

Nuclear Science

Nuclear Science Committee (NSC)

The NEA science programme contributes to the basic scientific and technical knowledge needed to maintain the safe, reliable and economic operation of current nuclear systems and the development of next generation technologies. Special emphasis is being placed on the validation of calculation methods used in light water reactor stability investigations, advanced reactor fuel performance and behaviour, and the preservation of information from integral experiments.

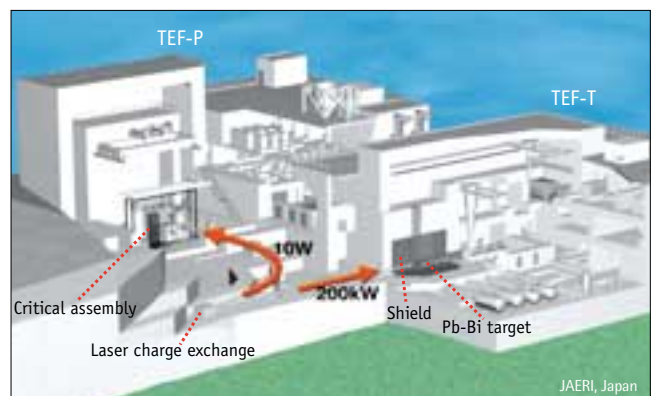
The NEA nuclear science programme is to a very large extent based on different benchmark studies, i.e. the comparison of results from international standard problem exercises. These benchmark studies are often based on well-documented integral experiments, of which a large number are collected, reviewed and safeguarded in a joint effort between the NEA Nuclear Science Division and the Data Bank. The main areas covered by the nuclear science programme are reactor physics, fuel behaviour, criticality safety and radiation shielding.

R&D needs in nuclear science

A workshop on scientific research and development needs for current and future nuclear systems was organised in Paris, France, on 6-8 November. Past and ongoing NEA scientific activities, as well as recent studies for future nuclear systems, including fourth generation reactors and accelerator-driven systems, were presented. The subject areas discussed during the workshop comprised nuclear data, reactor physics and system behaviour, fuels, materials, coolants and chemistry. The draft recommendations from the workshop were transmitted to the NEA Nuclear Science Committee for further discussion. The workshop proceedings and the final recommendations will be published in 2003.

Scientific issues in partitioning and transmutation

The Seventh Information Exchange Meeting on "Actinide and Fission Product Partitioning and Transmutation" (P&T) was organised in Jeju, Korea on 14-16 October. The main topics discussed were national and international P&T programmes, partitioning and waste forms, spallation targets and advanced coolants, and transmutation system design and safety. The meeting ended with a panel discussion on future P&T development. The proceedings will be issued in 2003. The Working Party on Scientific Issues in Partitioning and Transmutation (WPPT) also organised a workshop on the "Utilisation and Reliability of High Power Proton Accelerators" (HPPA) in Santa Fe, USA on 12-16 May. The proceedings will be issued in early 2003.



Conceptual view of the transmutation experimental facility, planned to be part of the Japanese proton accelerator research complex.

Two benchmark exercises related to nuclear waste transmutation systems are presently being conducted. One concerns a benchmark related to the effects of an accelerator beam interruption in a lead-bismuth-cooled, MOX-fuelled, accelerator-driven system (ADS). The other benchmark is devoted to the simulation of an experiment of a coupled accelerator-subcritical reactor system (MUSE-4), an experiment which will be performed at CEA Cadarache, France in 2003.

Reactor physics: reactor stability studies

A benchmark study of a pressurised water reactor (PWR) main steam line break was conducted based on reference design and data from Unit 1 of the Three Mile Island Nuclear Power Plant in the United States. The benchmark included a description of the event sequence with all activated system functions and typical plant conditions during the transient. The results of this study, using coupled 3-D neutronics/core thermal-hydraulics calculation methods, were published in November.

Two other reactor stability benchmarks are being conducted. One concerns the simulation of a turbine trip in a boiling water reactor

(BWR) based on experimental data from a BWR/4 in the United States. The results of this benchmark will be published in the first half of 2003. The other benchmark involves the study of a coolant transient in a Russian VVER-1000 reactor.

