

**NUCLEAR ENERGY AGENCY COMMITTEE  
ON REACTOR PHYSICS**

**SUMMARY RECORD  
OF THE THIRTY-THIRD MEETING**

TECHNICAL SESSION  
(NEACRP-L-332)

OECD, Château de la Muette, Paris  
15-19 October 1990

Compiled by  
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**ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT**

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## I. INTRODUCTORY REMARKS BY NEA'S DIRECTOR GENERAL.

The Director General of the OECD/NEA, Dr. K. Uematsu, welcomed the participants and made the opening remarks reported in full in Annex 1.

## II. TECHNICAL SESSION

A complete list of all the papers presented at this meeting is given in Annex 4. In the technical sessions, five new topics were introduced and five topics were carried over from the previous meeting. Following an established practice, for each topic a Committee member was assigned to prepare a draft summary, and these summaries were reviewed by the other members of the Committee.

1. New Topics1.1 Current Issues of Plutonium Recycling in LWRs

Rapporteur : P. D'Hondt

Papers : A-1047, A-1048, A-1049, A-1055, A-1066, A-1067, A-1116

As large-scale MOX irradiation campaigns are now considered in various industrial countries, there is a need to develop, improve and validate nuclear computer codes.

Most of the papers presented in this session, apart from papers A-1066 and A-1067, dealt with this aspect.

Papers A-1047, A-1048, A-1049 give an overview of the recently started VIP-programme. The objective of this programme is to constitute a complete set of experimental measurements performed with UO<sub>2</sub> and MOX fuel rods in order to provide an extensive nuclear data base for the development and the validation of nuclear calculation methods for MOX fuels used in LWRs. A VIP programme is devoted to Pu-recycling in BWRs; the technical proposal for the phase 1 of this programme constitutes paper A-1048. Another one is devoted to Pu-recycling in PWRs; paper A-1049 is the technical proposal for the phase 1 of this programme.

Paper A-1055, entitled "Plutonium reload experience and perspective in French PWR plants", describes a two-year experience of Pu-reload operation in 900 MWe PWRs now acquired in France. Following the French policy of spent fuel reprocessing, the Pu-recycle presents two main interests:

- reduction of natural uranium needs for PWR plants
- temporary solution for the Pu-storage during the intermediate period before the FBR programme economic interest is demonstrated.

Different aspects leading to the French experience in Pu-reload are treated:

- neutronic calculations organisation and methods
- critical experiments performed by CEA
- available neutronic calculations and measurements of PWR MOX cycles obtained by EDF

- available radiation measurements during MOX cycles in French PWR plants
- MOX fuel behaviour
- economic aspects and EDF programme.

Paper A-1116, entitled: "Investigations on Pu-recycling and High Burn-up for LWRs in the Federal Republic of Germany", gathers five papers presented at different other technical meetings. The paper was not presented in detail but was distributed as information on current issues in FRG related to the subject of this session. It was stressed that one of the papers in this bundle also gave information on enriched reprocessed uranium (EPU).

Paper A-1066 deals with a new Japanese concept of a Pu-generation boiling water reactor (PGBR). Feasibility studies were performed for three kinds of PGBR core designs from the viewpoint of nuclear, thermal-hydraulic, mechanical and safety performances. The authors claim that the proposed design concept of PGBR has a potential for achieving a plutonium generation ratio close to 1.0 and for better natural uranium utilization by a factor of 5 to 10 compared with current LWRs. They further claim that the concept has the potential of realising a new recycle system in which Pu and other actinides are confined only to nuclear reactors and reprocessing plants.

Paper A-1067 is entitled "Utilization of MOX fuel assembly containing Gd<sub>2</sub>O<sub>3</sub> in ATR". This Japanese paper describes the analysis of changes in the characteristics of the fuel assemblies due to the addition of Gd. Utilization of UO<sub>2</sub>-Gd<sub>2</sub>O<sub>3</sub> fuel within the MOX assemblies is reported, as well as the use of duplex-fuel in which the outer region and inner region of the pellets are made respectively of MOX and Gd<sub>2</sub>O<sub>3</sub>. The outcome of this work shows that progress is made to meet the requirement for burn-up extension and high performance in ATR.

The general discussion on this session dealt mainly with economical aspects of Pu-recycling. At this very moment no clear answer could be given to Heinz Kuester's question if Pu-recycling is more economical than the classical UO<sub>2</sub>-fuel cycle. Although French delegates claimed that for identical burn-up (about 33 GWd/t) the MOX-cycle cost is lower than the UO<sub>2</sub>-cycle-cost, the situation might be different with a view to the enhanced burn-up policy for UO<sub>2</sub>-fuel.

Dr. Uematsu, Director General of the NEA, showed his interest in this economic aspect of the Pu-recycling in LWRs. With a view to the future activities of the NEA, he showed interest not only in the reactor physics aspect but also in the aspects related to the economics and the waste disposal problems associated with Pu-recycling.

Due to the large interest in this topic from the Committee as well as from the NEA Direction, it was felt that the topic should be kept for the next meeting.

1.2 Review of Requirements for the Methods of Validating Neutronics Codes (i.e. Quality Assurance for Neutronics Codes)

Rapporteur : L. Lesage

Papers : A-1056, A-1084, A-1085, A-1091, A-1094, A-1095,  
A-1096

Two papers (A-1056 and A-1084) discussed formal procedures used in the validation and documentation of neutronics codes, for the management and control of the code. Paper A-1056 discussed the procedures which have been specifically developed for the ERANOS code, procedures which are particularly important because of the multinational involvement in the development of this code. These procedures stressed coding standards, documentation, rules for code testing and code maintenance. Paper A-1084 described the procedures which have been used at Argonne National Laboratory (USA) for neutronics codes for the past several years.

Paper A-1085 (not presented) contained three inserts from the Reactor Analysis Support Package of the Electric Power Research Institute. These inserts describe the methods used to validate neutronics codes and calculational methodologies for LWR reactors in the U.S.A. with specific guidance for submitting these methodologies to the USNRC for approval. The calculational methodologies include both the codes and the way the codes are applied to particular problems. The titles of the three inserts are "BWR Physics Analysis Guidelines", "PWR Physics Analysis Guidelines" and "Guidelines for Developing a Reload Capability".

Paper A-1091 reviewed the uncertainties and validation requirements of several safety parameters important to modular high-temperature gas-cooled reactors (MHTGR). The parameters evaluated included core temperature coefficient, control rod bank worth and shutdown margins, and water ingress effect. In general, the analyses of the available measurements of importance to these parameters were in reasonable agreement with the measured values. However, for many of the measurements the analyses were old and calculation with current methods and data is desirable.

A narrative description of the difficulties encountered in licensing the shutdown system software at the CANDU Darlington Nuclear Generating Station was included in paper A-1096. These difficulties essentially eliminated the potential advantages of adopting a software based system, and highlighted the type of problems that can be encountered when trying to obtain licensing approval of sophisticated safety related software. Papers A-1094 and A-1095 (not presented) gave more details of validation process for this software system.

It was also noted that some of the NEACRP benchmarks (e.g. the criticality safety benchmark) contribute to neutronics code validation. The validation requirements for codes with direct licensing/safety implications were observed to be different (more formal and auditable) than for codes which are used for R and D purposes. It was decided to retain this item on the Agenda for the next meeting of the Committee.

### 1.3 Physics Related Safety Aspects of Fast Reactors

Rapporteur: M. Salvatores  
Papers : A-1057, A-1058, A-1059, A-1068, A-1086.

Five papers were discussed during this session. Three French papers (A-1057, A-1058, A-1059), one Japanese paper (A-1068) and one US paper (A-1086).

The first French paper (A-1058) discussed ways to reduce the Na void coefficient in large size LMFBRs (1000 MWe or more), making use of a systematic investigation of the physical characteristics of that reactivity effect. Some present indications concern the favorable results obtained a) with an "H"-shaped core (i.e. inner core with reduced height and an outer core with increased height), b) with a core where axial blankets are eliminated and axial upper structures are reduced (to enhance leakage), and c) with radial heterogeneous configurations.

The second French paper (A-1059) discussed the potential for Na void reduction of a modular island core. Benefits and disadvantages of increased decoupling were pointed out in the discussion. Special attention should be exercised on increased tiltiness of power shapes in this type of core.

Papers A-1057 from France and A-1068 from Japan discussed the performances of dense fuels for large LMFBRs. Paper A-1057 shows that a metal core should be optimized explicitly, otherwise known characteristics (such as higher positive Na void coefficient and low Doppler) counterbalance the better breeding gain in comparison with an oxide core. Paper A-1068 indicated the possibility to design an optimized nitride fuel core with respect to safety without degrading core performance.

Finally, paper A-1086 presented the first results on a measurement-based method for predicting the response of an LMR core to unprotected accidents. The method has been tested successfully by processing simulated measurements generated for the EBR-II reactor.

It is felt by the Committee that the topic of physics related safety aspects of fast reactors is still of high interest for several member countries and that relevant work is going on. It was decided to keep the topic on the Agenda for the next meeting. However, Committee members were invited as far as possible to submit contributions aiming to shape guidelines for physical judgement on this important subject.

