

# New publications

## General information

### 2005 Annual Report

ISBN 92-64-01089-0

Free: paper or web.



## Economic and technical aspects of the nuclear fuel cycle

### Advanced Nuclear Fuel Cycles and Radioactive Waste Management

ISBN 92-64-02485-9

€ 50, \$ 67, £ 36, ¥ 6 900.

This study analyses a range of advanced nuclear fuel cycle options from the perspective of their effect on radioactive waste management policies. It presents various fuel cycle options which illustrate differences between alternative technologies, but does not purport to cover all foreseeable future fuel cycles. The analysis extends the work carried out in previous studies, assesses the fuel cycles, and covers high-level waste repository performance for the different fuel cycles considered.

The estimates of quantities and types of waste arising from advanced fuel cycles are based on best available data and experts' judgement. The effects of various advanced fuel cycles on the management of radioactive waste are assessed relative to current technologies and options, using tools such as repository performance analysis and cost studies.

### French R&D on the Partitioning and Transmutation of Long-lived Radionuclides

#### An International Peer Review of the 2005 CEA Report

ISBN 92-64-02296-1

Free: paper or web.

For many politicians and members of the public, the very long life of some of the radionuclides in radioactive

waste is an issue of particular importance in terms of its ultimate disposal. The developing techniques of partitioning (isolating specific radioactive elements) and transmutation (re-irradiating them in order to convert them to shorter-lived or stable elements) hold the promise of eliminating or greatly reducing the long-lived radioactivity, bringing with it other technical benefits.

In France, the 1991 Waste Act required *inter alia* a research and development programme on partitioning and transmutation, with a milestone for review in 2006. The French authorities requested the OECD/NEA to organise an independent, international peer review of the results of this extensive research and development programme, with a view to help inform the parliamentary decision-making process on the way forward for radioactive waste disposal in France. This report presents the findings from that review, which was conducted by ten of the foremost international experts in the field.

### Nuclear Energy Data: 2006 Edition

ISBN 92-64-02489-1

€ 30, \$ 40, £ 21, ¥ 4 100.

2005 was a year of major activity within the nuclear sector. Interest in nuclear energy is growing significantly in many OECD member countries with the construction of new plants, new plans for nuclear futures along with innovations in enrichment and reprocessing. This and other insights related to nuclear energy can be found in *Nuclear Energy Data*, the Nuclear Energy Agency's annual compilation of essential statistics to 2025 on nuclear energy in OECD countries. The compilation provides readers with a comprehensive and easy-to-access overview of the

current situation and expected trends in the various sectors of the nuclear fuel cycle.

## Uranium 2005: Resources, Production and Demand

A Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency

ISBN 92-64-02425-5 € 120, \$ 150, £ 82, ¥ 16 700.

Since 2001 the price of uranium has steadily climbed over five-fold, at a rate and reaching heights not seen since the 1970s. As a result, the uranium industry has seen a surge of activity, ending a period of over 20 years of relative stagnation. Worldwide exploration expenditures in 2004 increased almost 40% over 2002 figures. Overall, resource totals have increased over the past two years, indicating that increased uranium prices have begun to have an impact. Based on patterns observed following previous periods of heightened exploration efforts, further additions to the uranium resource base are anticipated given the recent dramatic increase in exploration expenditures. In 2004, significant production increases (>30%) were recorded

in Australia, Kazakhstan and Namibia, while more modest increases (between 5% and 15%) were recorded for Brazil, Niger, the Russian Federation and Uzbekistan. Significant expansions are also planned in future production capacity in Australia, Canada and Kazakhstan. This very dynamic and major expansion of production capability could significantly alter the supply and demand relationship of recent years, provided planned centres are constructed on schedule and successfully reach full production capacity. Clearly, major changes in the uranium industry are under way, driven by recent uranium price increases.