Fuel cycle physics

One of the main questions related to the recycling of plutonium as mixed-oxide (MOX) fuel in a pressurised water reactor (PWR) is the number of times the plutonium can effectively be recycled. This question was addressed in a report published in October entitled *Multiple Plutonium Recycling in Advanced PWRs*. The report describes an exercise that followed plutonium through five generations of recycling in a PWR. It considered both a standard PWR design and a highly moderated design. The study of these two designs in parallel has provided a better understanding of their different merits, as well as insight into the limitations of multiple recycling and the long-term toxicity of fission products and actinides.

The international agreement to dispose of weapons-grade plutonium led the NEA to launch a benchmark to study the possibility of burning such plutonium in the form of mixed-oxide (MOX) reactor fuel. This specific study concerned a Russian light water (VVER-1000) reactor. The report, published in 2002, contains results for low-enriched uranium (LEU) and MOX fuel, and contributes to the computer code certification process and to the verification of calculation methods used in the Russian Federation.

Nuclear criticality safety

The International Criticality Safety Benchmark Evaluation Project (ICSBE) issued a new version of the ICSBE handbook on CD-ROM in November. The new version contains 330 evaluations with benchmark specifications for 2 881 critical or near-critical configurations. An upgraded version of the DICE database, to facilitate the retrieval of data from ICSBE, was also included on the CD-ROM. This new version has enhanced capabilities, such as the plotting of detailed neutron spectra and reaction rates.

A database providing information on the isotopic composition of spent fuel from light water reactors, SFCOMPO, has been installed at the NEA and can be accessed directly online through the NEA Internet pages. The database will be further developed to allow more refined retrievals to be performed.

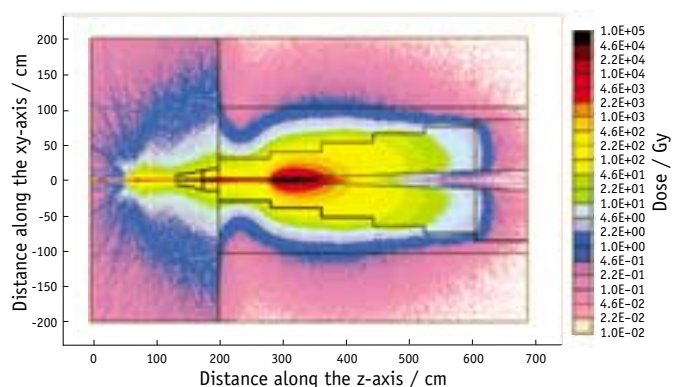
Radiation shielding

The sixth workshop on "Shielding of Accelerators, Targets and Irradiation Facilities" (SATIF-6) was hosted by the Stanford Linear Accelerator Center, Menlo Park, USA, on 10-12 April. The workshop reviewed recent progress in radiation shielding of accelerator facilities and the status of computer codes, cross-sections and shielding data libraries. A discussion was also held on further developments needed with respect to international co-operation in this field. The proceedings will be published in early 2003.

- A workshop was held to discuss research and development needs for current and future nuclear systems, specifically in the area of nuclear science.
- A workshop on actinide and fission product partitioning and transmutation was organised in close collaboration with the NEA Nuclear Development Division.
- A study on *Multiple Plutonium Recycling in Advanced PWRs* was published.
- A report was released on the modelling of the effects of a main steam line break in a pressurised water reactor (PWR).

A benchmark on deterministic 2-D/3-D MOX fuel assembly calculations, without spatial homogenisation, was conducted. Calculated solutions for the two- and three-dimensional configurations were collected and analysed. The results of the exercise will be published in early 2003.

Calculation of the radiation dose close to the target area of the NA60 experiment at CERN, to determine the optimum placement of electronic equipment. (Results presented at the SATIF-6 meeting.)



The SINBAD database containing data from radiation shielding experiments have been updated and new versions were issued on CD-ROM by the Data Bank in March and October.



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