### 1.4 New Facilities of Importance for Neutronics and Reactor Physics Research (Intense Neutron Sources, MAPLE, etc.)

Rapporteur: L. Lesage  
Papers : A-1052, A-1087.

The design of a cold neutron moderator facility for use with the SINQ continuous wave (CW) spallation neutron source is described in paper A-1052. The source is driven by a CW high current proton cyclotron. Since the source is CW and not pulsed it was decided to design the moderator source facility to be as similar to a reactor neutron facility as possible. The moderator

facility arrangement includes vertical beam injection into the center of a large D<sub>2</sub>O tank. Both cold and thermal neutron ports and ports for neutron guides are provided. The safety analysis for the facility was discussed.

In paper A-1087 a proposal for a high neutron flux fusion materials testing facility was discussed. The spallation neutron source would be driven by the Continuous Wave Deuterium Demonstrator (CWDD), a very high current D<sup>+</sup> accelerator currently under construction at Argonne National Laboratory. The CWDD is very similar to the accelerator part of the previously proposed, but later cancelled, FMIT fusion materials facility; The availability of the CWDD for use in a fusion materials facility greatly reduces the projected cost of the proposed facility. The CWDD is a joint project of the Grumman Corporation, Argonne National Laboratory, the Culham Laboratory, the Marconi Company, and Los Alamos National Laboratory.

It was decided to retain this item on the agenda for the next meeting and to interpret its scope to be fairly broad, including all significant new nuclear research facilities (both reactor and non-reactor).

#### 1.5 Fusion Blanket - Shield Neutronics with Emphasis on the Effects of Uncertainties (including Effects of Double Differential Data)

Rapporteur : H. Rief

Papers : A-1053, A-1060, A-1069, A-1070, A-1071, A-1088,  
A-1092, A-1101, A-1113.

Papers tabled in this Session focused on the capability of calculating fission blanket characteristics such as:

- breeding ratios, with or without neutron multipliers
- data uncertainties
- sensitivities of the T. F. coil shielding parameters, and
- a program for the analysis of neutron induced transmutations and activations.

There is one overall conclusion that can be drawn from this session: except for minor details, the cross-sections required in fusion blanket research at this moment are sufficiently well-known, if the most recent nuclear data libraries (such as ENDF/B-VI, JENDL-3, JEF-2) are applied.

For report A-1053 the effect of different Beryllium data (ENDF/B-V, ENDF/B-VLA and ENDF/B-VI) on the neutronic characteristics of the breeder blanket of ITER is analyzed. Differences of 7% were found for the total tritium breeding ratio and 27% for the damage rate in the superconducting magnets if ENDF/B-VI was used.

Paper A-1060 summarizes the results of an exhaustive sensitivity study of the NET blanket and shield parameters. They were obtained for the main radiation load parameters of the coil legs with the SN code BISTRO in the typical fusion 179 group structure. This analysis shows that the main uncertainties result from the iron cross-sections, leading to a  $\pm 25\%$  standard deviation of the calculated fast fluence and DPA in the coils and copper stabilizers. Similar results were obtained for the nuclear heating.

This confirms to a large extent the opinion of some other members of the NEACRP.

Paper A-1092 on reaction rate distributions and related data in the FNS Phase II experiments come to a similar conclusion for ENDF/B-V transport and ORACT activation cross-sections. They reproduce the measured spectra, activation and tritium production values in a satisfactory manner and will allow for future fusion reactor design studies.

The program ANITA described in A-1101 computes the radioactive inventory of a material exposed to neutron irradiation. It provides activity, decay heat, ingestion hazard, contact dose equivalent, gamma spectra and other relevant parameters as a function of the cooling time.

In paper A-1113 experimental and calculational results of a hybrid fusion blanket mock-up are discussed. A preliminary 3-D analysis shows agreement within the uncertainty limits of most of the measured values, again confirming the validity of the nuclear data bases.

## 2. Topics Carried over from Previous Meetings

### 2.1 Evaluation of the Uncertainty in FBR Burnup Reactivity Swing

Rapporteur: K. Jirlow  
Papers : A-1072, A-1089, A-1115.

During this session three papers were presented, two from Japan (A-1072 and A-1115) and one from the U. S. (A-1089).

In the first paper (A-1072) the prediction accuracies of the main safety-related core parameters - control rod worth, sodium void effect and Doppler reactivity - were evaluated for a large FBR core. The analysis was based on comparing C/E values for these parameters found in the Jupiter experiments, with calculations using JENDL-2 data and advanced 3-D diffusion method with mesh and transport corrections. The systematic and random errors in the C/E values and Beta-eff as well as in the core geometry, composition, temperature and cross-section data, were assessed. The results for this particular 1000 MWe FBR core show that the void reactivity is overestimated by 23 to 29% depending on radial position and that the random error is around 30%. The Doppler coefficient was slightly underestimated with a 2s uncertainty of 19%. The target accuracies estimated from design limits and safety analysis were 15% for these parameters, which means that there is a need for considerable improvement.

Paper A-1115 "Analysis of Joyo Burnup Characteristics" gives an overview of the post-irradiation analysis and the comparison with calculations using JENDL-2 data and the 3-D diffusion code MOSES. For the reactivity loss per 50 MWd burnup a C/E ratio close to 1 was found but the uncertainty was about 10%. For the relative changes in heavy isotope ratios (Pu-239/Pu, Pu-240/Pu etc.) there were in general slight overpredictions around 10%.

Paper A-1089 "Pin Power and Depletion of EBR-II" describes the development and validation of the RCT code based on spatial reconstruction of group fluxes and nuclide densities within the subassemblies (hexagonal nodes). This code is used in conjunction with the Hex-Z nodal option of the REBUS-3/DIF3D code for depletion calculations of EBR II fuel and for fuel cycle analysis of advanced FBR design (in particular, the IFR concept). The RCT

method uses higher order polynomial expansions assuming the neutron flux in the node is separable in the hex-plane and the axial direction.

Comparisons with EBR II measurements show that the method is accurate within experimental uncertainties.

## 2.2 The Reactor Physics of Advanced Gas-Cooled and Water Reactors

Rapporteur: M. Darrouzet

Papers : A-1050, A-1061, A-1073, A-1074, A-1109.

Five papers were discussed. Paper A-1061 from France presents some studies in progress concerning advanced water reactors (new absorbers, 3-D calculation methodology, studies of 100% MOX core, in particular with a higher moderation ratio).

Papers A-1073 and A-1074 from Japan discuss HTTR. The first paper reports the measurements by the pulsed neutron method, of void reactivity worth of HTTR mockup control rod hole in VHTRC-1 core. The comparison with calculated values shows that the Benoist anisotropic diffusion coefficient gives better agreement than conventional diffusion coefficient. It was concluded that the direction dependent diffusion coefficients must be taken into account to evaluate the streaming effect of neutrons through large holes. The second paper gives the results of the analysis of measurements of the temperature effect of reactivity for VHTRC and SHE with the nuclear design code system developed for the high temperature engineering test reactor. The conclusion is that this code system predicts well the temperature effect.

The member from Switzerland gave some information concerning the HTR experiment in PROTEUS: the project is approved, the fuel will arrive at the end of 1990. Discussion with possible partners is in progress on the content of the experimental program.

The first of the two papers from the USSR (A-1050) gives the results of the SPEKTR and MCU codes tested on a set of benchmarks covering fuel lattices of PWR and HCLWR reactors with different moderator to fuel ratios for uranium and mixed fuel compounds. Methodological features of the codes were analyzed and recommendations are given on their correct use. One of the conclusions is the need to refine nuclear data for HCLWR and SWPR neutronic calculations.

The second USSR paper (A-1109) concerns the experimental program investigated for HCLWR physics at Obninsk and in particular the measurements which have been realized in BFS57 with uranium fuel, in BFS59 with plutonium fuel and the temperature effects of reactivity measured between 20°C and 240°C for several configurations in MATR critical facility for uranium fuel.

A summary of the highlights of the meeting on the Technical and Economic Aspect of High Converters (Nueremberg, 26-29 March 1990) was presented by the IAEA observer. The workshop recommendations of interest to NEACRP were:

- need for reducing the relatively large discrepancy on calculated conversion ratios
- need for benchmark exercises: a) assembly calculation, and b) whole core calculation

- need in the field of safety-related physics for benchmarked space-time kinetics codes with thermal-hydraulics coupling.

After discussion, it was felt that the topic should be modified to cover advanced reactor concepts (other than LMFBRs). The information on HTR studies will be given in national progress reports. The purpose of the new topic should be to allow the Committee to give judgements on specific new advanced concepts.

### 2.3 Engineering and Physics Aspects of Transuranium Burning by Reactors and Accelerators

Rapporteur: Y. Kaneko

Papers : A-1054, A-1062, A-1075, A-1076, A-1090, A-1112

Paper A-1054 (Switzerland) has made an analysis on the reduction of the long-term toxicity of Neptunium by nuclear spallation. The toxicity of the transmutation products is dominated by spallation products and is 40 to 500 times smaller than the toxicity of the original Np-237 and its decay products between  $10^3$  and  $2 \cdot 10^7$  years. The residual long-term toxicity (beyond  $10^7$  years) is about the same as that of natural U308.

