

International Atomic Energy Agency

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 Division of Nuclear Power

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OVERVIEW OF THE INTERNATIONAL ATOMIC ENERGY AGENCY'SREACTOR PHYSICS ACTIVITIES

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Nuclear Power Technology Development Section

The reactor physics activities at the International Atomic Energy Agency fall under the responsibility of several Departments and Divisions. These include:

Department of Research and Isotopes

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| International Centre for
Theoretical Physics (ICTP, Trieste) | | (1) |
| Division for Physical and
Chemical Sciences (RIPC) | - Nuclear Data Section (NDS) | (2) |
| | - Physics Section | (3) |

Department of Nuclear Energy and Safety

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| Division of Nuclear Fuel Cycle (NENF)
and Waste Management | - Nuclear Materials and Fuel
Cycle Technology Section
(NM & FCT) | (4) |
| Division of Nuclear Power (NENP) | - Reactor Engineering Section
(RES) | (5) |
| | - Nuclear Power Technology
Development Section (NPTD) | (6) |
| Division of Scientific and
Technical Information | - Scientific Journals Unit (SJU) | (7) |

1. International Centre for Theoretical Physics (ICTP)

The Centre, which is operated jointly by the IAEA and the United Nations Educational, Scientific and Cultural Organization (UNESCO), helps foster advanced study and research in physical and mathematical sciences, especially in the developing countries, serving as an international forum for scientific

contacts between scientists from all countries, and providing facilities for visitors, associates and fellows - principally scientists from the developing countries - to conduct research.

The IAEA's programme in the physical sciences is designed similarly to help research workers and engineers especially in developing countries by promoting the dissemination and exchange of basic knowledge. The IAEA awards contracts to individual scientists and institutes in Member States for studies on such subjects as fission, neutron scattering and solid state physics. Regular international conferences and workshops on the physics of nuclear fission and on controlled thermonuclear fusion attract large numbers of distinguished scholars. The next workshop on Reactor Physics will be held early 1990 and will include lectures on research and power reactors.

2. Nuclear Data Section (NDS)

NDS has various activities to satisfy nuclear data needs in the field of reactor physics and other applications. The types of data include

- nuclear reaction data (induced by neutrons, charged particles, heavy ions or photons)
- nuclear structure and decay data
- atomic and molecular data (for fusion technology).

Data centre services are provided costfree by NDS to scientists in East Europe, Africa, Asia, Latin America, Australia. Other countries are serviced by the co-operating data centres at BNL (USA and Canada), Saclay (West Europe and Japan) and Obninsk (USSR).

Besides the maintenance of overall nuclear data files of experimental and evaluated data emphasis is given to the development of special data files and handbooks for various applications, and to the assessment of data needs and required data accuracies.

The NDS programme is reviewed by the International Nuclear Data Committee (INDC) which meets in intervals of about 18 months. Its 17th meeting took place in Vienna, 26-30 June 1989. The next meeting is scheduled for October 1990.

In the following, activities in the field of reactor physics are summarized.

- Reactor reactivity coefficients: The proceedings of a meeting on Nuclear Data for the Calculation of Thermal Reactor Reactivity Coefficients has been issued as IAEA-TECDOC-491. Essential data such as U-235 η in the thermal energy range will have to be re-evaluated.
- USSR evaluated data library BROND: A comprehensive evaluated nuclear data library, "BROND", has been issued by the USSR. The version BROND-NDS1 is available from NDS. A short documentation of this library is available as document IAEA-NDS-90 Rev. 1. A more detailed description of the evaluations is available as report INDC(CCP)-282 (English IAEA translation of a Russian original).

- Fission Products:

- * Issue nr. 12 of "Progress in Fission Product Nuclear Data" has been issued as report INDC(NDS)-191.
- * The summary report of a meeting on Fission Yield Evaluations (Sweden, Sept. 1987) has been issued as report INDC(NDS)-208. Another meeting in this topic will be held in Sept. 1989. A co-ordinated research programme on this topic is envisaged.

- Neutron Dosimetry: NDS maintains the International Reactor Dosimetry File (IRDF) containing recommended values of activation cross-sections for a selected set of materials used for neutron dosimetry by foil activation. The last version available is from 1985. A new version is scheduled to become available in the first half of 1990.

