

Nuclear Science

Objective

To increase Member State capabilities in the development and application of nuclear science as a tool for their economic development.

Atomic and Nuclear Data

The Agency continues to play an important role in coordinating the generation, validation and compilation of atomic and nuclear data, while also facilitating easy, reliable access to a vast range of these well defined data for various applications. The Agency developed a new system in a collaborative effort with the US National Nuclear Data Center in Brookhaven, New York, which is better suited for the establishment of local data centres including in regions where Internet connections may be slow. A local 'model' data centre of this kind became operational in November 2004 at the Bhabha Atomic Research Centre in Mumbai, India.

Collaboration with the Los Alamos National Laboratory (LANL) has produced an interface for running several computer codes for the calculation of atomic structure, electron impact excitation and ionization processes. The interface has been installed on a server at LANL and is now available to the public, resulting in the ability to access on-line atomic and molecular (A+M) data rapidly for a number of processes important in fusion energy research. A similar interface has also been developed for heavy particle collisions. Extensive new data sets have been added to the A+M electronic database, including data for charge exchange and for molecular processes.

As shown in Table 1, Member State use of the Agency's nuclear data services through the Internet, on CD-ROM and paper continued to increase in

2004. Figure 1 provides a detailed breakdown of Internet access to Agency nuclear data files. Agency training activities also proved popular, particularly the regular biennial workshop on 'Nuclear Data for Nuclear Reactors – Physics, Design and Safety' at the International Centre for Theoretical Physics in Trieste, Italy.

Research Reactors

To date, some 672 research reactors have been built, and of these 274 reactors in 56 countries continue to operate. In 2004, the Agency continued to provide support to the Reduced Enrichment for Research and Test Reactors (RERTR) programme, which has the mission of developing substitute fuel of higher density LEU. Specifically, fresh fuel was shipped to the Russian Federation from the Czech Republic, Libyan Arab Jamahiriya and Uzbekistan.

A draft technical document on the state of the art in the development and qualification of high density uranium–molybdenum fuels is under review prior to publication. This document will be included as an annex to the Agency's Core Conversion Guidebook. Qualification of uranium–molybdenum fuels is of crucial importance in the conversion of HEU fuels to LEU fuels. The Agency continues to be active in this area, and will participate as an observer in an international working group (under the RERTR programme) attempting to find remedies for fuel failures detected during high temperature irradiation.

Agency contributions to the assessment of stored spent fuel and its repatriation have taken various forms, such as a fact-finding mission to Belarus; convening of a training course in Indonesia; preparation of guidelines in Russian and English for fuels of Russian origin; and development of

Table 1. Requests for Agency Nuclear Data Services, 2001–2004

User requests	2001	2002	2003	2004
Internet retrievals from the main Agency nuclear databases	12894	20773	29875	22196
Access through the Internet to other Agency files and information	16153	18135	23146	33558
Information on CD-ROMs	883	1108	852	1489
Off-line retrievals	2528	2543	2420	2765

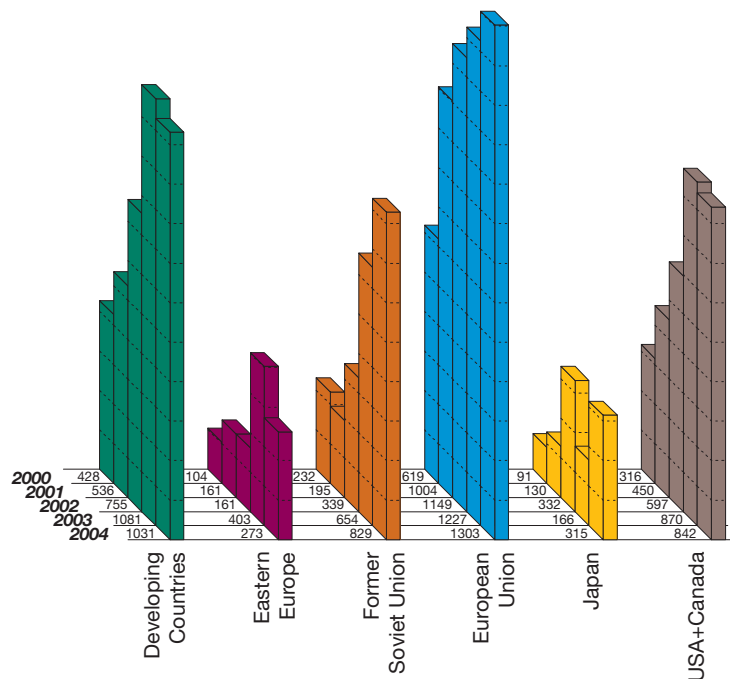


FIG. 1. Number of Internet accesses and retrievals of Agency nuclear data files, by region (average per month).

national and regional projects through the technical cooperation programme. In addition, the Agency assisted in the procurement of lower enriched fuel for the Maria research reactor in Poland and is assisting in the procurement of LEU for the TRIGA reactor in Romania.