Paper A-1062 (France) estimates the change of the radiotoxicity of nuclear waste followed by the introduction of the plutonium recycling (closed cycle with one recycling). The recycling is rather favorable to the reduction of the radiotoxicity of the wastes. But its impact is not decisive.

Paper A-1075 (Japan) reports on the present status of the studies on the TRU transmutation by use of the proton accelerator. The proposed transmutation plant is a hybrid system consisting of an internal proton accelerator, a tungsten target and a subcritical core loaded with the TRU metal fuel. In order to validate the data and method, an integral spallation experiment has been planned using a 500 MeV proton synchrotron accelerator at KEK. The Basic Technology Proton Accelerator (10 MeV, 10mA) is to be constructed aiming at establishing the technologies related to a high current accelerator.

Paper A-1076 (Japan) has made an analysis on the possibility of the TRU transmutation in LMFBRs. One method is dispersing TRUs homogeneously throughout the whole core. The other method is the use of a small number of sub-assemblies containing the TRU elements up to 50%. The former is more feasible, compared to the latter, from the viewpoint of the power peaking problem during burn-up.

Paper A-1090 (USA) analyzed the change of the radiological hazard of the nuclear waste measured in the fatal cancer dose using the various ICRP data. It is shown that in all cases the transuranics dominate the long-term hazard, Am-241, Pu-239, Pu-240, and Np-237 being the most important contributors.

Paper A-1112 (USSR) describes the feasibility of a special nuclear reactor where a large part of power is to be provided by actinides burning. It is pointed out that it is required extracting Cm isotopes which have the highest specific heat power from the mixture and subsequently burning them in separate fuel elements in highly diluted status. It is also shown that the

value of Beta-effective becomes very small (0.09-0.12) if Plutonium is extracted from the fuel.

Paper A-1112 (USSR) reports the assessment of requirements for actinides nuclear data for LMFBR core loaded with MOX fuel and evenly distributed TRU actinides. Preliminary analysis on the reactivity experiments for Pu-240 made at FCA has shown significant discrepancies with the results which have already been reported from Japan.

#### 2.4 Local Stability in LWRs and HWRs with Emphasis on 3-D Effects

Rapporteur: F. N. Mc Donnell

Papers : A-1077, A-1078, A-1098, A-1099, A-1102

This session covers papers on BWRs and CANDUs, from Japan, Sweden and Canada. The session stimulated much discussion and the consensus was that this topic should be retained on the Agenda in the future but perhaps in a modified form.

The first paper (A-1077) addresses regional oscillations in a BWR with TOSDYN-2. In particular, radial power distribution effects on the out-of-phase regional oscillation were analyzed with the 3-D transient analysis code TOSDYN-2, by changing the location of the hottest bundles in a BWR core. The calculated results show that the regional oscillation is likely to occur when the hottest bundles, which are thermal-hydraulically the least stable, are located close to the periphery rather than located close to the center of a core.

The second paper (A-1078) from Japan, examines nuclear-thermal oscillation modes in a BWR core. The analyses have successfully predicted the observed oscillation modes. A mode-map has shown that if the flow resistance out of the core is small, the core-wide mode appears before the out-of-phase mode, and that it is opposite in a core with a large flow resistance out of the core.

The next paper (A-1107) from Sweden, describes a BWR stability investigation performed on noise measurements collected at Ringhals 1 in connection with power oscillations which occurred on October 26, 1989. The incident demonstrated the value of on-line monitoring the measurement of stability (Decay-Ratio).

The fourth paper (A-1098) outlines a figure of merit to assess the first azimuthal mode instability in CANDU reactors. One outcome of the assessment was recognition of the importance of uniformly distributing voiding during a LOCA. This could be achieved by PHT feeder interlacing when subcriticality of the first azimuthal mode is less than -15mk.

The final paper (A-1099) from Canada provides a brief update on SMOKIN, a code used to calculate loss-of-coolant reactivity in CANDU-PHW reactors. SMOKIN uses modal kinetics theory. A validation program has been in progress for several years. It is likely that the results of this validation program will be presented at a future meeting.

## 2.5 Physics Methods in Fuel Accountability

Rapporteur: M. Darrouzet  
Papers : A-1063, A-1079.

The first paper from France presents active and passive non-destructive methods developed to measure burnup, cooling time and effective multiplying factor to allow a safety criticality control in reactor pools before taking the assemblies into the transport casks or to check, in a reprocessing plant, the declared compositions of the assemblies before shearing and dissolving. The qualification methods for an industrial context are given.

The second paper from Japan concerns two systems built for non-destructive measurement of trace amounts of fissile material contained in 200 liter drums of wastes. The first system uses the active neutron interrogation method. A large variety of matrices of waste were measured (bitumen, concrete, sand, etc.). The second system uses a neutron passive method and has a high efficiency of detection. An effort was performed to analyze the time spectrum. The claimed detecting sensitivity is very good.

No important evolution on this topic is expected in the near future. It seems that the topic should not be kept on the agenda for the next meeting.

## 3. Benchmarks and Data Bases.

H. Rief reported on a benchmark proposal made at the Monte Carlo Conference in Budapest (September 1990) which aims at identifying the most suitable biasing schemes for a set of problems, and at determining to what extent they can be automatised for use by non-experts. This benchmark would address the efficiency of the following biasing schemes:

- weight window (LANL);
- optimized splitting (ENEA and BGI-Israel);
- adjoint weighting (AEA T);
- TRIPOLI importance sampling (CEA).

The problems would be chosen so that they can be run also with an analogue Monte Carlo. The Committee felt that some of these comparisons are already taking place (MCBEND - MCNP - TRIPOLI). The conclusions of these studies should be reported to the Committee. As far as the new proposal is concerned, a leader should be identified (possibly ENEA Bologna) who should first enquire about the real interest in the shielding community, and if sufficiently large, submit the proposal to NEACRP.

R. Martinelli reported on another benchmark proposal, suggested in the concluding session of the Specialists' Meeting on Advanced Computational Methods for Power Reactors (Cadarache, September 1990). The new benchmark is aimed at assessing the performances of existing codes featuring 3-D neutron kinetics coupled to thermohydraulics, in realistic transient calculations for LWR cores. The Committee felt that the benchmark is timely and that all members should encourage participation in the respective Countries. Drs. H. Finneemann (KWU) and A. Galati

(ENEA) would take up the coordination. Specifications should be distributed before the next meeting.

### 3.1 Shielding Benchmark Data Base

Rapporteur: E. Sartori  
Paper : A-1093

The main purpose of establishing a shielding benchmark data base is to maintain the results of an international set of neutron propagation benchmark experiments for future use by shielders, both for data and computer code validations. The proposal for setting up the data base was made at the International Shielding Conference in Bournemouth in 1988; this idea was further developed by A. McCracken (NEACRP-A-1044). This paper sets out plans for a system of collecting the data, interpreting the experiments, and assigning figures of merit and indications to data evaluators as to which data need further improvement. This scheme, although a possible ultimate goal, was considered to be too ambitious for the first stage. Paper A-1093 describes the minimum effort required to collect the experimental data in a consistent way, which would facilitate data maintenance and distribution to users.

The Committee felt that the continuation of this project makes sense only if someone can be found who is prepared to take the lead in the project. D. Ingersoll, ORNL, (although absent), expressed the willingness to take over the responsibility of this project. ENEA, Bologna, would be available as an alternative candidate and is willing to make a substantial contribution to the project.

As far as the computational benchmark on assessment of resonance self-shielding effects in bulk media is concerned, the Committee felt that it has lost both momentum and a real justification. Correct resonance self-shielding methods are now well known and available, and their use is recommended for shielding applications. This benchmark will therefore not be continued.

### 3.2 Criticality Working Group

Rapporteur: E. Sartori  
Paper : A-1114

The results from the study of eighteen experimental benchmarks were consolidated in the unrestricted report NEACRP-L-306. The theoretical benchmarks, focusing on problems of double heterogeneous fissile regions (solid fissile material surrounded by fissile material in solution) have also been finalized and will be published shortly.

The Committee congratulated the Working Group for the excellent piece of work they had accomplished and noted that it had been proposed for publication in a journal by the PHYSOR'90 Programme Committee.

Further benchmark studies were recommended by the Criticality Working Group in the field of burnup credit.

With the pressure of increasing the enrichment of LWR fuel, the Group felt it was vital that a case be made to the licensing authorities to permit consideration of the effect of fissile burnup and/or the effect of the fission products in performing the criticality safety analysis. For instance, today's shipping flasks are designed for an upper limit of enrichment of 4 percent assuming a fresh fuel load.

Some participants expressed their willingness to make available, for the next phase of the benchmark study, critical experimental data that define LWR cores having different burnup.

The Committee's view was that from the reactor physics point of view, taking credit of burnup does not generally pose problems. This is currently done in reactor calculations and most of the state-of-the-art computational tools can cope with both criticality and reactor core calculations.

The Working Group's view is that three dimensional calculations are required, however, for axially varying burnup profiles. The systems can be very large and complex, which makes the use of discrete ordinates and Monte Carlo methods problematic. In addition, materials are used which are not used in reactors. Because of high packing, the self-shielding effect becomes particularly important. Criticality safety software requires stringent quality assurance characteristics.