The "Red Book", jointly prepared by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, is a recognised world reference on uranium. It is based on official information received from 43 countries. This 21<sup>st</sup> edition presents the results of a thorough review of world uranium supplies and demand as of 1<sup>st</sup> January 2005 and provides a statistical profile of the world uranium industry in the areas of exploration, resource estimates, production and reactor-related requirements. It provides substantial new information from all major uranium production centres in Africa, Australia, Central Asia, Eastern Europe and North America. Projections of nuclear generating capacity and reactor-related uranium requirements through 2025 are provided as well as a discussion of long-term uranium supply and demand issues.

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## Nuclear safety and regulation

### Building, Measuring and Improving Public Confidence in the Nuclear Regulator

Workshop Proceedings, Ottawa, Canada  
18-20 May 2004

ISBN 92-64-02590-1 Price: € 47, US\$ 59, £ 32, ¥ 6 500.

An important factor for public confidence in the nuclear regulator is the general public trust of the government and its representatives, which is clearly not the same in all countries. Likewise, cultural differences between countries can be considerable, and similar means of communication between government authorities and the public may not be universally effective.

Nevertheless, this workshop identified a number of common principles for the communication of nuclear regulatory decisions that can be recommended to all regulators. They have been cited in particular for their

ability to help build, measure and/or improve overall public confidence in the nuclear regulator.

### Nuclear Power Plant Operating Experiences from the IAEA/NEA Incident Reporting System

2002-2005

ISBN 92-64-02294-5

Free: paper or web.

The Incident Reporting System (IRS) is an essential element of the international operating experience feedback system for nuclear power plants. The IRS is jointly operated and managed by the Nuclear Energy Agency (NEA), a semi-autonomous body within the Organisation for Economic Co-operation and Development (OECD), and the International Atomic Energy Agency (IAEA), a specialised agency within the United Nations system.

## Regulatory Challenges in Using Nuclear Operating Experience

ISBN 92-64-01083-1

Free: paper or web.

The fundamental objective of all nuclear safety regulatory bodies is to ensure that nuclear utilities operate their plants in an acceptably safe manner at all times. Learning from experience has been a key element in meeting this objective. It is therefore very important for nuclear power plant operators to have an active programme for collecting, analysing and acting on the lessons of operating experience that could affect the safety of their plants.

NEA experts have noted that almost all of the recent, significant events reported at international meetings

have occurred earlier in one form or another. Counteractions are usually well-known, but information does not always seem to reach end users, or corrective action programmes are not always rigorously applied. Thus, one of the challenges that needs to be met in order to maintain good operational safety performance is to ensure that operating experience is promptly reported to established reporting systems, preferably international in order to benefit from a larger base of experience, and that the lessons from operating experience are actually used to promote safety.

This report focuses on how regulatory bodies can ensure that operating experience is used effectively to promote the safety of nuclear power plants. While directed at nuclear power plants, the principles in this report may apply to other nuclear facilities as well.

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# Radiological protection

## The Process of Regulatory Authorisation

A Report by the CRPPH Expert Group on the Regulatory Application of Authorisation (EGRA)

ISBN 92-64-01078-5

Free: paper or web.

Governments and regulatory authorities are responsible for the definition of regulatory controls or conditions, if any, that should be applied to radioactive sources or radiation exposure situations in order to protect the public, workers and the environment. Although countries use different policy and structural approaches to fulfil this responsibility, the recommendations of the International Commission on Radiological Protection (ICRP) are generally used as at least part of the basis for protection. Previously, the ICRP recommended the use of variable approaches to protection. New ICRP recommendations are proposing a single, conceptually simple and self-coherent approach to defining appropriate protection under all circumstances.

While the ICRP has been reviewing the broad principles of protection, the NEA Committee on Radiation Protection and Public Health (CRPPH) has been focusing its efforts on how radiological protection could be better implemented by governments and/or regulatory authorities. To this end, the CRPPH has developed a concept that it calls "the process of regulatory authorisation". It is described in detail in this report, and is intended to help regulatory authorities apply more transparently,

coherently and simply the broad recommendations of the ICRP to the real-life business of radiological protection regulation and application. In developing this concept, the CRPPH recognises the importance of an appropriate level of stakeholder involvement in the process.