A meeting on the RERTR was organized by the Agency, in cooperation with Argonne National Laboratory which manages the RERTR programme. The meeting recommended that the development and qualification of high density LEU fuels be pursued. On a related subject, another meeting was held during the RERTR conference to review the status of development of LEU targets for fission molybdenum-99 production. This is an important raw material radioisotope for nuclear medicine applications involving the technetium-99m radiotracer. This led to the formulation of a new CRP to foster further development of LEU targets for molybdenum-99 production.

The role of research reactors is gradually changing from the support of fundamental research and training to helping facilities formulate strategic plans for the development and use of new applications and techniques. A series of meetings were held during the year to review progress and assist in planning for the next phase of activities, and also to formulate a methodology to assess the utilization of research reactors, review the problems faced and suggest possible ways to resolve them.

Utilization of Accelerators

The first Research Coordination Meeting for a new CRP on the ion beam modification of insulators was held in Vienna. This subject is attracting significant interest around the world as a means of modifying surface properties and in the fabrication of new advanced materials. It also has applications in advanced electronic devices for high speed and power application and in radiation detection.

Large accelerator driven neutron sources (ADNSs) are based on high energy particle accelerators operating at energies over 1 GeV. These sources have advantages over conventional neutron sources because they use the highly efficient spallation process, which overcomes many limitations associated with steady state reactor neutron sources. In this connection, the Agency held a meeting to identify different possibilities that could promote the construction of small and medium scale ADNSs suitable for placement in developing countries. A report was drafted which outlined the advantages of these types of sources as a complement to existing conventional sources and large (>1 GeV) neutron spallation sources.

The development of an international data format standard for the exchange of ion beam spectral information was initiated as part of an intercomparison and validation exercise for accelerator based, nuclear analytical software. As part

of this exercise, an expert task force was established to generate challenging simulation exercises on the interaction of ion beams with matter, and critically evaluate and compare the outputs with the best available experimental data and between different nuclear models and computational strategies. The objective is to understand the advantages and deficiencies in the underlying science, and to develop new knowledge to drive improvements.

A CRP on the development of new techniques and applications of accelerator mass spectrometry (AMS) was initiated. This CRP will gather data and focus on those knowledge areas that underpin the development of new and improved AMS technologies, especially for the non-radiocarbon radionuclides. A broad spectrum of activities has been initiated that will strengthen the capacity of Member States to build and sustain their nuclear knowledge and expertise.

The Agency published a technical document on the results of a CRP to promote the potential of accelerator based nuclear techniques for the analysis of light elements in thin films. The CRP succeeded in:

- Developing a coordinated research effort between accelerator laboratories and materials science research groups to support and promote the development of quality assurance methods;
- Evaluating databases of the parameters needed for quantitative analysis;
- Developing and applying techniques for selected problems concerning the surface modification of materials and the production of thin films.

Nuclear Instrumentation

Training activities on the maintenance of nuclear instrumentation included:

- Introduction of ICT based training modules, which have replaced several introductory lectures;
- Distribution of more than 150 training modules;
- Creation of a new web site for the international groups working on X ray fluorescence (<http://www.iaea.org/OurWork/ST/NA/NAAL/pci/ins/xrf/pciXRFcurr.php>).

Nuclear Fusion Research

Programmes to harness the potential of controlled nuclear fusion power are being pursued in about 50 countries, as shown in the newly updated version



FIG. 2. Inside view of the Japanese stellarator LHD vacuum chamber — a toroidal nuclear fusion confinement concept — showing the covered helical winding of the coil system. The fusion plasma is confined by the coils inside the vacuum chamber.

of the world survey on controlled nuclear fusion (Fig. 2). The progress in magnetic confinement research is reflected in the design features of the 500 MW International Thermonuclear Experimental Reactor (ITER). One major breakthrough of the ITER meetings was the agreement on the financial plan for construction, operation and decommissioning. The negotiations on choosing a site for ITER continue.

A Technical Meeting, which was combined with the final Research Coordination Meeting on the 'Physics and Technology of Inertial Fusion Energy Targets, Chambers and Drivers', outlined the potential of laser or particle driven fusion approaches. This is in line with the Agency's mandate to foster the exchange of scientific and technical information on the peaceful uses of atomic energy. The biennial fusion energy conferences, which first began in 1961, are another example of the Agency's efforts to enlarge the contribution of nuclear technology for human welfare. The conference in 2004, held in Vilamoura, Portugal, highlighted the progress in magnetic confinement research made during the past two years, especially in the divertor tokamaks, which were used to carry out ITER baseline scenario experiments. Long pulse scenario with high performance has been demonstrated.

A new CRP on 'Joint Research using Small Tokamaks' was initiated in 2004 with the objective of making better use of existing infrastructure, and to support small tokamak projects that can be more easily integrated into national and international fusion activities. ■