The NEACRP felt that the next phase of the benchmark should be considered if the need is expressed by nuclear power operators. The background for such a need should be gathered, and the set of problems to be investigated should be clearly specified together with the difficulties that are expected.

The purpose of such a benchmark should be, as in the past, to clarify discrepancies.

The Working Group should come up at the next meeting with concrete proposals to submit to NEACRP for consideration.

### 3.3 Shielding of Transport Casks

Rapporteur: M. J. Halsall  
Paper : A-1107

The report A-1107 by Alan Avery of AEA Winfrith (UK) was presented by M. Halsall, with added comments by E. Sartori.

A meeting had been held in Paris in February/March to discuss progress, and especially to compare results of calculations for the TN-12 experimental benchmark. In general the agreement on gamma dose rates was good (apart from two results which were low by a factor of five) but the spread of calculated neutron dose rates was much bigger. The understanding of the neutron results was complicated by a lack of knowledge of the experimental energy response function of the dosimeter.

A meeting was provisionally arranged for April 1991 at which conclusion for all the benchmarks, theoretical and experimental, will be agreed. It is clear that the exercise has highlighted a number of areas where care must be taken in computation, and several areas for further work before April have been identified.

The principal problem remains the neutron dosimeter response function used for the TN-12 experiment. The way forward could be either measurement of the response function, or analysis of an

alternative experimental benchmark. A Japanese proposal for such an experiment had been received.

### 3.4 Noise Analysis

Rapporteur: P. D'Hondt  
Paper : A-1046

The 1989 Noise Analysis Benchmark Test was organized as a follow-up of the SMORN-V artificial noise benchmark test to look for improvement in AR-modeling of noise signals and in anomaly detection.

Although 15 groups of noise analysts from 10 different countries registered for participation in the benchmark test and received a magnetic tape with the data, only 8 contributions were finally received from 6 different countries. Several participants sent in their results rather late, long after the deadline of 1 November 1989.

A one-day evaluation meeting took place on 12 June 1990 at IRI, Delft, The Netherlands. The analysis of the participants' results is currently being performed at IRI and it is envisaged to report about this noise analysis benchmark test at SMORN VI (Gatlinburg, May 1991).

The Committee expressed their gratitude to Eduard Hoogenboom and Hugo Van Dam for their difficult job in organizing and analyzing the noise benchmark.

### 3.5 High Conversion Light Reactor Burnup Benchmark

Rapporteur: E. Sartori  
Paper : A-1108

The results of the first phase of this benchmark and the preliminary results from the second phase were presented at the PHYSOR' 90 conference.

This work was proposed for publication in a journal by the PHYSOR Programme Committee and attracted considerable interest. Additional results, received after the conference, will be consolidated in the unrestricted report NEACRP-L-321.

The Committee thanked the participants in this benchmark for the good work they have carried out. A set of important outstanding questions have been answered by this investigation. Further benchmark studies could be of interest if new experimental data are made available.

Most of the experimental results are proprietary involving research establishments, utilities and constructions. Some of the data could be made available, but it was felt that these would not contribute much to improve the calculational tools and data.

A benchmark with an excellent potential for this would be one on the temperature coefficient, when experimental data become available.

The suggestion that this benchmark is recalculated using the new evaluations ENDF/B-VI, JEF-2 and JENDL-3 is strongly supported. The Committee does not suggest that this activity should be stopped but new suggestions or results could be

discussed in the session on advanced reactor types at the next meeting.

### 3.6 Measurement of Tritium Production Rates

Rapporteur: Y. Kaneko  
Paper : A-1080

Paper A-1080 (Japan) reports the interim state of the "International Comparison on Measuring Techniques of Tritium Production Rate for Fusion Neutronics Experiments". Eight institutes and universities from six countries applied this program. The first irradiation experiments were performed in April and May 1989 at FNS and LOTUS, respectively. Six out of eight groups submitted the measured results to JAERI by the middle of September 1989. The measured results deviated among the participants far over the target accuracy of 5%.

It is thought to be the most important to identify the causes of discrepancy. Therefore three kinds of Tritium water samples which are made from the certified standard Tritium water were distributed to each participant by ANL. The results of the concentration measurements showed a fairly good agreement ( $1\sigma=3\%$ ). JAERI recommended running the second irradiation experiment after all the participants have succeeded in improving their own technique to extract Tritium from the irradiated samples. This proposal is endorsed in the meeting. The second irradiation will be done in April 1991.

### 3.7 Three-Dimensional Transport Benchmark

Rapporteur: Y. Kaneko  
Paper : A-1081

Paper A-1081 shows the interim state of the 3-D neutron transport benchmark, particularly for k-eff. The benchmark includes three XYZ geometry cores (a small LWR, a small FBR, a large axially heterogeneous FBR core) and a hexagonal-Z geometry small FBR. Nineteen organizations have participated from eleven countries.

For the small LWR, agreement was satisfactory for k-eff ( $\Delta k\text{-eff} \cong 0.5\%$ ). For the small XYZ and hexagonal-Z FBR problems, small disagreement in control rod worth was observed between Sn and Monte-Carlo methods. The disagreement in the control rod worth is more significant for the large FBR core.

A Specialist Meeting is to be held on 22nd and 23rd October 1990, where discussions between participants will be made in order to assess the benchmark calculations.

### 3.8 Validation of Delayed Neutron Data

Rapporteur: M. Salvatores  
Papers : A-1041, A-1064.

Two documents were tabled (A-1041 and A-1064).

A-1041 is a report prepared in the frame of the International Evaluation Co-operation (Subgroup no. 6), to give the state of the art on Delayed Neutron Data Uncertainties. A-1064 gives details on the preparation of the experimental benchmark at MASURCA. The intention to participate in that exercise has been given by the European partners of the LMFBRs co-operation, Italy (ENEA), Japan (JAERI) and USSR (Obninsk). Other groups could join. The first preparatory meeting is announced for 4th and 5th December 1990, in Cadarache. The experiments are expected to start at the beginning of 1992.

A short discussion on this topic concentrated on the achievable experimental accuracy. A target value of  $\pm 6$  percent was indicated and the need for a very careful preparation to reach that result was stressed.

### 3.9 Radial C/E Trends in Large FBRs

Rapporteur: L. Lesage

The specification of the benchmark problem has been prepared by Salvatores (CEA, France) and Orechwa and Collins (ANL, USA). As a result of the discussion, it was determined that several countries are interested in calculating this problem. The problem specification will be distributed to all members by December 1, 1990. A date for completion of the benchmark problem will be specified in the problem distribution; however, it is planned to have the solutions completed and available by the next meeting of the NEACRP. It was noted that this benchmark problem is not expected to require a large effort.

### 3.10 Pin Power Distribution within Assemblies

Rapporteur: M. Salvatores  
Paper : A-1065

The background of the pin-power benchmark proposal was illustrated by J.P. West from EDF (France). It was decided, after discussion, that the originators of the benchmark should consult with Dr. Koebke of KWU, Germany, to finalise the proposal. Afterwards, this improved proposal will be circulated among all potential interested parties, since most of the members expressed their interest. The results of the benchmark should then be gathered by J.P. West and a report should be prepared for the next NEACRP meeting.

#### 4. International and National Programmes

##### 4.1 Activities of Other International Bodies of Interest to the NEACRP

###### - NEANDC Topics of Interest to NEACRP

E. Fort presented a summary of some conclusions reached at the 28th NEANDC Meeting, in paper A-1100.

Works have been completed for both Fe-56 and U-238 Task Forces: the final reports are expected to be available, on a wide-scale NEA distribution, within mid-1991. Some problems still exist for Fe-56, which will probably be addressed by a new Working Group on Capture Data for Structural Materials.

Comparisons of Decay Heat Prediction data (A-1039) and codes (L-319) indicate that existing discrepancies must be attributed to basic nuclear data and could only be resolved basing on new, more accurate measurements.

A Working Group on Activation Cross-Sections has been created, which will take care of the intercomparison of measuring and/or evaluation techniques for important isotopes in selected energy ranges.

###### - Progress Report from Evaluated Data File Projects

M. Salvatores and E. Fort, the latter now being the coordinator of the benchmark testing activities for JEF-2, reported on this topic. The version that is currently under test is JEF 2.1, released in September 1990. Future work is planned, aimed at releasing the 2.2 version by mid-1991. For the moment, JEF-2 receives a distribution restricted to participating countries whilst ENDFB-VI (after completion of the testing) and JENDL-3 (already extensively validated also for fusion neutronics applications) will enjoy free distribution.

Technical details on the status of the three evaluated files are reported in paper A-1042.

###### - International Cooperation on Evaluated Data Files

The status reports presented in A-1042 by the seven sub-groups set up by the WG (Intercomparison of files for Cr-52, Fe-58 and Ni-58; Generation of covariance files for Fe-nat and Fe-58; Actinide Data in the thermal range; U-238 capture and inelastic cross-sections; Pu-238 1-100 keV fission cross-section; Delayed neutron data benchmarking; Multigroup cross-section processing), were briefly reviewed. It was recognized that the activities had just started in most cases, so that a significant account of the progresses made in these topics would be available only for the next meeting.

The Committee agreed with the Working Group's feeling that no more sub-groups should be created for the present time.