## Occupational Exposures at Nuclear Power Plants – 2004

Fourteenth Annual Report on the ISOE Programme, 2004

ISBN 92-64-02292-9

Free: paper or web.

The ISOE Programme was created by the OECD Nuclear Energy Agency in 1992 to promote and co-ordinate international co-operative undertakings in the area of worker protection at nuclear power plants. The programme provides experts in occupational radiation protection with a forum for communication and exchange of experience. The ISOE databases enable the analysis of occupational exposure data from 478 operating and shutdown commercial nuclear power plants participating in the programme (representing some 90% of the world's total operating commercial reactors).

The Fourteenth Annual Report of the ISOE Programme summarises achievements made during 2004 and compares annual occupational exposure data. Principal developments in ISOE participating countries are also described.

## Stakeholders and Radiological Protection: Lessons from Chernobyl 20 Years After

ISBN 92-64-01085-8

Free: paper or web.

Twenty years after the major accident at the Chernobyl nuclear power plant, the radioactive contamination continues to have an important impact on lives in the vicinity, and to a lesser extent in areas such as Western Europe and beyond. The purpose of this report is not to address clinical or environmental studies, but to look at how people are coping with the difficulties they still face. Commissioned by the Committee for Radiation Protection and Public Health of the OECD Nuclear Energy Agency (NEA), the report focuses on the role of radiological protection and how this disci-

pline has been deployed to help people manage their lives.

Although the topic of this report concerns radioactivity and nuclear power, it can also be very useful to policy makers and experts dealing with the aftermath of wide-scale disasters, regardless of their causes (natural, accidental or malicious).

Whilst we all hope never to see another event causing contamination on the scale that followed Chernobyl, it is prudent to be prepared. Hence this report also describes many of the problems that could need to be faced in the longer term by technical specialists, should such a contamination event occur, and presents ways of dealing with them. This report will provide readers with insights into how to plan better for this type of event, in particular beyond the immediate response phase.

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## Radioactive waste management

### Disposal of Radioactive Waste: Forming a New Approach in Germany

FSC Workshop Proceedings, Hitzacker and Hamburg, Germany, 5-8 October 2004

ISBN 92-64-02439-5

Price: € 30, US\$ 38, £ 20, ¥ 4 200.

Germany is exploring a new approach towards the final management of its radioactive waste. This international workshop, held in Germany, attracted 65 participants from 13 countries. A little more than half of the participants were German stakeholders. During the workshop invited speakers, representing

different groups of stakeholders, commented on relevant aspects of the new German approach being proposed. This served as a basis for subsequent round-table discussions.

These proceedings provide a historical introduction to radioactive waste management in Germany, give a detailed summary of the workshop presentations and discussions that took place, and also provide the NEA Secretariat's reflections which help place the main lessons of the workshop into a wider perspective. Five presentations – the three keynote papers and the two thematic reports – are also reproduced herein.

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## Nuclear Science and the Data Bank

### Benchmark on the KRITZ-2 LEU and MOX Critical Experiments

Final Report

ISBN 92-64-02298-8

Free: paper or web.

The plutonium produced during the operation of commercial nuclear power plants or that has become available from the dismantlement of nuclear weapons needs to be properly managed. One important contribution to the management process consists in validating the calculation methods and nuclear data used for the prediction of power in systems using

mixed-oxide (MOX) fuel. A series of computational physics benchmarks and issues regarding multiple recycling in various MOX-fuelled systems have been studied and published by the NEA. This has led to improvements in the nuclear data libraries and calculation methods. Full validation requires comparing those findings with data from experiments. The experiment at the KRITZ research reactor in Sweden is being used for this purpose.

This report provides an analysis of the 12 sets of results supplied by 16 experts from 7 countries, together with the comparison against the KRITZ evaluated experimental data. The report concludes

that the computer codes and cross-sections used by the participants, which are presently in widespread use, can adequately predict the multiplication factor and pin-power distributions of the MOX cores.

