the
abdus salam
international centre for theoretical physics

ICTP 40th Anniversary

SMR.1555 - 41

Workshop on
Nuclear Reaction Data and Nuclear Reactors:
Physics, Design and Safety

16 February - 12 March 2004

Computer Codes and Integral Experiments
for Nuclear Applications

OECD/NEA Data Bank Services

Ivo KODELI
Organization for Economic Co-operation and Development (OECD)
Nuclear Energy Agency - Data Bank
12 Boulevard des Iles
F-92130 Issy Les Moulineaux
FRANCE

These are preliminary lecture notes, intended only for distribution to participants

Computer Codes and Integral Experiments for Nuclear Applications

OECD/NEA Data Bank Services

Ivo Kodeli
IAEA representative at OECD/NEA Data Bank
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www.nea.fr/html/dbprog/

Outline of Presentation

- Role of basic data, codes and integral experiments for model development, evaluation/validation
- Where can these tools be obtained from?
  - OECD/NEA, NSC, Data Bank
  - IAEA, RSICC, ESTSC, National Organisations
  - Computer Program Service
  - Access to services
- How to request the codes and associated data
  - Forms, etc.
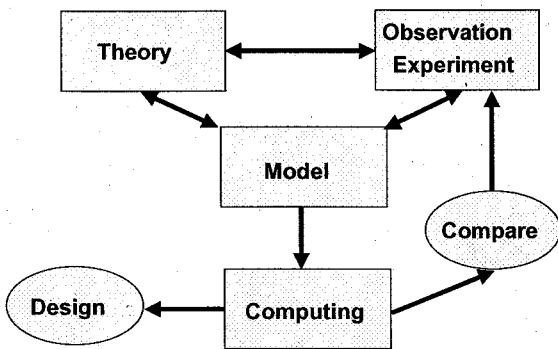
- *Measurement:*
  Data are the starting point -
  a signal from reality -
  i.e. from the physical world
- *Modelling:*
  a matter of scale / dimension
- *Sensitivity Analysis:*
  a guide to constructing models
- *Uncertainty Analysis:*
  building confidence in the model
- *Microscopic phenomena ⇒ macroscopic behaviour in technological applications*

Time-independent Boltzmann Transport Equation

$$\vec{\Omega} \cdot \nabla \phi(\vec{r}, \vec{\Omega}', E') + \sum_{T}(\vec{r}, E)\phi(\vec{r}, \vec{\Omega}, E)$$

$$- \int_0^{E_{max}} \int_{4\pi} dE' \, d\Omega' \sum_s (\vec{r}, \vec{\Omega}' \cdot \vec{\Omega}, E' \to E)\phi(\vec{r}, \vec{\Omega}', E') = Q(\vec{r}, \vec{\Omega}, E)$$

where:
- $\phi(\vec{r}, \vec{\Omega}, E)$: angular flux at location $\vec{r}$ with energy E, direction $\vec{\Omega}$
- $\sum_T(\vec{r}, E)$: total macroscopic cross-section at energy E
- $\sum_s(\vec{r}, \vec{\Omega}' \cdot \vec{\Omega}, E' \to E)$: scattering cross-section from E' to E

Particle transport methods

- **_Monte Carlo:_** MCNP, KENO, McBEND, TRIPOLI, MORSE, EGS4, PENELOPE, MONK, ITS, FLUKA, LAHET
- **_Deterministic discrete ordinates:_** ANISN, DOORS, DANTSYS, PARTISN, TWOTRAN, CEPXS/ONELD

The only certainty concerning the scientific data, measured or calculated, is that they differ from their true values.

Reasons:
experimental errors, unperfect instruments, counting statistics, approximations used in modelisation (geometry, material composition), calculational methods and physical theory.

Predictions of measured data can be only based on weighted averages of all possible true values. Weights and averages represent probabilities and expectation values.

Iron total cross-section - point data
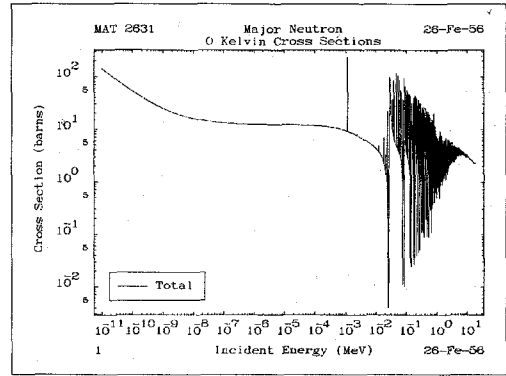
Iron total cross-sections in 640 group structure
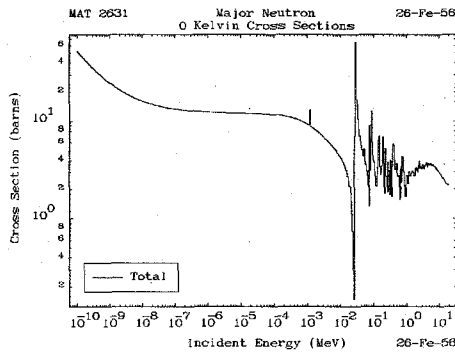
Probability theory

Applied long time ago to repeated observations of random variables (coin tossing):

$$\langle x \rangle = \sum_i \frac{x_i}{N}$$

Extension to physical quantities which are not random variables: the probability distribution indicates how plausible various possible values are.

$$\langle x \rangle = \sum_i \langle f_i \rangle x_i$$

f = probability distribution function

$$\langle x \rangle = \int x f(x) dx$$

$$\sum_i f_i = 1$$

Expressing uncertainties

In practice an experimental result is usually characterized by its mean value and standard deviation:

$$\langle x \rangle \pm \Delta x$$

where

$$(\Delta x)^2 = \langle (x - \langle x \rangle)^2 \rangle \quad \text{...variance of x}$$

Standard deviation (Δx or σ)

Normal (Gaussian) : ± 1 σ ~ 68 % confidence level
± 2 σ ~ 95 % - " -
Flat distribution : ± 1 σ ~ 58 % - " -

Example

$$0.5 < \frac{V_{wine}}{V_{water}} < 1 \Rightarrow \left\langle \frac{V_{wine}}{V_{water}} \right\rangle = \frac{3}{4} = 0.75$$

$$1 < \frac{V_{water}}{V_{wine}} < 2 \Rightarrow \left\langle \frac{V_{water}}{V_{wine}} \right\rangle = 1.5 \Rightarrow \left\langle \frac{V_{wine}}{V_{water}} \right\rangle = \frac{2}{3} \sim 0.67$$

$$\left\langle \frac{V_{wine}}{V_{water}} \right\rangle = \frac{5}{7} = 0.71$$

2
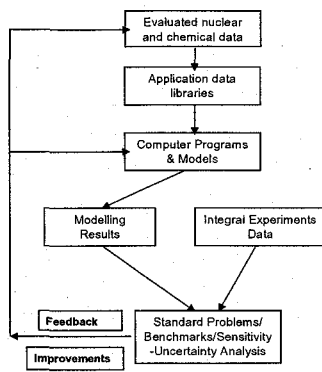
Computational tools needed

- basic data
- computer codes
- integral experiments - benchmarks and reference solutions

Benchmarks and standard problems (1/4)