- NEA Data Bank

E. Sartori presented paper A-1106, a summary report of NEADB's activities, emphasizing the topics that involve or interface the Committee.

In the Computer Services, where it is worth noting the still increasing rate of program dispatching to users, considerable effort was invested in acquiring improved or extended versions of cross-section processing codes, in view of the release of the three updated evaluated data libraries (JEF-2, JENDL-3, ENDFB-VI). Besides, the on-line service for computer code requesters has been upgraded by the addition of new options.

In the Nuclear Data Service, where it is worth noting the increased use of computer networks for data and/or document requests, work has been concentrated on the finalization of the new evaluations for JEF-2 and on the support to the International Working Group that coordinates the exchanges among the major evaluated data files developed in the OECD countries.

- NEA Committee on Safety of Nuclear Installations (CSNI)

Dr. Mc Pherson presented paper A-1082, illustrating the scope, objectives and organization of the CSNI. Some areas of interface and of possible co-operation with CSNI, particularly in the review and assessment of specific safety-related issues, were discussed by the Committee.

- NEA Nuclear Development Committee (NDC)

Mr. Stevens presented paper A-1083, illustrating some recent initiatives of the NDC, including the organization of an Information Exchange Meeting on the Actinides. The Committee noted that the topic of Actinide transmutation has been thoroughly discussed, as it has been several times on its agenda. In fact, it is fair to say that the technical expertise for dealing with these studies just resides in the NEACRP, which still actively monitors the subject via the review of the National Programs.

- IAEA

M. Crijns reported in A-1105 on the activities of IAEA in areas related to reactor physics. In particular, he introduced two Co-ordinated Research Programs (CRPs) with benchmark connotations.

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 in the early eighties. Calculations have been performed for two cycles of the Spanish Almaraz PWR plant and for one cycle of the Laguna Verde-1 BWR plant. Currently, additional calculations are being performed and a proper intercomparison will be made. For the VVER, only recently reactor core and operating data

became available. The VVER-440 data are received from the Bulgarian Kozlodu plant and from the Soviet Koliniskaia plant. Also, operating data of the Finnish Loviisa plant are available. These data will be complemented with the reactor core input data later this year.

A second CRP on Safe Core Management with Burnable Absorbers in VVERs aims to improve the knowledge on burnable absorbers for usage in VVERs. During the first year, calculations have been performed on square and hexagonal lattices containing gadolinium fuel and experiments have been carried out at LR-0 in Rez and at ZR-6 in Budapest. Detailed intercomparisons of results are currently carried out and will probably be reported to the NEACRP at the next meeting. France and Germany showed some interest for parts of the programme. NEACRP members were invited by M. Crijs to consider participation in the CRPs.

#### 4.2 Review of Recent Activities and National Programmes

Reports on the reactor physics activities in the NEA Member countries were summarized and discussed. The USSR also reported on their reactor physics activities during the past year. The full papers will be consolidated into a report (L-322) to be issued by the NEA Secretariat.

### 5. Meetings

#### 5.1 Highlights of Recent Meetings of Interest to NEACRP

M. Salvatores presented paper A-1103, containing the exhaustive summary of PHYSOR '90 prepared by J. Rowlands.

R. Martinelli reported on IMORN-22 (Delft, NL, June 1990) and illustrated some reactor physics aspects of the International Workshop on BWR Stability, being held at the Brookhaven National Laboratory.

L. Lesage informed the Committee about two sessions of particular interest ("Breeding Blanket Technology" and "Neutronics") of the 9th Topical Meeting on the Technology of Fusion Energy, held at Oak Brook, US, in early October.

#### 5.2 Future Meetings of Interest to NEACRP

The following meetings are sponsored by, or are of direct interest to, the NEACRP.

##### 1990

- Nov. 5- 8 11th International Conference on the Application of Accelerators in Research and Industry; Denton, Texas, USA
- Nov 13-14 ANS Winter Meeting; Special Session on Reactor Physics Standards; Washington DC, USA

Dec. 4- 5 Preparatory Specialists' Meeting on the NEACRP Beta-eff Benchmark Measurement at MASURCA; Cadarache, France

1991

Jan. 7-10 8th Symposium on Space Nuclear Power Systems; Albuquerque, New Mexico, USA

Apr. 10-12 NEACRP Shipping Cask Shielding Benchmark Meeting; OECD, Paris

Apr. 28- Advances in Mathematics, Computations and Reactor  
May 1 Physics; Pittsburgh, USA

May 13-17 International Conference on Nuclear Data for Science and Technology; Juelich, Germany

Jun. 26-28 NEACRP Criticality WG Meeting; OECD, Paris

Sep. 9-13 ICNC '91, International Conference on Nuclear Criticality Safety; Oxford, UK

Sep. 17-20 Seminar on the Modular Code System SCALE-4 (Criticality, Shielding and Heat Transfer); OECD/NEA Data Bank, Saclay, France

Oct. 1- 4 Third Specialists' Meeting on In-core Instrumentation and Reactor Core Assessment; Pittsburgh, USA

Oct. 28-31 FR '91, International Conference on Fast Reactor Systems and Fuel Cycle; Kyoto, Japan

## A N N E X 1

OPENING REMARKS BY THE DIRECTOR GENERAL OF THE OECD/NEA AT THE  
MEETING OF THE NEA COMMITTEE ON RECTOR PHYSICS  
Paris, 15th October 1990

I have already met many of the members of this Committee individually, in particular at the PHYSOR meeting in Marseille this spring. I am very pleased to welcome you all to this meeting of the NEACRP at the OECD Headquarters.

The nuclear industry is currently suffering from a lack of new orders, and at such a time it is natural that conservative measures should come to the fore in the countries concerned. Our own Agency's programme gives special prominence to work in nuclear safety and regulation, including in particular waste management. However, the longer-term prospects for nuclear energy are likely to be brighter, and recent preoccupation with climatic changes, with a new realisation of the fragility of the world's petroleum supply, may indeed be leading gradually back to a cooler and more realistic appreciation of the problems and advantages of nuclear power. Therefore, establishing a balance of activities between regulation and advancement is becoming even more important.

The Agency's long term orientations have now been examined and adopted. As a consequence, I shall be convening several "Think Tanks" over the next year, as supported by the Steering Committee at its last meeting, in order to obtain expert views on the implementation of the topics identified in the long term orientations, with the ultimate objective of defining a possible role for our Agency in these fields. This series of think tanks will be convened from time to time to discuss different subjects.

The first of these think tanks will be to discuss the subject of fast reactors. As you know, the Agency has been concerned for some time at the declining momentum of fast reactor research, development and design projects and we find it important to ensure that these programmes continue to fruition over the next decade or two. Fast reactors are an essential element in extracting a higher proportion of the energy available from nuclear fuel: the low price of uranium now will not remain low if there is a major world expansion of nuclear power in the 21st century. The question of reactors able to consume long-lived higher actinides is already the object of several studies carried out by this Committee. It may be that fast reactors can offer worthwhile facilities for actinide burning.

The Committee on Reactor Physics represents the interests of many Member countries in preserving momentum in reactor development; the wide attendance at the Physor meeting this year, and the quality of the contributions presented, offered confirmation of this view. Fortunately, much effort is being devoted to innovative and advanced studies, and I note in particular:

- Development of small and medium-sized reactor designs with possible increased safety;
- Further research and development of fast reactors;
- Work on improving the fuel cycle, including actinide treatment;
- Work on plant life extension.

The current period of stagnation in reactor construction has led to uncertainty in some of our Member countries about attitudes to the development of advanced reactor types. Those countries strongly committed to nuclear power are clearly in favour of continued development, as are other countries where there is a large contribution from nuclear to overall electricity production and where replacements must be found for existing reactors early in the next century. Small and medium-sized reactors are an attractive option for study, partly because of their interest for countries without a highly-developed transmission network, but also because of their relative simplicity, and possible increased safety features which may ease public acceptance.

In all this, NEACRP's contribution is an essential one, in ensuring that currently reduced resources for reactor physics are used to the best possible effect. Its programmes, and there are many topics pursued in parallel at your meetings from year to year, provide a very valuable concentration of the most important work in progress in this area in our Member countries.

NEACRP's work must, of course, be seen alongside that of the other NEA committees. However, recent discussions on the long term orientations have shown a very wide gap in understanding between the scientific committees, NEACRP and NEANDC, and some other NEA technical committees. We are taking clear measures to improve the understanding between committees and to extend work-sharing where this is appropriate. In particular:

- The Chairman of the Steering Committee has invited the chairmen of standing committees to attend its meetings.
- Wider exchange of observers or the establishment of a mechanism to discuss subjects of common interest between committees will be encouraged.

The second think tank which I shall organise is on the subject of nuclear science, including scientific services. I shall be convening a small group of independent experts from some of our Member countries towards the end of this year. The results of this think tank will, of course, be presented to your Committee at the appropriate time.

You may know that the OECD has set up a special unit to handle relations with the so-called European Economies in Transition, notably countries in Eastern Europe, including the USSR. Our Agency will be holding a special seminar on 6th and 7th December of this year, to present the Agency's work to representatives of these countries, and to explore possible co-operation which the NEA could establish with these countries. Safety issues, but also waste management and legal questions are clearly of common interest to all countries. The nuclear development area may also be of concern to all parties. You are invited to discuss a possible contribution of your Committee to this co-operation.

