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 workshop on Advanced Reactors with Innovative Fuels (ARWIF-2005) was organised in Oak Ridge, Tennessee, USA on 16-18 February 2005.
- The Third Information Exchange Meeting on Nuclear Production of Hydrogen was held on 5-7 October 2005 in Oarai, Japan.
- A report on an evaluation of proposed integral critical experiments with low-moderated mixed-oxide (MOX) fuel was issued in June 2005.
- Two status reports dealing with the transmutation of nuclear waste were issued in the autumn of 2005: one on fuels and materials, and one on accelerator and spallation target technologies for accelerator-driven system (ADS) applications.

The principal areas covered by the NEA nuclear science programme are reactor physics, fuel cycle physics and chemistry, criticality safety and radiation shielding. The main objective of the programme is to validate the models and data used in member countries for predicting the behaviour and performance of different nuclear systems by comparing calculated and experimental results in international benchmark exercises. In addition, the nuclear science programme sponsors specialist meetings and workshops and the production of state-of-the-art reports as necessary.

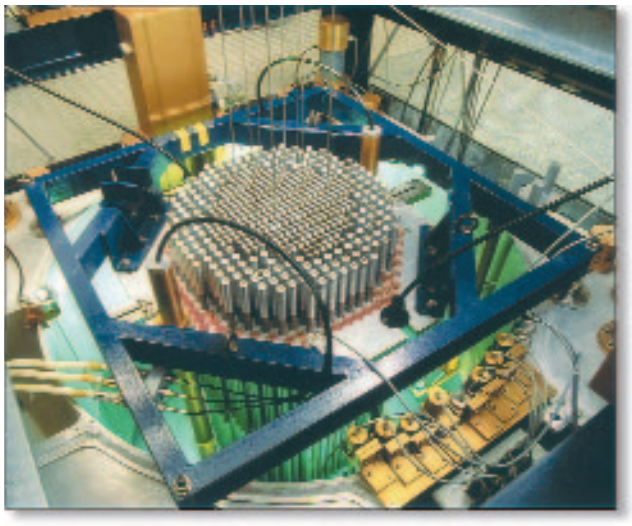
Reactor physics and fuel behaviour

The NEA reactor physics programme covers both current and advanced reactor systems. Activities related to current reactor systems include a benchmark on control rod ejection in a pressurised water reactor (PWR) loaded with mixed-oxide (MOX) fuel, and a study of kinetic parameters and reactivity effects based on experimental data from the CROCUS zero-power research reactor in Switzerland. The use of MOX fuels with weapon-grade plutonium in current reactors is being studied in a reactor physics benchmark exercise based on data from the VENUS critical facility in Belgium. The behaviour of this fuel type is also being investigated in two benchmarks: one on a comparison of hollow and solid MOX pellets, based on experimental data from the Halden reactor in Norway, and another based on a ramped MOX fuel rod from the PRIMO (PWR Reference Irradiation of MOX Fuels) measurement campaign by *Belgonucléaire* and SCK•CEN in Belgium.

Specific efforts are also being devoted to the study of coupled light water reactor (LWR) transients and core-plant interactions. Three benchmarks are currently in progress in this field: one on a boiling water reactor (BWR) turbine trip transient, one on a VVER-1000 coolant transient, and another devoted to a BWR full-size bundle test, based on experimental data from Japan.

Among the activities dedicated to advanced reactor systems are a benchmark on a high-temperature reactor (HTR) fuelled with reactor-grade plutonium, and a study of a coupled neutronics/thermal-hydaulics transient in a pebble bed modular reactor (PBMR).

View of the CROCUS zero-power research reactor in Switzerland.



