the provision of technical content and through the TC programme.

18. The Agency has maintained and expanded the operations of the network of centres of excellence in training in and demonstrations of technologies for the geological disposal of radioactive wastes in underground research facilities. The network supports knowledge transfer between centres of knowledge and Member States that are beginning their programmes. The network of regional and national training centres on education and training in radiation and waste safety, established in 2003 to promote knowledge sharing and ensure short term and long term availability of necessary expertise and competence, is now fully operational.

19. The Agency developed an electronic nuclear training catalogue called ENTRAC (http://entrac.iaea.org), designed to share information collected by both the Agency and nuclear industry organizations in the areas of training, human performance, management systems, and engineering and technology.

20. In the field of nuclear science and nuclear applications, curricula for training courses in the fields of human health, food and agriculture, management of water resources, management of the marine and terrestrial environments, and radiation-based manufacturing processes are being designed

to enhance and sustain nuclear training. Distance-learning modules and information and communication technology-based training materials are being developed and made available on CD. Many of these activities are implemented under or supported by the TC programme.

21. In July 2005, AFRA Member States, with support from the TC programme, held a regional meeting in Senegal on national strategies for human resources development, skills retention, succession plans and nuclear knowledge management and preservation in nuclear science and technology. Guidelines for developing national human resources for nuclear science and technology programmes were adopted, including the establishment of the African Education Network in Nuclear Science and Technology (AFRA-NEST).

E. Preserving nuclear knowledge

22. A new coordinated research project on Comparative Analysis of Methods and Tools for Nuclear Knowledge Preservation was initiated in 2005, with the objective to assist Member States in the selection and implementation of cost-effective technical solutions to preserve critical nuclear knowledge.

23. The Fast Reactor Knowledge Preservation Initiative was further developed. Since 2004, special fast reactor taxonomies have been developed, together with specifications for the final fast reactor knowledge preservation Internet portal, which will eventually make the collected data and knowledge accessible to all initiative members. A structured process for capturing data and knowledge on fast reactors was agreed upon in 2005.

24. In cooperation with the Commission of Commonwealth of Independent States (CIS) on the Peaceful Use of Atomic Energy, the Agency has been supporting the development of a common approach on nuclear knowledge preservation in CIS countries. A related publication on *Nuclear Knowledge Preservation in CIS-Countries — Current Status and Relevant Suggestions* is under preparation. The Agency also started to develop 'Knowledge Packages' on selected issues.

25. The Agency provides assistance in the field of nuclear sciences to preserve knowledge according to their diverse applications. One important area is the preservation of knowledge on how to operate and maintain nuclear instruments supplied to Member States for which the initial suppliers do not provide continuous support. Information and communication technology based training materials have been developed and disseminated to all Member States to help them manage efficiently their nuclear instrumentation.

26. INIS is actively contributing to the preservation of information, making use of the INIS Secretariat's capabilities to digitize printed or microfiched information and of the INIS Thesaurus for indexing information to be preserved. In 2005, over 1.5 million pages were digitized in close cooperation with the French, Mexican and Russian INIS centres as part of the INIS non-conventional literature (NCL) collection. In addition to the NCL collection, the INIS Secretariat is preserving selected sets of information, including Agency policy level documents, safety related and technical documents and historical Agency documents, which are digitized, archived and made electronically accessible to users.

27. The Agency is also exploring and assessing options for coordinated implementation and synergies between subprogrammes C.4, International Nuclear Information System, and C.5, Library and Information Support, recognizing that the IAEA Library constitutes an important mechanism for

preserving and sharing knowledge and that these synergies could also be used for the Agency's nuclear knowledge preservation activities. This knowledge can also be delivered to Member States through the International Nuclear Library Network (INLN), which is at present made up of the IAEA Library and four other nuclear libraries in Member States.

F. Knowledge management for nuclear verification

28. The training of Member State personnel remains an important dimension of knowledge management, and the training curriculum continues to evolve, with increasing emphasis on strengthening safeguards. The nature and purpose of nuclear verification are such that knowledge management activities in this area are geared mainly to internal needs; at the Agency, knowledge management in the area of nuclear verification is being implemented through the Department of Safeguards' quality management system. Experiences from this implementation will be passed on to Member State personnel through training on pertinent and topical safeguards issues, thereby contributing towards capacity y building for the future.