- Crucial issues of reactor physics, shielding, criticality safety etc. for reactor and fuel cycle installation design:
  - Assessment of calculational tools
  - Validation of nuclear data performance
- Developing an approach of global method and data validation, using integral experiments

Benchmarks and standard problems (2/4)

- Types of benchmarks

  - theoretical or computational benchmark
  - experimental benchmark
  - hybrid theoretical/experimental

Benchmarks and standard problems (3/4)

- Categories of comparisons

  - blind benchmark comparison
  - model comparison
  - code comparison
  - comparison of the use of the codes

Benchmarks and standard problems (4/4)

- Highly sophisticated experimental techniques have been developed and used in order to reduce uncertainties and to allow the definition of resulting bias factors, design margin or cross-section adjustments, which could have a clear impact on cost reductions and safety improvement.
- Past experiments contribute to the present state-of-the-art in designing existing reactors or fuel cycle installations. They provide the record on which development and validation of present data and methods are based.
- will certainly be extremely useful in the future in assessing promising new design and concepts.
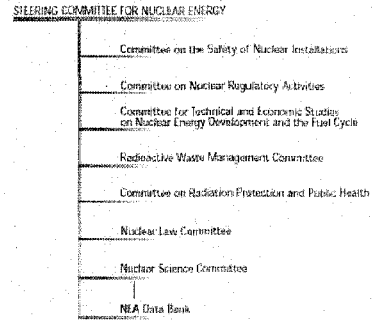
What is the OECD

SCOPE OF WORK PERFORMED

- General Economic Policies
- Trade policies
- Financial, Fiscal & Enterprise affairs
- Energy ⬅
- Environmental Policies
- Food, Agriculture & Fisheries
- Social Affairs, Manpower & Education
- Science, Technology & Industry
- Relations with Non-Member Countries
- Public Management

OECD Nuclear Energy Agency Committees

STEERING COMMITTEE FOR NUCLEAR ENERGY

Committee on the Safety of Nuclear Installations

Committee on Nuclear Regulatory Activities

Committee for Technical and Economic Studies on Nuclear Energy Development and the Fuel Cycle

Radioactive Waste Management Committee

Committee on Radiation Protection and Public Health

Nuclear Law Committee

Nuclear Science Committee

NEA Data Bank

OECD/Nuclear Energy Agency Member Countries

Australia ●	France	Japan	Slovak Republic
Austria	Germany	Korea	Spain
Belgium	Greece	Luxembourg ●	Sweden
Canada ●	Hungary	Mexico	Switzerland
Czech Republic	Iceland ●	Netherlands	Turkey
Denmark	Ireland ●	Norway	United Kingdom
Finland	Italy	Portugal	United States ●

● Not members of the Data Bank

http://www.nea.fr/
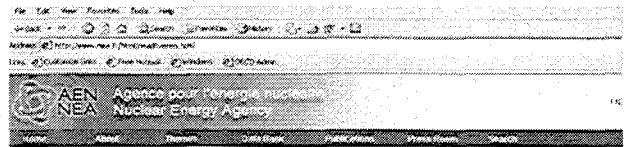
The Nuclear Energy Agency

The Nuclear Energy Agency (NEA) is a specialised agency within the Organisation for Economic Co-operation and Development (OECD), an intergovernmental organisation of industrialised countries, based in Paris, France.
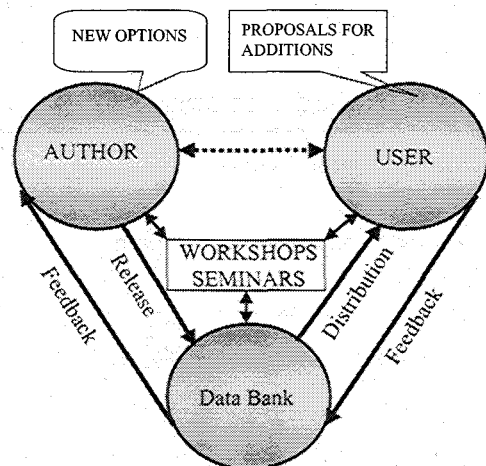
The NEA mission

The mission of the NEA is to assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for the safe, environmentally friendly and economical use of nuclear energy for peaceful purposes. To achieve this, the NEA works as: a forum for sharing information and experience and promoting international co-operation; a centre of excellence which helps Member countries to pool and maintain their technical expertise; a vehicle for facilitating policy analyses and developing consensus based on its technical work.

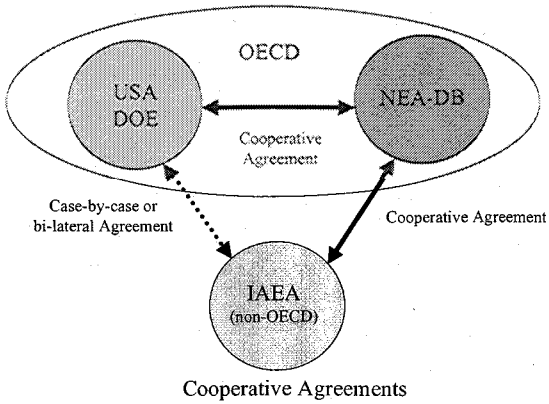The NEA's current membership consists of 28 countries, in Europe, North America and the Asia-Pacific region:

Australia	France	Japan	Slovak Republic
Austria	Germany	Korea	Spain

Topics

- Acquisition / Testing ⬅ Country specific statistics is distributed
- Dispatches ⬅
- Innovation and evolution of the service
- Tools for 3D codes
- Workshops/Training Courses

- Service to IAEA-non-OECD

NEW OPTIONS   PROPOSALS FOR ADDITIONS

AUTHOR   USER

WORKSHOPS SEMINARS

Release   Distribution

Feedback   Feedback

Data Bank

Cooperative Agreements

OECD

USA DOE

NEA-DB

Cooperative Agreement

Case-by-case or bi-lateral Agreement

Cooperative Agreement

IAEA (non-OECD)

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http://www-rsicc.ornl.gov/rsic.html

OAK RIDGE NATIONAL LABORATORY

RADIATION SAFETY INFORMATION COMPUTATIONAL CENTER

RSICC

Software Index: 1 | 2 | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z
Software | By Subject Category | Catalog | Newsletters | Workshops
Benchmarks | Nuclear Science Resources | Glossary | Notebook
New Items - Reviews - Roadmaps

ANS Joint Benchmark Effort	Medical/Health Physics/Dosimetry	Nuclear Criticality
		Nuclear Data
ANS Aerospace Nuclear Science and Technology ***New***	Plutonium Data Resources	Other Nuclear Information

P. O. Box 2008, Oak Ridge, TN 37831-6362 USA
Phone: 865-574-6176 Fax: 865-574-6182
Home | Services | Email us | Mission Statement | Disclaimer
Guidance | Executive Service | Computing Resources | Scientific Service

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http://www.osti.gov/estsc/

E·S·T·S·C
ENERGY SCIENCE and TECHNOLOGY
SOFTWARE CENTER
U.S. DEPARTMENT OF ENERGY

U.S. Department of Energy

Energy Science and Technology Software Center

The Energy Science and Technology Software Center (ESTSC) is the U.S. Department of Energy's (DOE) centralized software management facility. Operated by DOE Office of Scientific and Technical Information (OSTI), the ESTSC licenses and distributes Federally funded scientific and technical software developed by national laboratories, other facilities and DOE contractors. This scientific and technical software represents the latest in Federal technology. In addition, the collection contains selected scientific and technical software from the Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development (OE...