- Radiation Damage: An Advisory Group Meeting on Status and Requirements of Nuclear Data for Radiation Damage and Related Safety Aspects is being held in Vienna, 19-22 Sept. 1989.

- Gamma-ray detector calibration: A co-ordinated research project (CRP) on X- and Gamma-ray Standards for Detector Efficiency Calibration is in its final stage. The product will be a recommended data set for x-ray and gamma-ray emission probabilities for a carefully selected set of radionuclides suitable for calibration purposes. The accuracy of such data has been improved significantly by new precision measurements and data evaluations of CRP members.

- Actinide decay data: A recommended data set of Decay Data of the Transactinium Nuclides exists as IAEA Technical Report No. 261, issued in 1985 (printed 1986). In Nov. 1989 a specialists meeting will be held to review the status and requirements of transactinium isotope decay data, and to decide what actions must be taken to update the recommended data set.

- Assistance to developing countries:

- * Support for the creation of national data centers for reactor calculations was given to China and Indonesia in the form of fellowships, expert missions and equipment.
- * A Workshop on Nuclear Data and Reactor Physics is held biannually in Trieste, Italy. The next is scheduled for Feb. 1990.

Various other NDS activities exist in the fields of thermonuclear fusion, radiotherapy, technical assistance to developing countries in nuclear physics metrology, and - last but not least - international co-ordination of nuclear data centers.

3. Physics Section

The reactor physics activities are directed towards applications to research reactors and to the Agency's fusion programme.

Through the mechanism of research contracts, reactor physics codes for small computers have been and are being developed for different types of research reactors. Within the ARCAL (Latin America region) programme, a co-ordinated programme is ongoing for the analysis of research reactor cores for conversion to use low enriched uranium fuels. The programme includes meetings as well as expert services. Short courses on experimental reactor physics have also been conducted. A similar program for the RCA (Asia-Pacific region) has also been proposed.

Training courses on basic reactor physics calculations and analysis for core conversion are held at approximately two year intervals. These courses are intended to initiate and strengthen reactor physics activities in developing countries.

The fusion programme is carried out with the advise of the International Fusion Research Council (IFRC) which is composed of the leaders of the world's major fusion programmes. With the guidance of the IFRC the IAEA organizes a number of yearly international meetings in various fields of fusion research that are not adequately otherwise covered.

The fusion activities also support the developing Member States of the Agency. In this regard the Agency supplies expert services, equipment and limited financial contributions to selected laboratories. One Technical Committee Meeting per year, addressing the needs of the laboratories with small fusion programmes, is organized and support for attendance is provided.

The section organizes, on a biannual basis, the International Conference on Plasma Physics and Controlled Fusion Research. This is the largest meeting of its kind in the fusion calendar; attendance at these meetings is approximately 700 scientists from all national fusion programmes. Support for a limited number of scientists from developing Member States to attend the Conference is provided.

The International Thermonuclear Experimental Reactor (ITER) is conducted under the auspices of the IAEA. This project, conducted jointly by the EEC, Japan, the USSR and the USA, has the purpose of producing, by the end of 1990, the conceptual design for a next step tokamak experiment that will reflect the consensus of all the partners. The IAEA provides the administrative support for ITER.

4. Nuclear Materials and Fuel Cycle Technology Section (NM & FCT)

The main activities of the section cover studies on water reactor fuel. Lately, greater emphasis has been given to fuel design and manufacture, materials reliability under various operating conditions

(including abnormal and up to severe accident) and to improving the economics of the fuel cycle (options of high burnup of open versus closed cycle etc.). The steady growth of fuel related programmes in developing Member States required a more acute assistance with the aim of maintaining highest reliability standards throughout the world.

This section is co-ordinating also the work of the International Working Group on Water Reactor Fuel Performance and Technology (IWGFPT). The objectives of the IWGFPT are to assist the IAEA and to co-ordinate the work in the following areas:

Fuel design and engineering, fuel fabrication, fuel behaviour, fuel performance modelling, fuel utilization and management, alternate fuels and advanced fuel technology and materials and economics of fuel design, fabrication and operation.