In the present meeting, your Committee will be discussing its own medium-term programme for the 1990s, and I would ask you to consider not only your own present range of study, but also to express your point of view on the whole area of Nuclear Science in the Agency, in which you now collaborate with NEANDC and the NEA Data Bank. I look forward to hearing the results of your work, and wish you all a successful meeting.

## Annex 2

## LIST OF PARTICIPANTS

Delegates

For Canada	McDONNELL Frank N.	(Vice-Chairman)
For Japan	KANEKO Yoshihiko WAKABAYASHI Toshio	
For the United States	LESAGE Leo	
For the countries of the European Communities and the European Commission acting together	D'HONDT Pierre RIEF Herbert W. DARROUZET Michel SALVATORES Massimo KUESTERS Heinz MARTINELLI Renato HALSALL Mike J. INGRAM Gerald	Belgium CEC France France Germany Italy (Scientific Secretary) United Kingdom United Kingdom
For the other European countries of the OECD	JIRLOW Klas WYDLER Peter	Sweden Switzerland (Chairman)
Nuclear Energy Agency	SARTORI Enrico	Secretariat
Observers	CRIJNS Martin MATVEENKO Igor P. SLESAREV Igor S. FORT Eric WEST Jean-Pierre	IAEA Secretariat IAEA IAEA NEANDC France

Apologies for absence were received from G.S. Robinson (Australia), R. Caro (Spain), P. Hemmig (USA) and D. Ingersoll (USA).

Following an established rotation K. Jirlow (Sweden) represented also Denmark, Norway and Finland. The delegate of Switzerland, P. Wydler, also represented Austria.

Annex 3  
Agenda Proposed for the 34th NEACRP Meeting

PSI, Würenlingen, 7-11 October 1991

PART A : EXECUTIVE SESSION

- 1.a Participants in the Meeting
- 1.b Committee Membership
2. Adoption of the Final Summary Record of the 33rd Meeting.
3. Adoption of the Agenda of the Meeting.
4. Completion of Actions Arising from Previous Meetings.
5. Proposed Reorientation of the NEA Nuclear Science Programme.
6. Arrangements for the Next Meeting of the Committee.
7. Other Business.
8. Election of Committee Officers

PART B: TECHNICAL SESSIONS

1. New Topics
  - 1.1 Physics Problems of 3D On-Line Monitoring
  - 1.2 Physics Aspects of Fast and other Advanced Reactors
  - 1.3 Experience with New Computer Architectures when Using Reactor Physics Codes (Vector and/or Parallel Computers, Advanced Work Stations, etc.)
  - 1.4 New Applications of Neutron Radiography
2. Topics Carried over from Previous Meetings
  - 2.1 Current Issues of Plutonium Recycling in LWRs
  - 2.2 Review of Requirements for the Methods of Validating Neutronics Codes (i.e. Quality Assurance for Neutronics Codes)
  - 2.3 Physics and Safety Aspects of Transuranium Burning Reactors and Accelerators Performance
  - 2.4 New Facilities of Importance for Neutronics and Reactor Physics Research (including non-reactor facilities)
  - 2.5 Fusion Blanket and Shield Performance
3. Benchmarks and Data Bases
  - 3.1 Radiation Shielding Benchmark Data Base.
  - 3.2 Criticality Safety: Burnup Credit
  - 3.3 Shielding of Transport Casks.
  - 3.4 Noise Analysis.
  - 3.5 Measurement of Tritium Production Rates.
  - 3.6 Three-Dimensional Transport Benchmark.
  - 3.7 Validation of Delayed Neutron Data.
  - 3.8 3D Dynamics for LWR Cores
  - 3.9 Pin Power Distribution within Assemblies

4. International and National Programmes

4.1 Activities of Other International Bodies of Interest to NEACRP.

- NEANDC Topics of Interest to NEACRP
  - Progress Report from Evaluated Data File Projects
  - International Cooperation on Evaluated Data Files
- NEA Data Bank,
- NEA-CSNI,
- NEA Nuclear Development Committee
- IAEA

4.2 Review of Recent Activities and National Programmes

5. General Discussion

5.1 Presentation of Technical Summary Records by Rapporteurs - Discussion.

5.2 General Discussion on New Trends in Member Countries

5.3 NEACRP's Renewal of Mandate

6. Meetings

6.1 Highlights of Recent Meetings of Interest to NEACRP.

6.2 Future Meetings of Interest to the NEACRP.

**Annex 4**  
**Papers Discussed**  
**at the 33rd NEACRP Meeting.**

Introductory Remarks by the Director General, Dr. K. Uematsu  
(see Annex 1)

PART A : EXECUTIVE SESSION

- 1.a Participants in the Meeting
- 1.b Committee Membership
2. Adoption of the Final Summary Record of the 32nd Meeting.
3. Adoption of the Agenda of the Meeting.
4. Completion of Actions Arising from Previous Meetings.
5. Trends for future work of NEACRP,  
(follow-up of the discussion held at the 32nd meeting)
6. Distribution and Discussion of Summaries by Session Rapporteurs  
Selection of Topics for Next Meeting
7. Arrangements for the 34th Meeting of the Committee.
8. Other Business.
9. Election of Committee Officers

PART B : TECHNICAL SESSIONS

1. NEW TOPICS  
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1.1 Current Issues of Plutonium Recycling in LWRs  
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NEACRP-A-1047

VENUS International Programme (VIP),  
A Nuclear Data Package for LWR Pu Recycle  
September 1990  
A. Charlier, J. Basselier, L. Leenders

NEACRP-A-1048

VENUS International Programme (VIP),  
A Nuclear Data Package for BWR Pu Recycle  
September 1990  
J. Basselier, A. Charlier, P. D'Hondt, L. Leenders, G. Minsart

NEACRP-A-1049

VENUS International Programme (VIP),  
A Nuclear Data Package for PWR Pu Recycle  
September 1990

J. Basselier, A. Charlier, P. D'Hondt, L. Leenders, G. Minsart

NEACRP-A-1055

Plutonium Reload Experience and Perspective in French PWR Plants  
October 1990

M. Rome, M. Salvatores, J. Mondot, M. Le Bars

NEACRP-A-1066

Plutonium Generation Boiling Water Reactor Concept  
October 1990

Renzou Takeda, Motoo Aoyama, Yoshihiko Ishii, Osamu Yokomizo,  
Kazuya Ishii, Noriyuki Sadaoka, Sadao Uchikawa

NEACRP-A-1067

Utilization of MOX Fuel Assembly Containing Gd203 in ATR  
October 1990

Norio Kawata, Toshio Wakabayashi

NEACRP-A-1116

Investigations on Pu-Recycling and High Burnup for LWRs in the  
Federal Republic of Germany

F.U. Schlemmer, G.J. Schlosser, W.D. Krebs, H.P. Fuchs, R. Manzel,  
H.W. Wiese

## 1.2 Review of Requirements for the Methods of Validating

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Neutronics Codes (i.e. Quality Assurance for Neutronics Codes)  
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NEACRP-A-1056

Quality Assurance Provisions for ERANOS  
October 1990

J.M. Rieunier, G. Palmiotti

NEACRP-A-1084

Quality Assurance (QA) for Neutronics Codes at ANL  
October 1990

ALN Secretariat

NEACRP-A-1085

Requirements for Validating (LWR) Neutronics Codes  
October 1990  
David J. Diamond

NEACRP-A-1091

A Review of Reactor Physics Uncertainties and Validation  
Requirements for the Modular High-Temperature Gas-Cooled Reactor  
May 1990  
A.M. Baxter, R.K. Lane, E. Hettergott, W. Lefler (General Atomics)

NEACRP-A-1094

Verification of the Shutdown System Software at the  
Darlington Nuclear Generating Station  
September 1990  
G.N. Archivoff et al. (NOT RECEIVED)

NEACRP-A-1095

The Canadian Process for Regulatory Approval of  
Safety Critical Software in Nuclear Power Reactors  
September 1990  
G.J.K. Asmis et al. (NOT RECEIVED)

NEACRP-A-1096

Licensing Safety Critical Software.  
Public Opinion and the Full Power of the Mind.  
G.H. Archinoff, R.A. Brown.  
Hans Y. Tammemagi

1.3 Physics Related Safety Aspects of Fast Reactors.

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(Reactivity Feedback Properties, Design tradeoffs and Safety  
-----  
Implications)  
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NEACRP-A-1057

Comparative Study of the Neutronic Performances of a Large LMFBR Using  
Oxide Fuel or Metallic Fuel  
October 1990  
J.C. Garnier, A. Zaetta

NEACRP-A-1058

Sodium-Voiding Reactivity Effect Reduction in Fast Breeder Reactors  
October 1990  
J. Thommasi, A. Zaetta

NEACRP-A-1059

Modular Island Cores  
October 1990  
C. De Pascale, A. Zaetta

NEACRP-A-1068

Study of Enhanced Safety Core Characteristics of Nitride Fuel FBR  
October 1990  
Y. Ohkubo, T. Wakabayashi

NEACRP-A-1086

A Measurement Based Method for Predicting Margins and  
Uncertainties for Unprotected Accidents in the Integral  
Fast Reactor (IFR)  
R.B. Vilim