Online Catalog

What's New   Most Frequently Requested

Ordering Information   Frequently Asked Questions

Software Available   Technical Support

Hot Links   Subject Categories

Comments/Questions

U.S. Department of Energy

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http://www.nea.fr/html/dbprog/

AEN NEA — Agence pour l'énergie nucléaire / Nuclear Energy Agency

Data Bank Computer Program Services

About Computer Program Services

This service we provide
Material available from us
Contact us

Rules for requesters

NEA-Data Bank member countries
Non-NEA Data Bank countries
USA and CANADA

Computer Program Abstracts Catalogue

SEARCH programs by key words
LIST of programs by category
TIPS for searching materials

Related Information

Benchmarks and Code Validation
Other LINKS to Computer Codes
Meetings, Workshops/Training Courses & International Conferences

What's New

ICPS Home | DBProg CPS | Contact CPS | Abstracts | TNS2 | Links

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AEN NEA — Agence pour l'énergie nucléaire / Nuclear Energy Agency

Computer Program Services

Rules for Requesters from non-NEA Data Bank countries

If your country is NOT a member of the NEA Data Bank, please consult the nominated establishment in your country (see List of non-NEA Data Bank nominated establishments). If there is no nominated establishment in your country, contacts are of the following centers:

For all codes of US origin with ESTS-, NESC- and USCD- prefixes please contact:

Energy Science & Technology Software Center

Kim BUCKNER

U. S. Department of Energy
Energy Science and Technology Software Center
P.O. Box 1020
OAK RIDGE, TN 37831-1020
U. S. A.
E-mail: ESTSC@adonis.osti.gov

For all codes of US origin with PSR-, CCC-, DLC- and USCD- prefixes please contact:

Radiation Safety Information Computational Center

OECD Nuclear Energy Agency | Home | Publications | Activities | About NEA | Search | Site map | Register
Nuclear Science | Data Bank | Nuclear Data | Chemical Data | ComputerProgs

List of non-NEA Data Bank Nominated Establishments

P.R. OF CHINA
MOROCCO
MOZAMBIQUE
MYANMAR (BURMA)
NAMIBIA
NEW ZEALAND
NICARAGUA
NIGERIA
P.R. OF CHINA
PAKISTAN
PANAMA
PARAGUAY
PERU
PHILIPPINES
POLAND
PRINCIPALITY OF MONACO
QATAR

Display

Registration

P.R. OF CHINA

CNDC	GE ZHIGANG, Mr.	Tel:+86 10 6935 7275	
	Chinese Nuclear Data Centre	Fax:+86 10 6935 7009	
	P.O. Box 275-41	Eml:gezg@aipsa.ciae.ac.cn	
	102413 Beijing		

The Nuclear Energy Agency Web site is mirrored at www.oecdnea.org and at www.nea.fr
You may find that one of the two sites has a much faster access for you.

NEA Home - Programmes - Publications - Practical Information
Who to contact? - Search the Site - What's New? - Other Links - Registration

Environmental and Earth Sciences - Impact of Nuclear Activities onto Environment - Category R

⬥ Environmental impact studies, geology, seismology, geophysics calculations, hydrology and ground water studies, bioenvironmental systems analyses, meteorological calculations relating to the atmosphere and its phenomena, studies of airborne particulate matter, climatology, etc. (full list)

⬥ Radioactive Waste Management Studies - Geological Disposal

⬥ Atmospheric Dispersion of radioactive/toxic materials

⬥ Radiation Dosimetry, Biosphere Modelling

⬥ The OECD/NEA THERMOCHEMICAL DATA BASE (TDB) PROJECT

The objective of the TDB project is to to make available a comprehensive, internally consistent, internationally recognised and quality-assured chemical thermodynamic database of selected chemical elements.
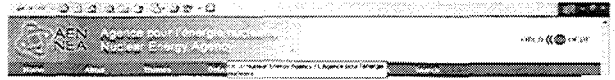
OECD/NEA Data Bank

Computer Program Service (CPS) E-Newsletter

No. 16, December 2003

Computer Program Service of the OECD/NEA Data Bank
Content:

1. New computer codes & related information
2. Integral Experiments
3. Workshops, Training Courses & Tutorials, Meetings

The most recently acquired or tested computer codes and data libraries are:

Identification	Name	Description
NEA-1682/04	IRPHE/B&W-SS-LATTICE	IRPHE/B&W-SS-LATTICE, Spectral Shift Reactor Lattice Experiments (Revised Edition)
NEA-1715/01	IRPHE-JAPAN	Reactor Physics Experiments carried out in Japan (New)
NEA-1660/04	IRPHE-SNEAK	IRPHE-SNEAK, KFK SNEAK Fast Reactor Experiments, Primary Documentation (Revised Edition)
NEA-1713/01	IRPHE/RRR-SEG	Reactor Physics Experiments from Fast-Thermal Coupled Facility RRR-SEG, Rossendorf (New)
NEA-1714/01	IRPHE/STEK	Reactor Physics Experiments from Fast-Thermal Coupled Facility STEK, Petten (New)
NEA-1694/02	SATIF/CYCLO-RADSAFE	Health Physics and Radiological Safety of Cyclotrons 10-250 MeV (Revised Edition)
NEA-1716/01	TRIPOLI-4.3.2	Coupled Neutron, Photon, Electron, Positron 3-D, Time Dependent Monte-Carlo, Transport Calculation (New)
NEA-1640/07	22-BWRTT	BWR Turbine Trip Transient Benchmark Based on Peach-Bottom 2 (Revised Edition)
NEA-1654/05	22-PWR-MSLB	PWR Main Steam-Line Break Benchmarks. Coupled Neutronics Thermal-

Computer Program Services

Search programs by key words

The NEA Data Bank Computer Programs Abstracts catalog can be searched without restrictions. However, requests and retrievals of programs can only be made by officials of nominated establishments (see RULES FOR REQUESTERS):

YEAR 2000 (Y2K) STATEMENT

Enter words or phrases, separated by commas:

Monte Carlo

Meetings and conferences organised/sponsored by the Nuclear Science Committee and the Data Bank

List of Meetings

- 2002(Last updated: 04-Nov-2002)
  Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
- 2003 (Last updated: 13-June-2003)
  Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
- 2004(Last updated: 05-May-2003)
  Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
- 2005(Last updated:09-May-2003)
  Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

and a summary on CD-ROM.
- MCNPX Training course , Intermediate Level, 6-10 October 2003, University of Stuttgart , Rechenzentrum , Allmandring 30, D-70550 Stuttgart, Germany
- International Conference on Supercomputing in Nuclear Applications (SNA'2003) , 22-24 September 2003, Paris, France
- GLOBAL 2003 Conference on future nuclear energy systems and their fuel cycles, 16-20 November 2003, New Orleans, Louisiana, USA

Workshops, Training Courses & Tutorials planned for 2004:

- For 2004 Training Courses on PENELOPE and TRIPOLI-4 are planned. Announcements for possible courses on MCNPS , MCNPX , SCALES and others will be made later. Future courses, tutorials etc. will be held depending on user interest and participation. For more information please contact : sartori@nea.fr