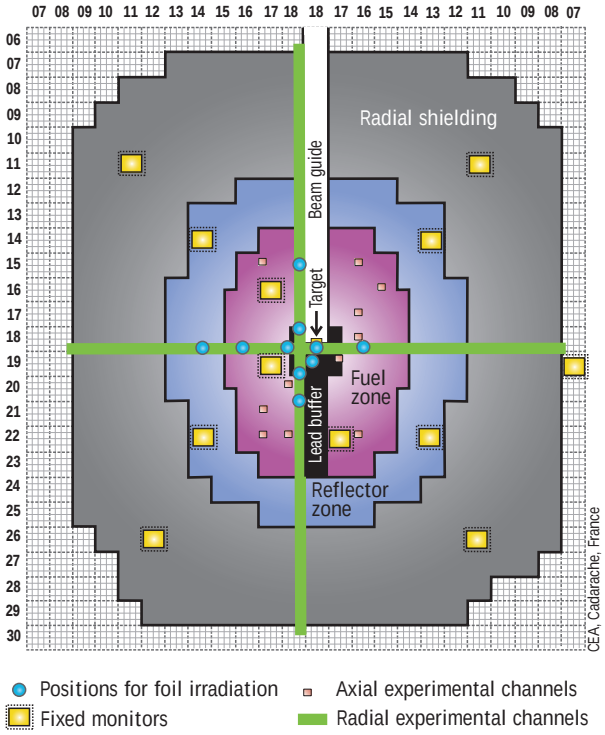
École polytechnique fédérale de Lausanne, Switzerland

Fuel cycle physics and chemistry

The nuclear science programme also covers areas of more direct bearing on strategic issues, including a study of the technical information needed to fully apprehend the transition from current fuel cycles to long-term sustainable fuel cycles, and a study on fuel separation criteria to optimise the use of future nuclear waste repositories and to establish a methodology for evaluating the impact of existing repository projects on various current and advanced fuel cycle scenarios.

Reports from the recently reorganised Working Party on Partitioning and Transmutation have been published or are being finalised. These reports cover national programmes in partitioning, fuels and materials for transmutation, and accelerator and spallation target technologies for ADS applications. A report on a benchmark study of a fast, sub-critical core linked to an external neutron source – the MUSE *(Multiplication avec source externe)* experiment at Cadarache, France – is planned to be published in early 2007, as will a handbook on lead-bismuth eutectic technology.

Core loading of the MUSE 4 configuration.



Nuclear criticality safety

The fabrication of MOX fuel has been identified as an area in which there are specific needs for additional integral benchmark data. An expert group has reviewed the situation and published a report documenting the evaluation of different experimental proposals and providing recommendations on which experimental programme(s) should be pursued.

In addition, the nuclear criticality programme covers studies of minimum critical reference values for uranium and plutonium, as well as benchmark reports related to the reduction in reactivity of burned nuclear fuel due to the change in composition during irradiation (burn-up credit); criticality accident analyses; and convergence problems in the calculation of the source term for spent fuel casks, spent fuel storage pools and fuel processing systems.

Radiation shielding and reactor dosimetry

A benchmark exercise has been launched to study the spatial energy distributions of neutrons and photons scattered in the air (skyshine) near a reactor. The benchmark is based on data from an experiment carried out in the Kazakhstan steppe using two research reactors near Semipalatinsk.

In the area of dosimetry, the NEA has launched a benchmark based on reaction rate and fission chamber data measured in the VENUS-2 reactor at Mol, Belgium. The NEA has also actively contributed to the definition and selection of computational problems to be addressed within the framework of the EC-sponsored CONRAD activity, devoted to studying the use of complex computer codes in dosimetry calculations and to assessing uncertainties associated with the numerical results.

R&D facilities in nuclear science

An expert group has been established to review the needs of research and test facilities in nuclear science. The study is a follow-up to the report on *Research and Development Needs for Current and Future Nuclear Energy Systems* published in 2003.

The expert group will seek to anticipate future needs by reviewing and exchanging information on the status of integral data and the availability of research and test facilities for future R&D in the field of nuclear science. The final products of this study will be a database on existing facilities and a status report identifying future needs of nuclear science research facilities. The group will also make recommendations concerning international collaboration.

Knowledge preservation

The importance of preserving information and data from well-documented experiments and making them available to the nuclear community in a comprehensive and structured format for use in computer model validation exercises is recognised in all NEA member countries. The NEA nuclear science programme is well-advanced in this sense and has established databases in the areas of reactor physics (IRPhE), fuel behaviour (IFPE) and radiation shielding (SINBAD). The NEA is also co-ordinating the effort to compile data into the International Handbook of Evaluated Criticality Safety Benchmark Experiments (ICSBEP).

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