

# 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 comprehensive *Handbook on Lead and Lead-bismuth Eutectic Technologies* was published.
- The results of two scientific studies relevant to the physics of plutonium recycling were issued.
- The International Conference on Nuclear Data for Science and Technology (ND2007) was held in France in April.
- The International Conference on Nuclear Criticality Safety (ICNC'07) was organised on 28 May-1 June in Russia.

Material science was introduced as a new activity in the NEA nuclear science programme in 2007 in addition to the habitual activities which comprise reactor physics, fuel cycle physics and chemistry, criticality safety and radiation shielding. The detailed work programme of this new activity will be further developed in 2008.

### Fuel cycle physics and chemistry



A comprehensive *Handbook on Lead and Lead-bismuth Technologies*, including for example materials compatibility and thermal-hydraulics, has been published. The handbook contains some 700 pages of reference materials for these heavy liquid metals. In addition,

a specific benchmark exercise has been launched on a thermal-hydraulic loop for lead-alloy-cooled advanced nuclear systems.

The Expert Group on Chemical Partitioning is writing a report on national programmes in partitioning and is also studying different aqueous and pyrochemical fuel cycle flowsheets, including the calculation of waste products generated within each individual flowsheet. Recently, the group also launched an activity on curium separation and management. This activity will cover available strategies (transmutation or interim storage), separation methods, storage and disposal requirements, and handling experiences.

A state-of-the-art report on fuel cycle transition scenarios, including issues on country-dependent scenarios and key technologies for implementing future scenarios, has been completed. As a complement to this report, the expert group is also pursuing two benchmark exercises, one to compare the performance of different scenario codes and one to study a regional European transition scenario. It is also planned to initiate a global transition scenario study.

### Reactor physics

The results of two benchmark studies relevant to the physics of plutonium recycling were issued in 2007. One of the studies concerned a pebble bed modular reactor (PBMR) fuelled with reactor-grade plutonium, whereas the second study involved an evaluation and analysis of reactor period measurements carried out in the CROCUS reactor in Switzerland for different delayed super-critical conditions.

A number of reactor physics benchmarks involving mixed-oxide (MOX) fuels are being conducted. A report containing the results from a MOX fuel modelling code benchmark exercise, using irradiated fuel rod data from the OECD/NEA Halden Reactor Project in Norway, was published in 2007. In addition, three MOX benchmarks,



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At the Halden reactor in Norway.

based on experimental data from the VENUS reactor in Belgium, are under way.

The NEA nuclear science programme also comprises a series of benchmark exercises related to transients in different reactor types with special focus on coupled neutronics and thermal-hydraulics. The series covers BWR fuel bundle tests, based on unique experimental data from Japan, VVER-1000 coolant transient benchmarks and a PBMR-400 coupled neutronics/thermal-hydraulics transient study.

Considering the importance of a correct treatment of model and data uncertainties in the analysis of different reactor parameters, an expert group was established to develop best-estimate simulation methods with systematic uncertainty analysis across different phenomena (multi-physics) and different scales.

An Expert Group on Minor Actinide Burning in Thermal Reactors was established and will hold its first meeting in early 2008.

## Nuclear criticality safety

A new edition of the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* was issued in September. The new edition contains 491 evaluations describing about 4 500 critical, near-critical or sub-critical configurations, as well as five criticality alarm placement/shielding evaluations and three fundamental physics measurements relevant to criticality safety applications.

A new Expert Group on Uncertainty Analysis for Criticality Safety Assessment has been established. The group will formalise a procedure for the validation of codes used in criticality computation with one of the goals being, for example, to investigate the potential reduction in costs related to the redundant safety margins employed in the handling of fissile materials.

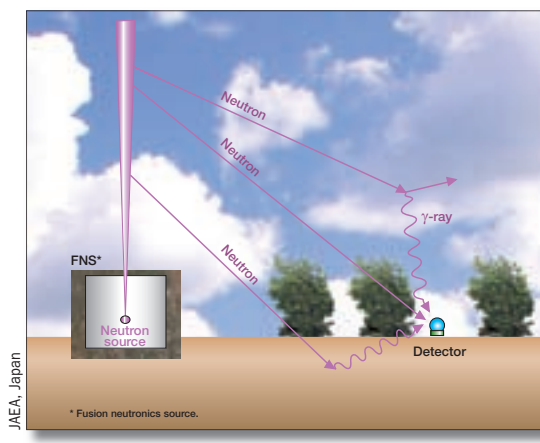
An activity has been started to systematically obtain and document new isotopic composition data from post-irradiation experiments. The data will be stored in the NEA Spent Fuel Isotopic Composition Database (SFCOMPO).

The Expert Group on Burn-up Credit has launched an exercise to study the performance of the depletion calculations codes for long-term geological disposal applications. The study will be undertaken in close co-ordination with the NEA radioactive waste management programme.

## Radiation shielding and reactor dosimetry

A computational radiation transport benchmark exercise is under way. The benchmark is designed to elucidate important issues necessary to judge the quality of numerical solutions obtained with particle transport software. The results from deterministic solutions will be compared to a reference solution based on Monte Carlo calculations.

A study of radiation skyshine effects, based on experimental data from a reactor in Kazakhstan, is also being conducted as part of the NEA radiation shielding programme.



Schematic diagram of a skyshine experiment.

## R&D facilities in nuclear science

A review of the needs for research and test facilities in the area of nuclear science is being undertaken. The outputs of this activity will be a status report and a database containing information about existing R&D facilities. The database, which will be publicly released in the beginning of 2008 on the NEA website, contains information on over 750 scientific research facilities. The report will be published later in 2008.

## 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 nuclear application areas. Data from integral experiments have been collected in the areas of reactor physics (IRPhE), fuel behaviour (IFPE) and radiation shielding (SINBAD). The NEA is also co-operating with the US Department of Energy in the compilation of data for the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* (ICSBEP). All the collected data are made available through the Data Bank to the nuclear community in a comprehensive and structured format for use in computer model and benchmark validation exercises.

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