Meetings Sponsored by the Nuclear Science Committee & Data Bank

Meetings scheduled for the next two years and of interest to clients of the Computer Program Service
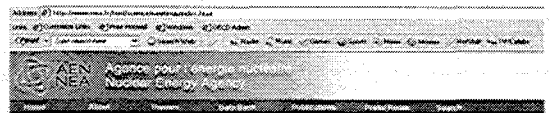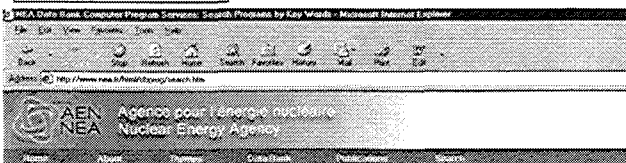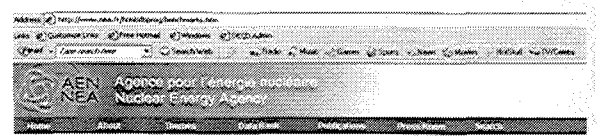
In particular we signal here:

- Seminar on Pellet-Clad Interaction (PCI) in Water Reactor Fuels, 9-11 March 2004, Aix-en-Provence, France
- Tenth International Conference on Radiation Shielding (ICRS-10) with ANS Topical on Radiation Protection & Shielding (RPS), 9-14 May 2004, Madeira Island, Portugal

News from the OECD Nuclear Energy Agency (NEA)

The latest issue of the NEA on-line bulletin.

NEA Data Bank Computer Program Services

Benchmark Experiments for Data and Code Validation

Benchmark Validation Databases (NSC):

- ICSBEP : International Criticality Safety Benchmark Evaluation Project
- IFPE : International Fuel Performance Experiments
- SINBAD : Shielding Integral Benchmark and Database (RSICC)
- IRPHE : International Reactor Physics Experiments Project

Data and reports from joint research projects related to Nuclear Safety (CSNI):

- CCVM: CSNI Code Validation Matrix Integral Test Data
- CCVM: CSNI Code Validation Matrix Separate Effects Test Data
- STRESA: CSNI Code Validation Matrix on-line (requires password)
- PSB-VVER Project: Experiments for transient analysis of VVER-1000 reactors project (available to participants)
- SETH Project: PKL and PANDA experiments relevant for accidents management (available to participants)
- IRSN Cabri Water Loop Project: High burnup fuel behaviour in RIA conditions (available to participants)
- RASPLAV Project: High burnup fuel behaviour in RIA conditions (available to OECD countries and Russia)

Evaluated Nuclear Data Processing and Visualisation:

- NJOY General Nuclear Data Processing System for Files in ENDF Format

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Links to NJOY Web Pages and Sites

NJOY: Data Processing System of Evaluated Nuclear Data Files in ENDF format.

- NJOY official Web Site
- Understanding NJOY
- NJOY99 Issue Tracker
- NJOY Listserver Archive (NEA Data Bank) (March 2000 - present)
- NJOY Notebook (RSICC)
- Proceedings of the Seminar on NJOY and THEMIS 1989
- Proceedings NJOY91 & Themis Seminar 1992
- NJOY User Notes Archive (1991-January 2000)
- NJOY-2001 Workshop and User Group Meeting Proceedings 15 May 2001

Benchmark experiment data bases

The OECD/NEA Nuclear Science Committee (NSC) has identified the need to establish international databases containing all the important experiments that are available for sharing among the specialists and has set up or sponsored specific activities to achieve this.

The aim is to preserve them in an agreed standard format in computer accessible form, to use them for international activities involving validation of current and new calculational schemes including computer codes and nuclear data libraries, for assessing uncertainties, confidence bounds and safety margins, and to record measurement methods and techniques.

Benchmark experiment data bases

- **Significant saving** results from disseminating a standard benchmark set to be used worldwide.
- A framework for professionals that use the standard benchmark set to validate and verify modeling codes and data for radiation transport, criticality safety and reactor physics applications **guarantees a comparative set** of analyses.
- It represents also a good basis for **pinpointing important gaps** and where efforts should be concentrated.

NSC sponsored projects

- **SINBAD** - Radiation Shielding Experiments
- **ICSBEP** - International Handbook of Evaluated Criticality Safety Benchmark Experiments
- **IRPhE** - Reactor Physics Experiments
- **IFPE** - International Fuel Performance Experiments
- **CCVM** - CSNI Code Validation Matrix Integral Test Data

SINBAD - an International Database for Integral Shielding Experiments - List of Experiments and Links to Abstracts

Objective: Validation and Benchmarking of Computer Codes and Nuclear Data used for Radiation Transport and Shielding Problems Preservation of a unique set of experiments for the needs of today and tomorrow.

Co-ordinators: OECD Nuclear Energy Agency (NEA) and Radiation Safety Information Computational Center (RSICC)

Contributors:

- AEA Technology (AEAT),
- Comissariat a l'Energie Atomique (CEA),
- EC Joint Research Centre (ISPRA),
- Ente per le Nuove Technologie, L'Energia e l'Ambiente (ENEA),
- Forschungszentrum Karlsruhe (F2K),
- Georgia Institute of Technology (GIT),
- Institute of Nuclear Techniques, Technical University of Budapest (TUB),
- Institute of Physics and Power Engineering,
- Interfaculty Reactor Institute (IRI), Delft University of Technology,
- Japan Atomic Energy Institute (JAERI),
- Jozef Stefan Institute (IJS),
- Los Alamos National Laboratory (LANL)
- National Institute of Standards and Technology, Gaithersburg (NIST)
- Oak Ridge National Laboratory (ORNL),
- Paul Scherrer Institute (PSI),
- Research Centre Mol (SCK-CEN)
- Technische Universitaet Dresden (TUD),
- University of Illinois,
- University of Osaka,
- University of Pavia,
- University of Tokyo,

and many experts who have contributed to the compilation, validation and review of the data.

SINBAD Experiments by Application

I Reactor shielding, pressure vessel dosimetry (34)

I Fusion Neutronics Shielding (22)

I Accelerator Shielding (8)

RSICC: http://www-rsicc.ornl.gov/BENCHMARKS.html
OECD/NEA: http://www.nea.fr/html/science/shielding/sinbad/sinbadis.htm

SINBAD -
Radiation Shielding Experiments

Materials

- B, Ti, H (1)
- C (graphite) (2)
- N (1)
- O (2)
- Na (4)
- H_2O (2)
- H_2O, C, Fe (1)
- H_2O, C, Pb (1)
- H_2O, Fe (2)
- H_2O, Steel (2)
- H_2O, Steel, Al (2)
- Concrete (1)
- Al (2)
- Al, Nb (1)
- Be (1)

- Fe (11)
- Fe, Pb (1)
- Fe, Concrete, $(CH_2)_{2n}$ (3)
- Ni (1)
- Steel (2)
- SS (2)
- Fe & SS (1)
- SS & $(CH_2)_{2n}$ (1)
- SS, $(CH_2)_{2n}$ & Cu (1)
- Pb (1)
- Si, SiC (2)
- V (2)
- W (3)
- Air (4)
- Multiple materials (8)

