Nuclear Science

Nuclear Science Committee (NSC)

The aim of the NEA nuclear science programme is to help member countries identify, pool, develop and disseminate basic scientific and technical knowledge used to ensure safe and reliable operation of current nuclear systems, as well as to develop next-generation technologies. The main areas covered are reactor physics, fuel behaviour, fuel cycle physics and chemistry, criticality safety and radiation shielding.

Highlights

- A report was published on the technical feasibility of extending the average fuel discharge burn-up in current light water reactors (LWRs).
- A report assessing the possibility of burning weapons-grade plutonium in the form of mixed-oxide (MOX) fuel in Russian-designed VVER-1000 reactors was issued.
- The 8th Workshop on Shielding Aspects of Accelerators, Targets and Irradiation Facilities (SATIF-8) was held in May in the Republic of Korea.
- The 9th Information Exchange Meeting on Actinide and Fission Product Partitioning & Transmutation was held in September in France.

The principal areas covered by the NEA nuclear science programme are reactor physics, fuel cycle physics and chemistry, criticality safety and radiation shielding. A large part of the work is based on international benchmark exercises, employed to validate models and data used in member countries for predicting the behaviour and performance of different nuclear systems. In addition, the nuclear science programme sponsors specialist meetings and workshops, as well as the preparation of state-of-the-art reports as necessary.

Reactor physics

Activities related to current reactor systems comprise studies of nuclear reactor stability and transient issues, as well as the possibility to burn weapons-grade plutonium in existing light water reactors. The work on reactor stability includes, among others, a benchmark on coupled neutronics and thermal-hydraulics transients in a pebble bed modular reactor (PBMR) and a benchmark on the detailed void distribution inside a boiling water reactor (BWR) fuel bundle, based on experimental data provided by NUPEC, Japan. A number of benchmarks concerning physics and fuel behaviour are being conducted to validate the modelling tools used in simulating the use of weapons-grade plutonium, in the form of mixed-oxide fuel, in current light water reactors.

In the area of advanced reactors, the emphasis has recently been on high-temperature reactors (HTRs). A benchmark designed to investigate the use of plutonium and thorium fuels in HTR systems was completed and the results will be published in early 2007. Another benchmark, based on experimental data from the Swiss PROTEUS research reactor, is being devoted to a study of low-enriched uranium HTR configurations, with the objective of reducing the design and licensing uncertainties for small and medium-sized, helium-cooled reactors using low enriched uranium and graphite high-temperature fuel.

Work was also recently started to review the current status and needs of sensitivity and uncertainty analysis in modelling exercises, with special emphasis on multi-physics and multi-scale simulations.

PSI, Switzerland

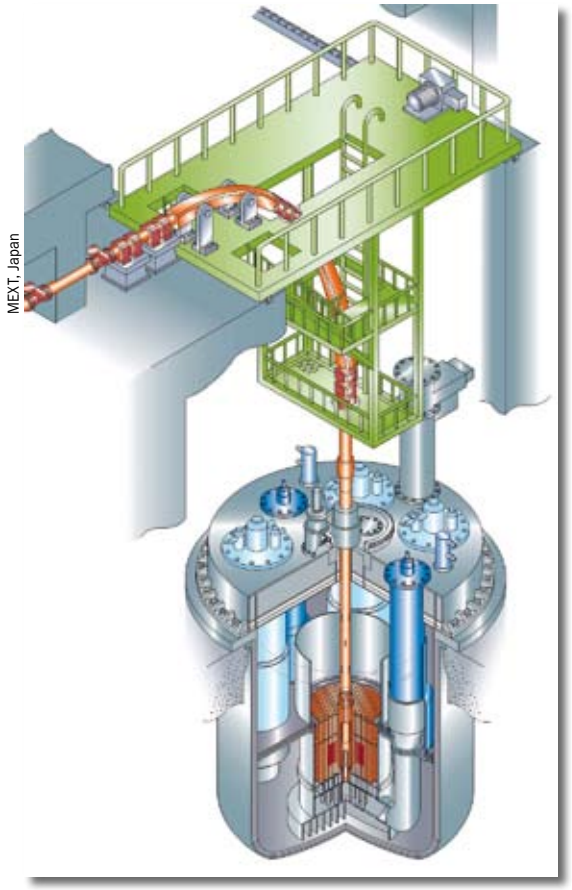
The PROTEUS research reactor
at the Paul Scherrer Institute, Switzerland.