This report will be of particular interest to reactor physicists and designers as well as to nuclear power plant utilities.

## Computer Simulation of MASURCA Critical and Subcritical Experiments

### MUSE-4 Benchmark – Final Report

ISBN 92-64-01086-6

Free: paper or web.

The efficient and safe management of spent fuel arising from the operation of commercial nuclear power plants is an important issue. In this context, the partitioning and transmutation (P&T) of minor actinides and long-lived fission products can play an important role, reducing significantly the burden on geological repositories of radioactive waste and enabling their more effective use.

International interest in accelerator-driven systems (ADS) has been expressed due to their potential use in the transmutation of minor actinides. However, much R&D work is still required in order to demonstrate the desired capability of the system as a whole, and the current methods of analysis and nuclear data for minor actinide burners are not as well established as those for conventionally fuelled systems.

A series of theoretical ADS physics benchmarks has thus been organised by the NEA. Many improvements and clarifications in nuclear data and calculation methods have been achieved. However, following an initial series of benchmarks, some significant discrepancies in important parameters were not fully understood and still required clarification. Hence, the first experiment-based benchmark using MASURCA critical and subcritical experiments (called MUSE-4 experiments) was launched.

This report provides an analysis of the benchmark results supplied by 16 institutions from 14 countries. The calculated results were compared against experimental data, whenever available. This report will be of particular interest to reactor physicists and nuclear data evaluators developing nuclear systems, especially ADS, for radioactive waste management.

## NUPEC BWR Full-size Fine-mesh Bundle Test (BFBT) Benchmark

### Volume I: Specifications

ISBN 92-64-01088-2

Free: paper or web.

Refined models for best-estimate calculations based on good-quality experimental data can improve the understanding of phenomena and the quantification of margins for operating nuclear power reactors. According to experts, refinements should not be

limited to currently available macroscopic approaches but should be extended to next-generation approaches that focus on more microscopic processes. Multi-scale/multi-physics approaches are the way forward in this respect.

This report describes the specification of an international benchmark based on high-quality fine-mesh data, released through the government of Japan and the Nuclear Power Engineering Corporation (NUPEC), with the aim of advancing the insufficiently developed field of two-phase flow theory. It has been designed for systematically assessing and comparing different numerical models used for predicting detailed void distributions and critical powers.

Additional volumes concerning this benchmark are planned and are intended to show to what extent the most recent approaches are capable of predicting two-phase flow phenomena.

## PENELOPE-2006: A Code System for Monte Carlo Simulation of Electron and Photon Transport

### Workshop Proceedings, Barcelona, Spain, 4-6 July 2006

ISBN 92-64-02301-1

Free: paper or web.

Radiation is used in many applications of modern technology. However, its proper handling requires competent knowledge of the basic physical laws governing its interaction with matter. To ensure its safe use, appropriate tools for predicting radiation fields and doses, as well as pertinent regulations, are required.

One area of radiation physics that has received much attention concerns electron-photon transport in matter. PENELOPE is a modern, general-purpose Monte Carlo tool for simulating the transport of electrons and photons, which is applicable for arbitrary materials and in a wide energy range. PENELOPE provides quantitative guidance for many practical situations and techniques, including electron and X-ray spectroscopies, electron microscopy and microanalysis, biophysics, dosimetry, medical diagnostics and radiotherapy, and radiation damage and shielding.

These proceedings contain the extensively revised teaching notes of the latest workshop/training course on PENELOPE (version 2006), along with a detailed description of the improved physics models, numerical algorithms and structure of the code system.

## Physics and Safety of Transmutation Systems

### A Status Report

ISBN 92-64-01082-3

Free: paper or web.

The safe and efficient management of spent fuel from the operation of commercial nuclear power plants is

an important issue. Worldwide, more than 250 000 tons of spent fuel from currently operating reactors will require disposal. These numbers account for only high-level radioactive waste generated by present-day power reactors.