Euracos - Sodium
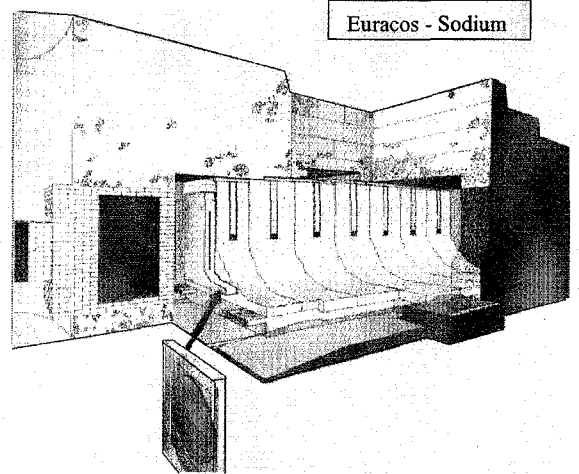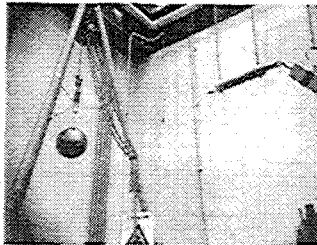
KFK - Iron Sphere

Fig. 1: Iron sphere, on the right PR-detector.
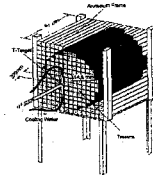
FNS Tungsten
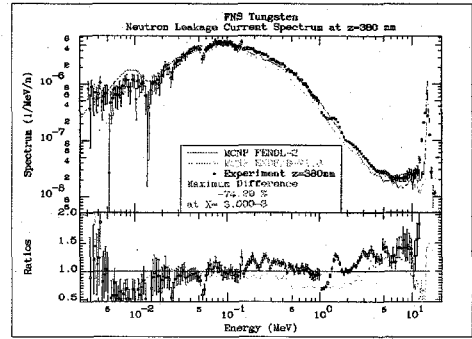
FNG Bulk Shield
Nb-93(n,2n)

ICSBEP

8

ICSBEP - (1/3)
International Handbook of Evaluated Criticality Safety Benchmark Experiments

- The purpose of the ICSBEP is to identify, evaluate, verify, and formally document a comprehensive and internationally peer-reviewed set of criticality safety benchmark data.
- The work of the ICSBEP is published as an OECD handbook entitled "International Handbook of Evaluated Criticality Safety Benchmark Experiments
- benchmark specifications for 2642 critical or subcritical configurations
- use in validation efforts and for test basic nuclear data evaluations

ICSBEP - (2/3)
International Handbook of Evaluated Criticality Safety Benchmark Experiments

- **Experiments are classified into seven different types of fissile materials**
  - Plutonium Systems
  - Highly Enriched Uranium Systems (wt.% $^{235}U \geq 60$)
  - Intermediate and Mixed Enrichment Uranium Systems ($10<$ wt.% $^{235}U< 60$)
  - Low Enriched Uranium Systems (wt.% $^{235}U \leq 10$)
  - Uranium-233 Systems
  - Mixed Plutonium - Uranium Systems
  - Special Isotope Systems

ICSBEP - (3/3)
International Handbook of Evaluated Criticality Safety Benchmark Experiments

- Participation in the Project:
  - the United States,
  - United Kingdom,
  - France,
  - Japan,
  - the Russian Federation,
  - Hungary,
  - Republic of Korea,
  - Slovenia,
  - Yugoslavia,
  - Kazakhstan,
  - Spain,
  - and Israel

The Public Domain Database on Nuclear Fuel Performance Experiments for the Purpose of Code Development and Validation

International Fuel Performance Experiments (IFPE) Database

(status 2 February 2004)

The Aim of the IFPE Database Project

The aim of the project is to provide in the public domain, a comprehensive and well-qualified database on Zr clad UO_2 fuel for model development and code validation. The data encompasses both normal and off-normal operation and include prototypic commercial irradiations as well as experiments performed in Material Testing Reactors. This work is carried out in close co-operation and co-ordination between OECD/NEA, the IAEA and the IFE/OECD/Halden Reactor Project.

Activities within the IFPE Database Project

- acquisition of data through discussion and negotiation with originators
- compilation of the data into a standard form and content as agreed by an Expert Group set up for supervising the work
- peer review of the data by independent experts
- integration and indexing of the data into the IFPE database, inclusion of all used reports in electronic form.
- distribution to interested parties and assistance where necessary in use of datasets.

IFPE: Data Currently Available

To date datasets about 416 rods/samples from various sources encompassing BWR, CAGR, PHWR, PWR, and WWER reactor systems have been included

Halden irradiated IFA-432	5 rods
Halden irradiated IFA-429	7 rods
Halden irradiated IFA-562.1	12 rods
Halden irradiated IFA-533.2	1 rod
Halden irradiated IFA-535.5 & 6	4 rods
The Third Risø Fission Gas Release Project	16 rods
The Risø Transient Fission Gas Release Project	15 rods
The SOFIT WWER fuel Irradiation Programme	12 rods
The High Burn-up Effects Programme	81 rods
WWER rods from Kola-3	32 rods
Rods from the TRIBULATION programme	19 rods
Studsvik INTER-RAMP BWR Project	20 rods
Studsvik OVER-RAMP PWR Project	39 rods
Studsvik SUPER-RAMP PWR Sub-Programme	28 rods
Studsvik SUPER-RAMP BWR Sub-Programme	16 rods
Studsvik DEMO- RAMP I - BWR	6 rods
Studsvik DEMO- RAMP II - BWR	8 rods
CEA/EDF/FRAMATOME Contact 1 & 2	3 rods
AEAT-IMC NFB 8 and 34	22 samples
CEA/EDF/FRAMATOME PWR and OSIRIS ramped fuel rods	4 rods
CENG defect fuel experiments	5 rods
CANDU elements irradiated in NRU	36 rods
Siemens PWR rods irradiated in GINNA	17 rodlets
CNEA six power ramp irradiations with (PHWR) MOX fuels	6 rods
CEA failed PWR rods irradiated in SILOE: EDITH-MOX 01	1 rod

Advanced Nuclear Physics
International Reactor Physics Evaluation Project (IRPhEP)
Related link: International Criticality Safety Benchmark Evaluation Project

Background Information

Since the beginning of the Nuclear Power Industry, numerous experiments concerned with nuclear energy and technology have been performed at different research laboratories, worldwide. These measurements required a large investment in terms of infrastructure, expertise and cost; however, many were performed without a high degree of attention to permanent archival of results for future use. The results and techniques developed from these measurements remain of great value today and in the future. They provide the basis for recording, development, and validation of methods, and represent a significant collection of data for present and future research. This valuable national asset is in jeopardy of being lost. If the data are compromised, it is unlikely that any of these measurements will be repeated in the future.

At present, there is an urgent need to preserve integral reactor physics experimental data including separate or special effects data for nuclear energy and technology applications and the knowledge and competence contained therein. The International Reactor Physics Evaluation Project (IRPhEP) was initiated by the Organisation for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) in May of 2000.