During 1989 meetings were held in the framework of the following programmes:

- Examination and Documentation Methodology for Water Reactor Fuel (ED-WARF);
- Technology and Performance of Integrated Burnable Absorbers;
- Water Reactor Extended Burn-up Study (WREBUS);
- Treatment of damaged nuclear fuel.

The following meetings are planned:

- CRP on Behaviour of Fuel Assemblies in Extended Storage (BEFAST-II);
- TCM on Recycling of Plutonium and Uranium in Water Reactor Fuels;
- AGM on Advanced Fuel Technology and Performance.

5. Reactor Engineering Section (RES)

This Section is responsible for the International Working Group on Nuclear Power Plant Control and Instrumentation (IWG-NPPCI) and on the Reliability of Reactor Pressure Components (IWG-RRPC).

International Working Group on Nuclear Power Plant Control and Instrumentation (IWG-NPPCI)

The objectives of the IWG-NPPCI are:

- a. To assist the IAEA in providing the Member States with information and recommendations on technical aspects of nuclear power plant control and instrumentation, with the aim to assure reliable plant operation; and
- b. To promote an exchange of information on national programmes, new developments and experience from operating nuclear power plants, and to stimulate the co-ordination of research on nuclear power plant control and instrumentation.

The scope of the IWG-NPPCI activities includes among other things the following main topics: nuclear instrumentation, control systems, protection systems, process instrumentation, control room and man-machine interface, human factor engineering, use of computer technology in NPP operation, electrical power supply for I&C and actuating devices, NPP training simulators.

The following specialists' meetings are planned for 1990:

1. Communication and Data Transfer in Nuclear Power Plants, France, April;
2. Probabilistic Reliability Analysis and Experience in I&C as a Decision Tool, The Netherlands, second half of 1990;
3. Symposium on Balancing Automation and Human Actions in Nuclear Power Plants, Munich, Federal Republic of Germany, 7-13 July 1990.

International Working Group on the Reliability of Reactor Pressure Components (IWG-RRPC)

Major objectives of the IWG-RRPC foresee a provision of the IAEA Member States with information and comments on design aspects, material selection, fabrication aspects, testing and operational aspects related to NPP pressure systems and components with the aim to assure their reliable function.

Scope of activities of the IWG-RRPC includes a large number of major topics like design, information on service and test conditions, materials assessment and selection, fabrication (shop and field) including problems of repair and replacement, testing and inspection, which embraces preservice inspection, in-service inspection and surveillance, surveillance programmes, continuous surveillance.

"Nuclear Power Plant Ageing and Life Extension" is one of the recent activities which is included in the scope of the IWG-RRPC activities with the emphasis on technological aspects of the phenomenon covering investigations of anticipated mechanisms, methods of component categorization and prioritization approaches to component life-time assessment and monitoring.

There is also a co-ordinated research programme, "Optimizing Reactor Pressure Vessel Surveillance Programmes and Their Analysis" (Phase III). Within the subject area four goals are delineated: 1) optimization of the means for measuring fracture resistance, 2) establishing correlations between different mechanical test methods used for measuring irradiation response, 3) understanding of the underlying mechanism responsible for embrittlement and 4) establishing methods for ameliorating embrittlement.

6. Nuclear Power Technology Development Section (NPDT)

This Section is in charge of the official Agency liaison with the NEACRP of OECD. It furthers progress in the area of thermal reactor technology, improved reactor concepts, nuclear heat applications and fusion engineering and technology. More particular, the Section is dealing with subjects on in-core fuel management, applied reactor physics, core design and management for power reactors.

Late 1988, three Co-ordinated Research Programmes (CRP) were initiated:

- a. The CRP on the Establishment of a Thermal Data Base aims to provide reliable data on thermo-physical properties of all materials used in water-cooled power reactors. Unfortunately, not much progress has been made yet.
- b. The CRP on In-core Fuel Management Code Package Validation is set up to obtain well defined test cases for the verification of code packages for PWR, BWR and VVER developed at a CRP during the early eighties. This CRP will terminate end of this year.
- c. The CRP on Safe Core Management with Burnable Absorbers in VVERs aims to improve the knowledge on burnable absorbers for usage in VVERs. Calculations and experiments are foreseen in the first year. It is also hoped to get access to up to date nuclear data libraries for gadolinium isotopes.