NEACRP-A-1111

Sensitivities to Nuclear Constants and Related Computational  
Errors in Safety Characteristics of Fast Reactors with  
Different Coolants  
October 1990  
G.G. Kulikov, V.B. Glebov, A.G. Morozov, I.V. Kurchatov

1.4 New Facilities of Importance for Neutronics and Reactor  
-----  
Physics Research (Intense Neutron Sources, MAPLE, etc.)  
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NEACRP-A-1052

The Cold Neutron Moderator for the Continuous Spallation Neutron  
Source SINQ  
March 1990  
F. Atchison, G. Bauer, W. Fischer, K. Skala, H. Spitzer

NEACRP-A-1087

High Neutron Flux Fusion Materials Test Facility  
L.G. LeSage

NEACRP-A-1097

The Advanced MAPLE Concept

September 1990

R.F. Lilstone et al. (NOT RECEIVED)

1.5 Fusion Blanket - Shield Neutronics with Emphasis on the  
-----  
Effects of Data Uncertainties (Including Effects of Double  
-----  
Differential Data)  
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NEACRP-A-1053

On the Effect of ENDF/B-VI Beryllium Data on the Neutronics of  
ITER Blankets

September 1990

Sandro Pelloni, Mark J. Embrechts, Edward T. Cheng

NEACRP-A-1060

Sensitivities Analysis of the T.F. Coil Shielding Parameters  
in the NET Design to the Nuclear Data Uncertainties

October 1990

A. Santamarina, H. Smith

NEACRP-A-1069

Integral Experiments to Improve Tritium Breeding Ratio

October 1990

Akito Takahashi, Ken Yamanaka, Kenji Sumita

NEACRP-A-1070

Phase-IIIA Experiment of the JAERI/USDOE Collaborative Program on  
Fusion Neutronics

October 1990

Y. Oyama, C. Konno, Y. Ikeda, H. Maekawa, K. Kosako, T. Nakamura

NEACRP-A-1071

Benchmark Test of Be Nuclear Data in JENDL-3 Through Analyses of  
Time-of-Flight and Integral Experiments on Be Assemblies at FNS

October 1990

Hiroshi Maekawa, Yukio Oyama, Kazuaki Kosako

NEACRP-A-1088  
Sensitivity/Uncertainties Analyses for Fusion Applications  
September 1990  
ANL Secretariat

NEACRP-A-1092  
Reaction Rate Distributions and Related Data in the  
FNS Phase II Experiments: Comparison of Measured and  
Calculated Data  
July 1990  
R.T. Santoro, R.G. Alsmiller, Jr., J.M. Barnes (ORNL)

NEACRP-A-1101  
ANITA - Analysis of Neutron Induced Transmutation  
and Activation  
April 1990  
C. Ponti, S. Stramaccia, (JRC Ispra)

NEACRP-A-1113  
Fusion Blanket Benchmark Experiments  
October 1990  
V.V. Afanasiev, A.G. Belevitin, Y.M. Verzilov, V.L. Romodanov,  
V.V. Khromov, D.V. Markovshij, G.E. Shatalov

2. Topics Carried over from Previous Meetings  
=====

2.1 Evaluation of the Uncertainty in FBR Burn-up Reactivity Swing  
-----

NEACRP-A-1072  
Prediction Accuracies of Safety Related Core Design Parameters  
for FBR  
October 1990  
Keisho Shirakata, Toshio Sanda

NEACRP-A-1089  
Pin Power and Depletion in EBR-II  
October 1990  
W.S. Yang, R.D. McKnight

NEACRP-A-1115  
Analysis of JOYO Burnup Characteristics  
October 1990  
Akihiro Hara, Kastuya Kinjo

2.2 The Reactor Physics of Advanced Gas-Cooled and Water Reactors.  
-----

NEACRP-A-1050  
Calculation of Neutron-Physical Parameters of the Advanced Light-Water  
Reactor Fuel Lattices  
September 1990  
V.V. Kuznetsov, A.G. Morozov, A.A. Dudnikov, I.S. Slesarev

NEACRP-A-1061  
Reactor Physics Studies at CEA on Advanced Water Reactors  
October 1990  
A. Leridon et al.

NEACRP-A-1073  
Measurement of Void Reactivity Worth of HTTR Mockup  
Control Rod Hole in VHTRC-1 Core  
October 1990  
F. Akino, T. Yamane, M. Takeuchi, Y. Kaneko

NEACRP-A-1074  
Analysis of Temperature Effect of Reactivity for VHTRC and SHE  
with Nuclear Design Code System for High Temperature  
Engineering Test Reactor (HTTR)  
October 1990  
Isao Murata, Kiyonobu Yamashita, Ryuichi Shindo

NEACRP-A-1110  
Experimental and Computational Investigation on HCLWR Physics  
October 1990  
IPPE, Obninsk and IAE, Moscow Secretariats

2.3 Engineering and Physics Aspects of Transuranium Burning by  
-----  
Reactors and Accelerators.  
-----

NEACRP-A-1054

Reduction of the Long-Term Toxicity of Neptunium by Nuclear Spallation  
September 1990

H.U. Wenger, P. Wydler, S. Atchison

NEACRP-A-1062

Radiotoxicity of Wastes Impact of Plutonium Recycling  
October 1990

M. Darrouzet, G. Flamenbaum, J.P. Grouiller

NEACRP-A-1075

Study of TRU Transmutation Plant with Proton Accelerator  
October 1990

T. Nishida, I. Kanno, H. Takada, T. Takizuka, M. Mizumoto,  
M. Akabori, Y. Nakahara, Y. Okumura, H. Yasuda, Y. Kaneko

NEACRP-A-1076

TRU Transmutation in an LMFBR  
October 1990

M. Ishikawa, M. Yamaoka, T. Wakabayashi, T. Kawakita

NEACRP-A-1090

Hazard Quantification for LWR Spent Fuel  
October 1990

R. N. Hill

NEACRP-A-1109

On Actinides Transmutation Possibility in Fast Reactors with Various Coolant  
October 1990

D.F. Tzurickov, A.N. Shmelyov, A.G. Morozov, V.B. Glebov, G.G. Koulickov,  
V.V. Kuznetsov

NEACRP-A-1112

Investigations for Design Justification of Actinides Transmutation Reactor.  
On Actinides Transmutation Possibility in Fast Reactors with Various Coolant  
October 1990

S.M. Bednyakov, V.A. Dulin, L.V. Korobeinikova, G.N. Manturov, I.P. Matveen  
A.M. Tsibulya / D.F. Tzurickov, A.N. Shmelyov, A.G. Morozov, V.B. Glebov,  
G.G. Koulickov, V.V. Kuznetsov

## 2.4 Local Stability in LWRs and HWRs with Emphasis on 3D Effects.

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NEACRP-A-1077

A Study of Regional Oscillation with TOSDYN-2

October 1990

Y. Takigawa, Y. Takeuchi, H. Namba, S. Ebata,  
S. Kasai, T. Anegawa

NEACRP-A-1078

Examination of Nuclear Thermal Hydraulic Oscillation Modes  
in BWR Core.

October 1990

O. Yokomizo, I. Sumida, T. Anegawa, Y. Yoshimoto, T. Fukahori

NEACRP-A-1098

Neutronic Decoupling and Coolant Void Reactivity  
in CANDU

September 1990

V.K. Mohindra, A.R. Dastur

NEACRP-A-1099

SMOKIN - A Code for Time-Dependent Three-Dimensional Neutronics  
Calculations in CANDU-PHW Reactors Based on Modal Kinetics  
Theory - Application to Loss of Coolant Accidents

September 1990

M. Gold, J.C. Luxat

NEACRP-A-1102

BWR Stability Investigation in Ringhals 1.

Measurement Data from October 26, 1989

(Summary of Studsvik Report NI-90/17)

October 1990

Bengt-Goeran Bergdahl, Ritsuo Oguma

## 2.5 Physics Methods in Fuel Accountability.

---

NEACRP-A-1063

Active and Passive Non-Destructive Measurements for  
Nuclear Monitoring of Spent Assemblies

October 1990

G. Bignan, L. Martin-Deidier

NEACRP-A-1079

Development of Non-Destructive Measuring Techniques for Trace Amount of Fissile and Fertile Materials in Drum-Sized Waste  
October 1990

H. Gotoh, M. Haruyama, N. Wakayama

3. Benchmarks and Data Bases

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3.1 Radiation Shielding Benchmark Data Base.