INEEL's Advanced Test Reactor

IRPhEP is a joint project between the Idaho National Engineering and Environmental Laboratory (INEEL) - Argonne National Laboratory (ANL) and is closely coordinated with the International Criticality Safety Benchmark Evaluation Project (ICSBEP).
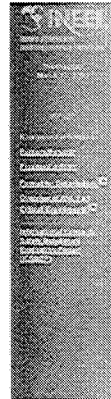
SUMMARY OF IRPhE ACTIVITIES

- **BFS-RESR-EXP-001**: Critical Experiments with Pu, SiO2, Polyethylene (IPPE Obninsk)
- **BFS-RESR-EXP-002**: Critical Experiments with Highly Enriched U, SiO2, Polyethylene (IPPE Obninsk)
- **DIMPLE-RESR-EXP-001**: LW Low Enriched UO2 (3 wt.% 235 U) Rod Lattices Dimple S01 (Serco Assurance)
- **KRITZ-RESR-EXP-001**: KRITZ-2:19 Experiment on Regular H2O/Fuel Pin Lattices With MOX Fuel (Studsvik)
- **PFACILITY-VVER-EXP-001**: VVER Physics Experiments (KIAE)
- **VENUS-PWR-EXP-001**: VENUS-2 PWR MOX Core Measurements (SCK-CEN)
- **ZR6-VVER-EXP-001**: VVER Experiments (AEKI) (331 configurations)
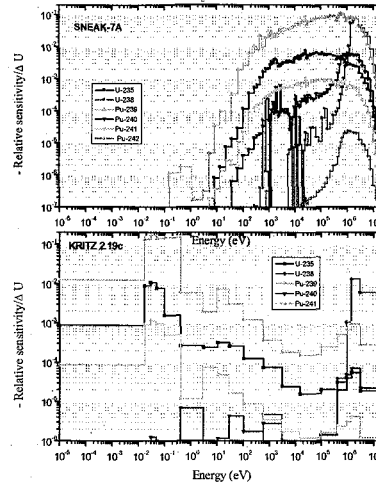
KRITZ / SNEAK

Sensitivity of core eigenvalue to fission cross sections of U and Pu isotopes

Back

CCVM

CSNI Code Validation Matrix

INTEGRAL TEST DATA

This project is dedicated to the memory of Gianni Frescura, who managed it as Head of the NEA Safety Division from 1993 to 2003

Go to CCVM Separate Effects Test Data Page (updated June 2003)

Facility
GENERAL
BETHSY
DOEL2
FIST
FIX-II
LEIBSTADT
LOBI
LOFT
OTIS
PACTEL
PIPER
PKL
ROSA-III

CSNI Code Validation Matrix of Thermo-Hydraulic Codes for LWR LOCA and Transients

Data Collection at NEA Data Bank

Revised January 2004

Updates to latest version: Additional reports, photographs, and micrographs for LOFT/LP-FP2 and LOFT/L2-5 have been added.

Over the years the NEA Data Bank could collect a sizable subset of separate effects test reactor transient and LOCA integral test data (I.T.D.), as defined in the Code Validation Matrix of Document OCDE/GD(97)12. These data with accompanying documentation are now available on CD-ROMs. The writing format of the CD conforms to the standard ISO 9660. Each CD contains a copy of the INDEX file. It summarizes the complete contents of all CDs.

- The reports describing the experiments have been electronically scanned and transformed into PDF files. Each report is stored in a separate subdirectory.

Overview of benchmark activities at OECD/NEA (1/3)

- **NSC benchmark topics**
  - Reaction cross-sections/yields
  - Reactor physics
  - Core and system transients
  - Fuel behaviour
  - Radiation shielding
  - Criticality safety (*away from reactor*)
  - ADS performance

Overview of benchmark activities at OECD/NEA (2/3)

- **Radiation shielding benchmarks**

  - reactor shields
  - pressure vessel dosimetry
  - shipping cask shielding
  - 3D radiation streaming in ducts
  - SINBAD (shielding experiments database)

Overview of benchmark activities at OECD/NEA (3/3)

- **Criticality safety benchmarks**
  - storage (wet - dry)
    - burnup credit
  - transport - shipping casks
    - burnup credit (safety margins, burnup profiles)
    - PWR, BWR, MOX spent fuel
  - minimum critical masses
  - ICSBEP (criticality safety experiments handbook)

Coupled 3D neutronics / thermal-hydraulics

– Rod Ejection (PWR)
– Cold Water Injection / Pressurisation (BWR)
– Rod Withdrawal at Zero Power (PWR)
– BWR Stability - Ringhals1
– Time Series (BWR) Forsmark 1 & 2
– Main Steam Line Break (PWR)
– Turbine Trip Transient (BWR)
– VVER-1000 Coolant Transient (V1000 CT)
– BWR Full Bundle Test (BFBT)

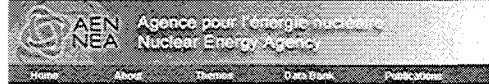http://www.nea.fr/html/science/projects

Nuclear Science Projects

This page shows the categories of projects supported by the Nuclear Science Committee. A complete list of NSC projects is also available.

- Nuclear Data
- Fuel Behaviour
- Innovative Fuel Cycles and Advanced Reactors
- Partitioning and Transmutation
- Criticality
- Mathematics and Computing, including Reactor Physics and Shielding
- Miscellaneous projects

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http://www.nea.fr/html/science/projects/nucleardata.html

Nuclear Data

- Working Party on Evaluation Co-operation (WPEC)
  (Last updated: 18/May/01)
  WPEC introduction. This page contains information on several publications arising from WPEC activities.

  o Nuclear Data Measurements (last updated: 15/May/01)
  The WPMA was merged with the WPEC in 1999.

  o Latest High Priority Data Request list (Mar 2001)
  (pdf, 261 kb)
  The Nuclear Energy Agency's High Priority Nuclear Data
  Request List is a compilation of the highest priority nuclear
  data requirements.

  o Nuclear Models & Code Comparisons (last updated: 14/March/01)
  This is a list of publications for International code and model comparison carried out by the OECD/NEA.

- Nuclear Data Databases (to Databank web page)
  JEFF and EFF projects, and general information on Nuclear Data Services.

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http://www.nea.fr/html/science/projects/innovativefuelcycles.html

NSC Projects

Innovative Fuel Cycles and Advanced Reactors

- Working Party on the Physics of Plutonium Fuels and Innovative Fuel Cycles (WPPR)
  WPPR Introductory page.(Last updated: 09-Dec-2002)

  o Innovative fuel cycles and advanced reactors (Last updated: 11-April-2001)
  The purpose of the workshop is to exchange information on R&D activities and to identify areas and research tasks where international co-operation can be strengthened.

- Expert Group on Reactor-based Plutonium Disposition (Last updated: 27-July-2002)
  This Expert Group deals with the status and trends of reactor physics, fuel performance, and fuel cycle issues related to the disposition of weapons-grade plutonium as mixed-oxide fuel.

Mathematics and Computing, including Reactor Physics and Shielding

- Fission Reactor Benchmarks (Last updated: 18-March-2003)
  The benchmarks concern the validation of computer codes and data required for reactor design and operation, covering LWR reactor core transients, power distribution within fuel assemblies and reactor cores.

- Radiation Shielding (Last updated: 04-March-2002)
  SINBAD, a Radiation Shielding Experiments database and associated meetings.

  o Expert Group on Shielding Aspects of Accelerators, Targets and Irradiation Facilities (Last updated: 06-May-2003)
  This group is responsible for SATIF activities.

- Expert Group on 3D Radiation Transport Benchmarks (Last updated: 16-Dec-2002)
  This Expert Group deals with scientific issues in the field of deterministic and stochastic methods and computer codes relative to three-dimensional radiation transport.