Fuel cycle physics and chemistry

A report assessing the scientific and technological limits to very high burn-up fuel cycles (up to 100 GWd/t) in current light water reactors (LWRs) was published during the year. The study reviews the repercussions for the fuel cycle, for reactor operation and safety, as well as for fuel cycle economics, and provides recommendations regarding scientific and technological areas in which further development would be required to achieve these very high burn-ups.

An expert group on chemical partitioning is finalising a status report describing the aqueous and pyrochemical processes being used or developed for the reprocessing of irradiated fuel in different countries. This group is also reviewing fuel separation criteria influencing future nuclear waste repositories and a methodology for evaluating the impact of existing repository projects on current and advanced fuel cycle scenarios.

The 9th Information Exchange Meeting on Actinide and Fission Product Partitioning & Transmutation (P&T) was



Development of an accelerator-driven nuclear transmutation system in Japan.

organised on 25-29 September 2006 in Nîmes, France. The meeting was attended by 170 scientists who reviewed progress in national and international programmes as well as in different areas of P&T, such as fuels and targets, chemical partitioning and waste forms, spallation targets, dedicated transmutation systems, coolants, physics and nuclear data.

A study of the technical information needed to fully understand the transition from current nuclear fuel cycles to long-term sustainable fuel cycles has been undertaken. An overview report is being finalised and two specific scenario benchmarks are being conducted: one benchmark to compare three different transition scenarios (once-through, limited plutonium recycling in LWRs, and plutonium and minor actinide recycling in fast reactors), and another benchmark to study a theoretical regional European approach involving a sharing of facilities and fuel inventories to optimise the use of resources.

Nuclear criticality safety

A report assessing the ability of computer codes to handle slow convergence in calculating problems relevant to a fission source was issued. Four different test problems, which could be used to develop test cases for criticality safety codes, were investigated. It was concluded that although advanced source convergence methods are normally worth using in difficult problems, there are presently no substitutes for a sound understanding of the physics of the individual system and a carefully applied, appropriate computational technique.

A workshop on the Need for Post-irradiation Experiments to Validate Fuel Depletion Calculation Methodologies was held on 11-12 May 2006 in Řež, Czech Republic to review the need for and availability of fuel post-irradiation experiment (PIE) data, especially for VVER reactors. It was concluded that the status of PIE data for all light water reactors needs to be further investigated and that all available data should be entered into the NEA Spent Fuel Isotopic Composition Database (SFCOMPO). The NEA has established the Expert Group on Assay Data of Spent Nuclear Fuel to co-ordinate this activity.

Radiation shielding and reactor dosimetry

The 8th Workshop on Shielding Aspects of Accelerators, Targets and Irradiation Facilities (SATIF-8) was held on 22-24 May 2006 in Pohang, Republic of Korea. The workshop participants reviewed progress in areas such as dosimetry, shielding of high-energy accelerators, induced radioactivity, status of computer codes, and shielding data libraries and shielding in medical and industrial accelerator applications. The proceedings will be published in early 2007.

Work is also currently under way on the preparation of a handbook which will contain benchmarks related to neutron slowing and neutron transport theory.

R&D facilities in nuclear science

In follow-up to the report on *Research and Development Needs for Current and Future Nuclear Energy Systems*, an expert group has been established to review the needs of research and test facilities in nuclear science. A database containing information on more than 700 facilities is being established, and a status report identifying future needs of nuclear science research facilities is being drafted.

Knowledge preservation

The NEA science programme is, in close collaboration with the Data Bank, pursuing the preservation of information from important and well-documented experiments in many application areas. Databases have been established in the areas of reactor physics (IRPhE), fuel behaviour (IFPE) and radiation shielding (SINBAD). The NEA is also co-ordinating the compilation of data into the International Handbook of Evaluated Criticality Safety Benchmark Experiments (ICSBEP). The data are made available to the nuclear community in a comprehensive and structured format for use in computer model and benchmark validation exercises. In addition, the NEA science programme is contributing to the Agency's pilot project on boron dilution (see page 14).

Contact: Claes Nordborg
Head, Nuclear Science Section
+33 (0)1 45 24 10 90
claes.nordborg@oecd.org