Recently a CRP on Benchmark for In-core Fuel Management Programs of PHWRs has been initiated. In this CRP test cases are set up for verifying PHWR code packages.

For late 1989, the following meetings are foreseen:

1. Research Co-ordination Meeting of the Co-ordinated Research Programme on In-core Fuel Management Code Package Validation for LWR, VIC, 28 November - 1 December 1989;
2. Technical Committee/Workshop on In-core Fuel Management, VIC, 4-7 December 1989;
3. Research Co-ordination Meeting of the Co-ordinated Research Programme on Safe Core Management with Burnable Poisons in VVERs, VIC, 11-13 December 1989.

From 26-29 March 1990, a Technical Committee meeting will be held on Technical and Economic Aspects of High Converters in Nuremberg, Federal Republic of Germany. This TC was originally scheduled for 1989, but had to be postponed to 1990. The object is to review and discuss worldwide progress on the implementation of high conversion reactors.

The Section is also responsible for the International Working Groups on Fast Reactors (IWG-FR), Gas-Cooled Reactors (IWG-GCR), and Advanced Technologies for Water-cooled Reactors (IWG-ATWR).

International Working Group on Fast Reactors (IWG-FR)

The IWG-FR exchanges information on sodium-cooled reactor technology development. In past years, reviews have covered areas of sodium technology, operational experience, reliability of control equipment, fuel behaviour and safety related aspects. The present trend is increasingly towards simplifying designs and extending the life of fuel in order to achieve vital costs reductions together with enhanced safety.

Under the IWG-FR two co-ordinated research projects are carried out:

1. acoustic signal processing for the detection of boiling or sodium/water reaction;
2. intercomparison of LMFBR core mechanics codes.

Further, the IWG-FR held a Specialists' Meeting on Advanced Control for Fast Reactors, in Argonne, USA, on 20-22 June 1989.

International Working Group on Gas-cooled Reactors (IWG-GCR)

The main interest of the IWG-GCR is on gas-cooled reactors utilizing either a steam cycle or a direct cycle for electricity generation and/or heat production. The scope of the IWG-GCR includes the areas of programme assessment and planning, systems analysis and utilization strategies, research, development, design, construction, safety aspects, related nuclear fuel cycle technology, process heat applications and operation and maintenance of gas-cooled reactors.

Recently, the IWG-GCR has published a status report on gas-cooled reactors design and safety.

In the framework of this IWG, it is planned to establish a new CRP. The aim of the CRP would be to collect, review and discuss high-quality experimental data on low-enriched uranium (LEU) pebble bed cores under clean cold core conditions and under simulation of water ingress resp. under presence of highly absorbing burnable poisons (e.g. boron and/or hafnium). Such experiments have never been carried out up to this day for LEU-HTR-cores. They would allow a better qualitative understanding of the phenomena investigated and would provide the necessary experimental background in this domain, against which analytical tools used in design and licensing procedures (computer codes and nuclear data) could be validated. It is planned to perform the experiments at the PROTEUS facility of the Paul Scherrer Institute in Würenlingen.

International Working Group on Advanced Technologies for Water-Cooled Reactors (IWG-ATWR)

The IWG-ATWR provides a forum for the exchange of information on improvements in the current generation of water-cooled power reactors, on the evolution of their design and on new design concepts for near-term application, with emphasis on reliability and safety.

A technical report on the status of Advanced LWR Design and Technology was published in 1988 and a similar report on HWRs in 1989.

7. Scientific Journals Unit (SJU)

This Unit is responsible for the peer reviewed journal Nuclear Fusion and its supplements, the most important of which is the World Survey of Activities in Controlled Fusion Research. The unit reports to NESI, to the Agency's advisory body on fusion, the International Fusion Research Council, and to the Board of Editors of the journal.

The journal publishes regular articles on experimental and theoretical thermonuclear research as well as review articles on atomic and nuclear data for fusion and on fusion reactor relevant technology. It publishes executive summaries of the Agency-sponsored INTOR and ITER reactor studies. The editor of the journal consults the Nuclear Fusion's Board of Editors on the journal's contents and on editorial policy matters. The Board consists of eminent scientists in fusion research coming from different Member States.

The World Survey lists the institutes, personnel and activities in thermonuclear research. An important part of the Survey deals with reactor oriented projects.