- Reactor Dosimetry (Last updated: 06-May-2003)
  Publication of VENUS-1 and VENUS-3 benchmarks and links to related meetings.

- Monte Carlo Techniques (Last updated: 06-May-2003)
  Recent meetings on the Monte Carlo Method.

- Expert Group on Reactor Stability and LWR Transient Benchmarks (Last updated: 06-May-2003)
  Forsmark 1 & 2 BWR Stability Benchmark;
  PWR Main Steam-Line Break Benchmark;
  BWR Turbine Trip Transients Benchmark.

Shielding-related activities

• Radiation Shielding and Dosimetry Calculation activities: (SATIF, SINBAD, QUADOS, Workshops, Training Courses, Conferences)

• This community is committed to further activities leading to refined modelling and improved predictions

Shielding aspects of accelerators, targets and irradiation facilities (SATIF)

http://www.nea.fr/html/science/egsaatif/index.html

- The NSC Task Force on "Shielding Aspects of Accelerators, Targets and Irradiation Facilities (SATIF)" deals with multiple aspects related to the modelling and design of accelerator shield systems

Shielding aspects of accelerators, targets and irradiation facilities (SATIF)

- SATIF Group: gathering of specialists in:
  - ⟿ Radiation Shielding (electron, proton, ion, spallation sources)
  - ⟿ Radiation Protection
  - ⟿ Radiation Dosimetry
  - ⟿ Computational (and modelling) aspects
  - ⟿ Nuclear data
  - ⟿ Benchmarking activities

EU-Concerted Action
QUADOS

Quality Assurance for Numerical Dosimetry

QUADOS
EURADOS
EUROPEAN DOSIMETRY GROUP
OECD
NUCLEAR ENERGY AGENCY

- **Monte Carlo** techniques and computer codes are widely used to solve problems in nuclear science, technology and applications
- Computer codes used as a "*black box*", user interaction performed via control cards, sometimes in detriment of the understanding of
  - *— "basic principles"*
  - *— the physics insight*
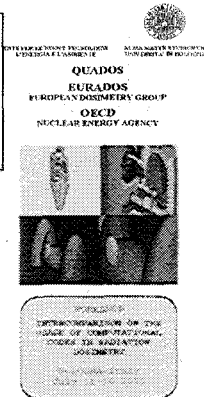
QUADOS Objectives

- The group designed a series of significant **reference problems,**
- **Verification of the correct usage of the computer codes,**
- Inform the community about the benefits to be obtained from **sensitivity and uncertainty analysis,**
- Inform the community about more sophisticated approaches that may be available to them.

Reference problems

- **Brachytherapy:** ^{192}Ir gamma-ray source.
- **Endovascular radiotherapy:** ^{32}P β^- source.
- **Proton therapy on the eye:** 50 MeV proton beam source
- **TLD-albedo dosemeter response:** neutron and/or photon sources.
- **Phantom backscatter:** X ray ISO reference beams.
- **Environmental scatter:** bare ^{252}Cf neutron source.
- **Germanium detector:** photon sources 15 keV< E <1 MeV.
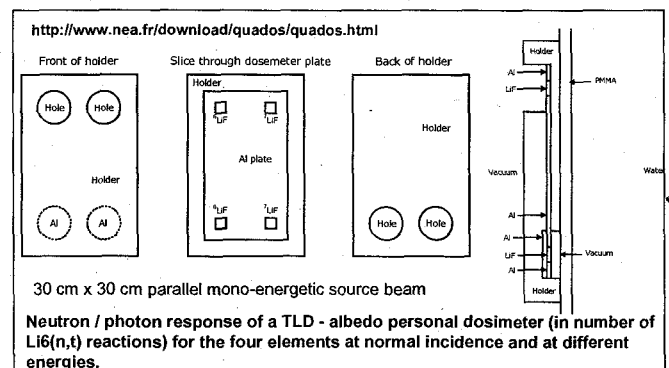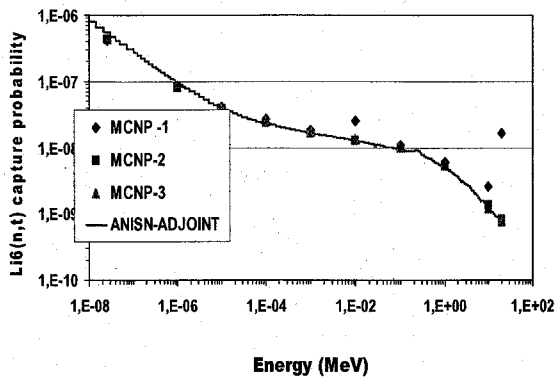- **Consistency check device:** ^{241}Am-Be neutron source.

http://www.enea.it

http://www.nea.fr/download/quados/quados.html

http://www.eurados.org

QUADOS Problem 4: TLD response function

http://www.nea.fr/download/quados/quados.html

Front of holder   Slice through dosemeter plate   Back of holder

30 cm x 30 cm parallel mono-energetic source beam

Neutron / photon response of a TLD - albedo personal dosimeter (in number of Li6(n,t) reactions) for the four elements at normal incidence and at different energies.

QUADOS - TLD

Detector 2

Legend:
- ◆ MCNP -1
- ■ MCNP-2
- ▲ MCNP-3
- — ANISN-ADJOINT

Y-axis: Li6(n,t) capture probability
X-axis: Energy (MeV)

TLD

MCNP/ANISN-ADJOINT

QUADOS TLD LI (EUGLE96)
Capture probability Li6(n,alpha)

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http://www.nea.fr/html/science/wppt/

Working Party on Scientific Issues in Partitioning and Transmutation (WPPT)

Scope	Objectives	Key Words
Meetings	List of Activities	Related Conference and Meetings
Publications	Links	Working Area (members only)

Scope

The Working Party will deal with the status and trends of scientific issues in Partitioning and Transmutation (P&T), comprising different disciplines such as accelerators, chemistry, material science, nuclear data and reactor physics.

Physics and safety of transmutation systems - benchmarks

- Calculation of Different Transmutation Concepts: An International Benchmark Exercise
- Comparison Calculations for an Accelerator-Driven Minor Actinide Burner (ongoing)
- ADS beam trip transient benchmark (ongoing)
- MUSE-experiment based ADS benchmark (ongoing)

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http://www.nea.fr/html/science/wpncs/

Criticality

- Working Party on Nuclear Criticality Safety (WPNCS)
  (Last updated: 25/Jan/01)
  WPNCS introductory page. This page contains several activities related to criticality safety studies.