Nearly all issues related to risks to future generations arising from the long-term disposal of such spent nuclear fuel is attributable to only about 1% of its content. This 1% is made up primarily of plutonium, neptunium, americium and curium (called transuranic elements) and the long-lived isotopes of iodine and technetium. When transuranics are removed from discharged fuel destined for disposal, the toxic nature of the spent fuel drops below that of natural uranium ore (that which was originally mined for the nuclear fuel) within a period of several hundred to a thousand years. This significantly reduces the burden on geological repositories and the problem of addressing the remaining long-term residues can thus be done in controlled environments having timescales of centuries rather than millennia stretching beyond 10 000 years.

Transmutation is one of the means being explored to address the disposal of transuranic elements. To achieve this, advanced reactor systems, appropriate fuels, separation techniques and associated fuel cycle strategies are required.

This status report begins by providing a clear definition of partitioning and transmutation (P&T), and then describes the state of the art concerning the challenges facing the implementation of P&T, scenario studies and specific issues related to accelerator-driven systems (ADS) dynamics and safety, long-lived fission product transmutation and the impact of nuclear data uncertainty on transmutation system design. The report will be of particular interest to nuclear scientists working on P&T issues as well as advanced fuel cycles in general.

## VENUS-2 MOX-fuelled Reactor Dosimetry Calculations

### Final Report

ISBN 92-64-01084-X

Free: paper or web.

It is essential to calculate the structural integrity of reactor components with a high degree of accuracy in order to make correct decisions regarding plant lifetime at the design stage, safety margins and potential plant life extensions. The OECD Nuclear Energy Agency (NEA) is therefore organising a series of benchmarks to verify the current international level of accuracy in pressure vessel fluence calculations and to clarify the relative merits of various methodologies. By extension, this enables the identification of areas for possible improvements in the various calculation schemes.

As a follow-up to the previous UO<sub>2</sub>-fuelled VENUS-1 two-dimensional (2-D) and VENUS-3 three-dimensional (3-D) benchmarks, and given that many commercial nuclear power plants in Europe and in Japan use MOX fuel and that the use of MOX fuel in

LWRs presents different neutron characteristics, the present benchmark was launched in 2004 using the measured data of the VENUS-2 MOX-fuelled critical experiments. This report provides an analysis of the results supplied by 12 participants from 7 countries. The results have revealed that the computer codes and nuclear data currently used for MOX-fuelled systems in OECD/NEA member countries appear able to produce results with a sufficiently high level of accuracy in dosimetry calculations. This report will be of particular interest not only to reactor physicists and nuclear data evaluators, but also to nuclear utilities.

## VVER-1000 Coolant Transient Benchmark

### Phase 1 (V1000CT-1), Volume 2: Summary Results of Exercise 1 on Point Kinetics Plant Simulation

ISBN 92-64-02295-3

Free: paper or web.

In the field of coupled neutronics/thermal-hydraulics computation there is a need to enhance scientific knowledge in order to develop advanced modelling techniques for new nuclear technologies and concepts, as well as current applications.

The present volume, a follow-up to the first volume describing the specification of the benchmark, presents the results of the first exercise that identifies the key parameters and important issues concerning the thermal-hydraulic system modelling of the simulated transient. This exercise aims to achieve the correct initialisation and testing of the system code models. The transient chosen for the exercise is caused by the switching on of a main coolant pump while the other three are in operation. It is based on an experiment that was conducted by Bulgarian and Russian engineers during the plant commissioning phase at the VVER-1000 Kozloduy Unit 6.

## VVER-1000 MOX Core Computational Benchmark

### Specification and Results

ISBN 92-64-01081-5

Free: paper or web.

The United States and the Russian Federation have each agreed to dispose of 34 tonnes of weapons-grade plutonium that are beyond their defence needs. One effective way to dispose of this plutonium is to convert it into mixed-oxide (MOX) fuel, burn it in a nuclear reactor and use it to produce electricity.

This report describes an international benchmark study that compared the results obtained for six different states in a VVER-1000 reactor core loaded with one-third MOX fuel. This NEA activity contributes to the computer code certification process and to the verification of calculation methods used in the Russian Federation.