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 on *Nuclear Fuel Cycle Transition Scenario Studies* was completed for publication.
- The 4th NEA workshop on Advanced Reactors with Innovative Fuels (ARWIF-2008) was held in Tsuruga and in Fukui, Japan on 20-22 February.
- The 10th NEA Information Exchange Meeting on Actinide and Fission Product Partitioning & Transmutation was held in Mito, Japan on 6-10 October.
- A report on a benchmark study on the impact of PWR axial burn-up asymmetry on fuel assemblies was issued.

The NEA nuclear science programme is to a large extent devoted to international comparison exercises or benchmark studies to validate computational methods and data used to predict the behaviour and performance of different nuclear systems. In addition, the nuclear science programme sponsors expert meetings and workshops and co-ordinates the preparation of state-of-the-art reports as necessary.

Fuel cycle physics and chemistry

A report on *Nuclear Fuel Cycle Transition Scenario Studies*, including country-dependant scenarios and key technologies to be identified to implement future scenarios, was completed and sent to print at the end of 2008. The associated benchmark studies of scenario codes and of a European and a global fuel cycle transition scenario continue.

A new activity devoted to progress in separation chemistry, including minor actinide separation and future R&D perspectives, was started in 2008. The main objective of this work is to assess technical maturity and needs for separation processes according to three recycling methods: aqueous, pyro and fluoride. It is also envisaged to evaluate separation requirements in different fuel cycle scenarios and to suggest possible future steps.

New activities on scientific and technical issues associated with the development of innovative fuels and structural materials have also been started, as well as studies on homogeneous versus heterogeneous recycling of transuranics in fast reactors, and the potential benefits of advanced fuel cycles using partitioning and transmutation.

CEA, France

View of the Atalante CBP hot cell.

Reactor physics

A study of coupled neutronics/thermal-hydraulics transients in a pebble bed modular reactor (PBMR) has been completed and will be published in 2009. A new benchmark, based on experimental data from the Russian VVER-1000 Kalinin-3 reactor, was started in 2008 in support of advanced simulation of coupled neutronics/thermal-hydraulics.

A benchmark based on PWR sub-channel and bundle tests performed by the Nuclear Power Engineering Corporation (NUPEC) of Japan has started. The benchmark will be devoted to simulations of PWR thermal-hydraulic conditions, including steady states and transients, such as power increase, flow reduction, depressurisation and temperature increase. It follows on from a similar, recently completed benchmark based on BWR fine-mesh full-bundle tests, also performed by NUPEC.

The reactor physics programme comprises a number of studies related to the use of mixed-oxide (MOX) fuel in reactors including, for example, results from fuel performance benchmark studies based on experimental data from the OECD Halden Reactor Project and the PRIMO programme at the SCK•CEN BR3 reactor. The results were presented at the Physor-2008 conference.

The preparatory work for the publication of a state-of-the-art report on minor actinide burning in thermal reactors was started, with plans to complete the report in 2009.

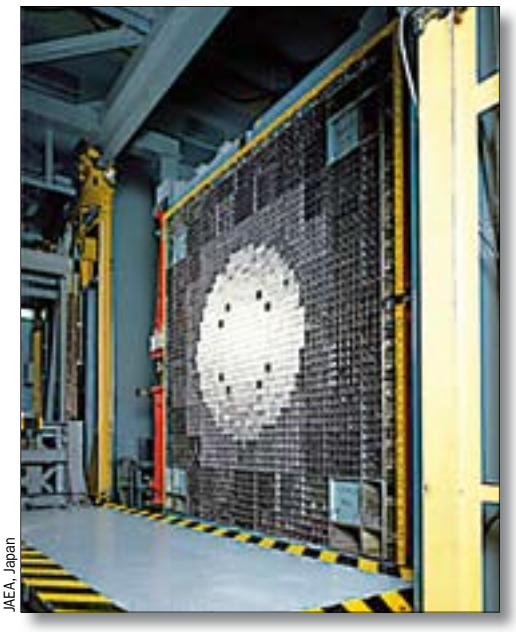
Material science

The content and organisation of NEA work in the area of material science was further defined in 2008. It was decided to address two issues: to revisit the displacement per atom (DPA) radiation damage definition and to review benchmark methods used by comparing the outcome of various codes with experimental results.

In addition, the programme will include the assessment of the possibilities and limits of numerical methods applied to multiscale modelling of materials for nuclear energy, and the means to link the different scales. A critical review will also be carried out on development and potential bottle-necks in the fields of fuels and structural materials.

Nuclear criticality safety

A state-of-the-art-report on assay data for spent nuclear fuel is under development. Special emphasis will be given to the development and validation of methods to estimate the uncertainties caused by the lack of experimental data. The related NEA database for spent nuclear fuel, SFCOMPO, has been updated with new data from Japan, Spain, Sweden, the United Kingdom and the United States. Data from VVER reactors will be collected and entered in the database.



JAEA, Japan

JAEA Fast Critical Assembly (FCA)
for mock-up reactor core experiments.

A study of uncertainty analyses for criticality safety assessment has been undertaken. The aim is to validate criticality analysis codes and to provide recommendations on the use and development of robust methodologies to determine biases and uncertainties when using these codes.

The September 2008 issue of the *International Criticality Safety Benchmark Evaluation Project* (ICSBEP) handbook contained evaluations of 485 experimental series, representing 4 207 critical or sub-critical experiments and 24 criticality-alarm/shielding configurations. It also includes four fundamental physics measurement evaluations relevant to criticality safety applications.

Radiation shielding and reactor dosimetry

The final meeting of the scientists involved in the benchmark exercise on the accuracy of solutions of 3-dimensional transport codes and methods over a wide range of parameters was held in September 2008 in connection with the Physor-2008 conference. The results will be summarised in a report to be published in 2009. A special issue of *Progress in Nuclear Energy* will cover the different solutions and compare the methods in greater detail.

The drafting of a handbook on accelerator shielding was started with the goal of having it published in the course of 2010.

R&D facilities in nuclear science

The study on needs for research and test facilities in the area of nuclear science was completed and the report was sent to print at the end of 2008. A database, containing information about existing R&D facilities, was also developed in addition to the report. The database, which was partly released to the public in the beginning of 2008 on the NEA website (www.nea.fr/rtfdb/), contains information on approximately 775 scientific research facilities.

Knowledge preservation

The NEA science programme also comprises the preservation of information from important and well-documented experiments in selected nuclear application areas. The activity is performed in close collaboration with the NEA Data Bank. Data from integral experiments have been collected in the areas of reactor physics (IRPhE), fuel behaviour (IFPE), radiation shielding (SINBAD) and criticality safety (ICSBEP). All the collected data are made available through the NEA Data Bank to the nuclear community in a comprehensive and structured format for use in benchmark validation exercises.

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