  - o Burnup Credit Criticality Safety
  - o Experimental Needs in Criticality Safety
  - o ICSBEP (■ web page hosted by INEEL) - International Criticality Safety Benchmark Experiments Project:
  - o Subcritical Measurements
  - o Minimum Critical Values
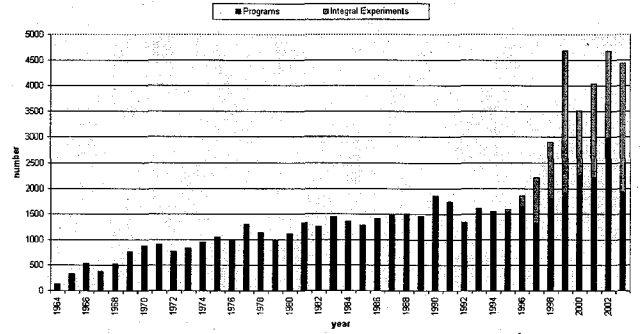 - o Source Convergence for Criticality Analyses

Program Acquisitions 1964-2003
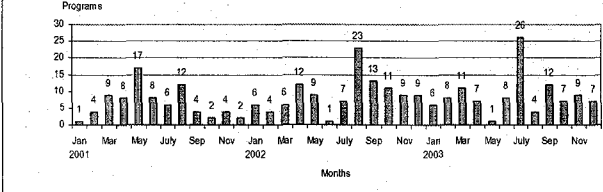
■ Programs OECD   □ Programs non-OECD
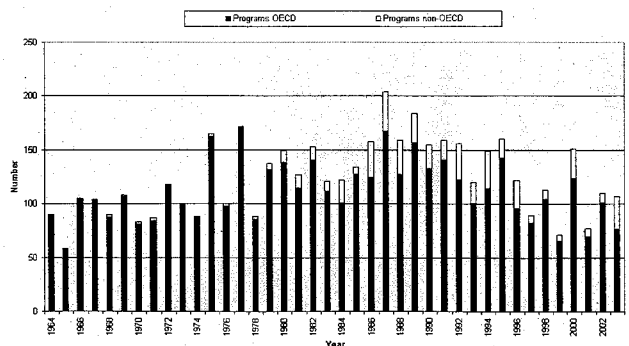
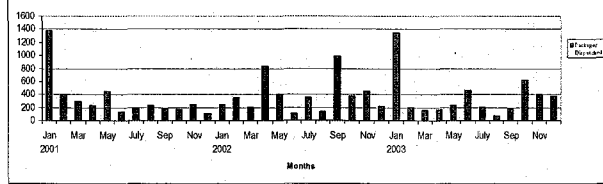Dispatches of Computer Codes 1964-2003 - total is 64340
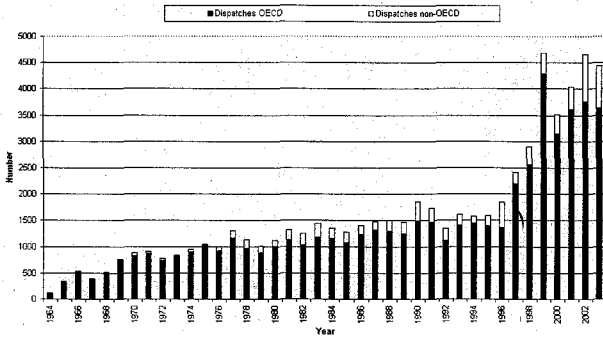
Computer Codes and Intergal Experiments Data distributed from 1964 - 2003
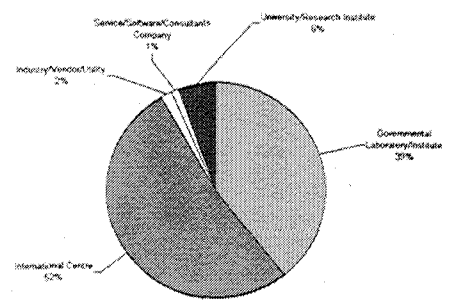

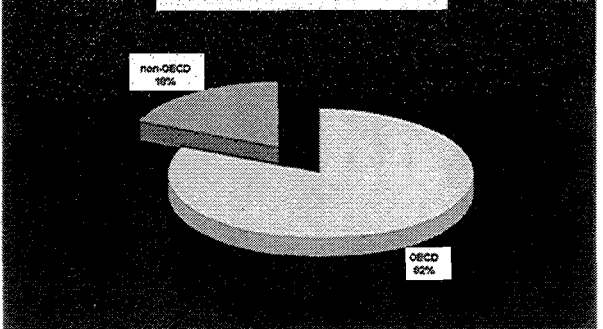Monthly Programs Acquisitions

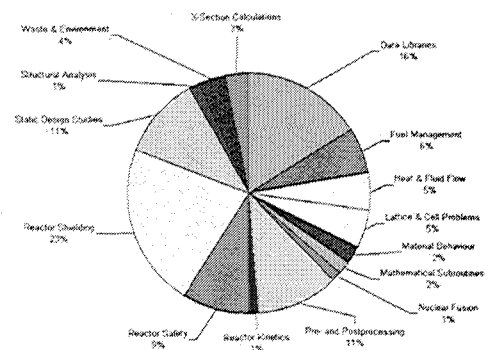Monthly Packages Dispatched

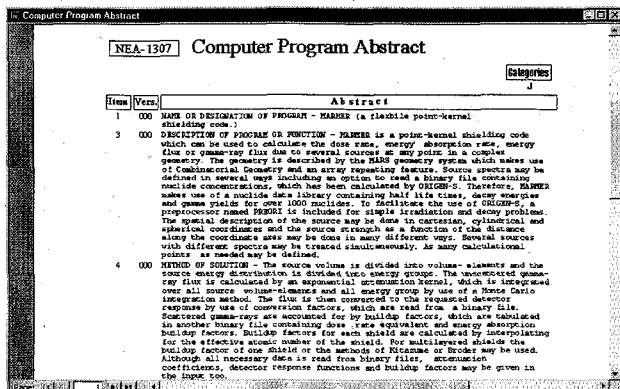Programs Acquired in 2003 by Establishment Type - total = 107

Dispatches to Service Areas 2003 (total is 4441)

Program Dispatches by Subject Categories 2003

Dispatches by Establishment type of Requester - 2003 - Total is 4441

Computer Program Abstracts on CD-ROM

Text Search

Example of results from Search

Codes presented at ICTP Workshop 2004

Code name	Abstract Id	Distributor
• ECIS-2003	NEA-0850/15	NEA Data Bank
• EMPIRE-II 2.18	IAEA1169/06	NEA Data Bank
• PREPRO-2002	IAEA1379/01	NEA Data Bank
• WIMSD-5B.12	NEA-1507/04	NEA Data Bank
• WLUP	IAEA1408/01	NEA Data Bank
• PREPRO-2002	IAEA1379/02	NEA Data Bank
• SAMMY-M6B	PSR-0158/10	RSICC
• NJOY99.90	PSR-0480/02	RSICC

Other Useful Codes for ICTP Workshop 2004

Code name	Abstract Id	Distributor
• GNOMER	IAEA1271/03	NEA Data Bank
• TRIGLAV	IAEA1370/02	NEA Data Bank
• CORD-2	IAEA1226/03	NEA Data Bank
• CALENDF-2002	NEA-1278/03	NEA Data Bank
• TRIPOLI-4.3	NEA-1716/01	NEA Data Bank
• PENELOPE-2003	NEA-1525/08	NEA Data Bank
• CHEMENGL/CHIMISTE	NEA-1561/08	NEA Data Bank
• NUCLEUS/CHART	NEA-1492/09	NEA Data Bank
• BOT3P3.0	NEA-1678/03	NEA Data Bank
• TOPICS-B	NEA-1406/02	NEA Data Bank

Web pages

OECD/NEA Data Bank:

- Computer program service:
  http://www.nea.fr/html/dbprog/
- Nuclear data :
  http://www.nea.fr/html/dbdata/
- Thermodynamic data :
  http://www.nea.fr/html/dbtdb/cgi-bin/tdbdocproc.cgi

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