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NEACRP-A-1044

The Establishment of a Shielding Experimental Benchmark at the OECD/NEA Data Bank  
June 1990

A.K. McCracken

NEACRP-A-1093

Considerations for a Shielding Experimental Benchmark Data Base  
October 1990

W.W. Engle, Jr., D.T. Ingersoll (ORNL)

3.2 Criticality of Fuel Undergoing Dissolution.

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(including irradiated fuel - burnup)

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NEACRP-A-1114

Activity Report of the Criticality Working Group  
October 1990

G. Elliott Whitesides, E. Sartori

3.3 Shielding of Transport Casks.

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NEACRP-A-1107

Status Report on the Intercomparison of Shielding Codes for Transport Flasks  
October 1990

A. F. Avery

### 3.4 Noise Analysis.

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NEACRP-A-1046

Status of the 1989 Noise Analysis Benchmark Test  
September 1990  
J.E. Hoogenboom

### 3.5 HCLWR Benchmarks.

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NEACRP-A-1108

Status Report of the NEACRP HCLWR Benchmark Working Group  
October 1990  
W. Bernnat, E. Sartori

### 3.6 Measurement of Tritium Production Rates.

-----

NEACRP-A-1080

International Comparison on Measuring Techniques of Tritium  
Production Rate for Fusion Neutronics Experiments  
October 1990  
Summarized by Hiroshi Maekawa

### 3.7 Three-Dimensional Transport Benchmark.

-----

NEACRP-A-1081

Progress Report on 3-D Neutron Transport Benchmark Problems  
October 1990  
T. Takeda, H. Ikeda, M. Tamitani

NEACRP-A-1117

Benchmark 3-D Neutron Transport Calculations  
October 1990  
L.N. Yaroslavtseva, P.A. Fomichenko, L.L. Kononova

NEACRP-A-1118

3-D neutron Transport Benchmark Problems  
October 1990  
V.I. Bryzgalov, V.V. Korobeiynikov, A.D. Rogov, M.S. Yudkevich

### 3.8 Validation of Delayed Neutron Data.

-----

#### NEACRP-A-1041

Status of Delayed Neutron Data, 1990

October 1990

J. Blachot, M.C. Brady, A. Filip, R.W. Mills, D.R. Weaver

Draft - circulated to NEACRP members

Now published as NEACRP-L-323, NEANDC-299U

#### NEACRP-A-1064

NEACRP Beta-effective Benchmark Measurements at MASURCA.

Proposal for the Experimental Program

October 1990

M. Martini, J.C. Gauthier, G. Granget, R. Soule

### 3.9 Radial C/E Trends in Large FBRs.

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### 3.10 Pin Power Distribution within Assemblies.

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#### NEACRP-A-1065

Proposal for Benchmark Calculations of Power Distribution  
within an Assembly using Standard or Nodal Diffusion Schemes

October 1990

J.C. Lefebvre, J. Mondot, J.P. West and al.

## 4. International and National Programmes

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### 4.1 Activities of Other International Bodies of Interest to NEACRP.

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- NEANDC Topics of Interest to NEACRP
  - Progress Report from Evaluated Data File Projects
  - International Cooperation on Evaluated Data Files
- NEA Data Bank,
- NEA Committee on Safety of Nuclear Installations
- NEA Nuclear Development Committee
- IAEA

#### NEACRP-L- 319

DECAY HEAT CALCULATION; An International Nuclear Code Comparison.

B. Duchemin, C. Nordborg

NEACRP-A-1042

Summary record of the Second meeting of the  
Working Group on International Evaluation Cooperation  
Marseille, 30th April - 1st May 1990  
NEA Data Bank Secretariat

NEACRP-A-1043

Summary Record of the Twelfth Meeting of the Scientific Coordination  
Group (SCG) of the Joint Evaluated File Project  
OECD, 1st June 1990  
NEA Data Bank Secretariat

NEACRP-A-1082

Viewgraphs on the Activities of the  
Committee on the Safety of Nuclear Installations (CSNI)  
October 1990  
CSNI Secretariat

NEACRP-A-1083

Summary of Activities of the Nuclear Development Committee (NDC)  
October 1990  
NDC Secretariat

NEACRP-A-1100

28th NEANDC meeting: Report on matters of interest to NEACRP  
October 1990  
E. Fort

NEACRP-A-1104

Summary Record of the Twenty-eighth NEANDC Meeting  
Harwell, 26-30 March 1990, (Technical Minutes)  
Herbert Vonach, IRK

NEACRP-A-1105

Overview of the IAEA Reactor Physics Activities 1989/1990  
October 1990  
M. Crijns, IAEA

NEACRP-A-1106

Activity Report of the OECD/NEA Data Bank for the NEACRP Meeting  
October 1990  
NEA Data Bank Secretariat

4.2 Review of Recent Activities and National Programmes

-----  
(Reports from: Australia, Belgium, Canada, Denmark, Finland,  
France, F.R. Germany, Italy, Japan, Netherlands, Spain, Sweden,  
Switzerland, United Kingdom, United States, IAEA Observers)

NEACRP-L- 322

Reactor Physics Activities in NEA Member Countries  
October 1989 - September 1990  
NEACRP Members

5. Meetings

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5.1 Highlights of Recent Meetings of Interest to NEACRP.

NEACRP-A-1103

PHYSOR'90: Conference Summary  
May 1990  
John L. Rowlands

5.2 Future Meetings of Interest to the NEACRP.

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Annex 4 (Continued)  
Papers Discussed  
at the 33rd NEACRP Meeting  
(ordered by identification number)

NEACRP-A-1041

Status of Delayed Neutron Data, 1990  
October 1990

J. Blachot, M.C. Brady, A. Filip, R.W. Mills, D.R. Weaver  
Draft - circulated to NEACRP members  
Now published as NEACRP-L-323, NEANDC-299U  
Session B 3.8

NEACRP-A-1042

Summary record of the Second meeting of the  
Working Group on International Evaluation Cooperation  
Marseille, 30th April - 1st May 1990  
NEA Data Bank Secretariat

NEACRP-A-1043

Summary Record of the Twelfth Meeting of the Scientific Coordination  
Group (SCG) of the Joint Evaluated File Project  
OECD, 1st June 1990  
NEA Data Bank Secretariat

NEACRP-A-1044

The Establishment of a Shielding Experimental Benchmark  
at the OECD/NEA Data Bank  
June 1990  
A.K. McCracken  
Session B 3.1

NEACRP-A-1045

Three-dimensional Neutron Transport Benchmark  
Notification of Meeting - 22/23 October 1990, OECD/NEA Data Bank, Saclay  
NEACRP Secretariat

NEACRP-A-1046

Status of the 1989 Noise Analysis Benchmark Test  
September 1990  
J.E. Hoogenboom  
Session B 3.4

NEACRP-A-1047

VENUS International Programme (VIP),  
A Nuclear Data Package for LWR Pu Recycle  
September 1990  
A. Charlier, J. Basselier, L. Leenders  
Session B 1.1

NEACRP-A-1048

VENUS International Programme (VIP),  
A Nuclear Data Package for BWR Pu Recycle  
September 1990  
J. Basselier, A. Charlier, P. D'Hondt, L. Leenders, G. Minsart  
Session B 1.1

NEACRP-A-1049

VENUS International Programme (VIP),  
A Nuclear Data Package for PWR Pu Recycle  
September 1990  
J. Basselier, A. Charlier, P. D'Hondt, L. Leenders, G. Minsart  
Session B 1.1

NEACRP-A-1050

Calculation of Neutron-Physical Parameters of the Advanced Light-Water  
Reactor Fuel Lattices  
September 1990  
V.V. Kuznetsov, A.G. Morozov, A.A. Dudnikov, I.S. Slesarev  
Session B 2.2

NEACRP-A-1051

(WITHDRAWN)

NEACRP-A-1052

The Cold Neutron Moderator for the Continuous Spallation Neutron  
Source SINQ  
March 1990  
F. Atchison, G. Bauer, W. Fischer, K. Skala, H. Spitzer  
Session B 1.4

NEACRP-A-1053

On the Effect of ENDF/B-VI Beryllium Data on the Neutronics of  
ITER Blankets  
September 1990  
Sandro Pelloni, Mark J. Embrechts, Edward T. Cheng  
Session B 1.5

## NEACRP-A-1054

Reduction of the Long-Term Toxicity of Neptunium by Nuclear Spallation  
September 1990  
H.U. Wenger, P. Wydler, S. Atchison  
Session B 2.3

## NEACRP-A-1055

Plutonium Reload Experience and Perspective in French PWR Plants  
October 1990  
M. Rome, M. Salvatores, J. Mondot, M. Le Bars  
Session B 1.1

## NEACRP-A-1056

Quality Assurance Provisions for ERANOS  
October 1990  
J.M. Rieunier, G. Palmiotti  
Session B 1.2

## NEACRP-A-1057

Comparative Study of the Neutronic Performances of a Large LMFBR Using  
Oxide Fuel or Metallic Fuel  
October 1990  
J.C. Garnier, A. Zaetta  
Session B 1.3

## NEACRP-A-1058

Sodium-Voiding Reactivity Effect Reduction in Fast Breeder Reactors  
October 1990  
J. Thommasi, A. Zaetta  
Session B 1.3

## NEACRP-A-1059

Modular Island Cores  
October 1990  
C. De Pascale, A. Zaetta  
Session B 1.3

## NEACRP-A-1060

Sensitivities Analysis of the T.F. Coil Shielding Parameters  
in the NET Design to the Nuclear Data Uncertainties  
October 1990  
A. Santamarina, H. Smith  
Session B 1.5

## NEACRP-A-1061

Reactor Physics Studies at CEA on Advanced Water Reactors  
October 1990  
A. Leridon et al.  
Session B 2.2

## NEACRP-A-1062

Radiotoxicity of Wastes Impact of Plutonium Recycling  
October 1990  
M. Darrouzet, G. Flamenbaum, J.P. Grouiller  
Session B 2.3

## NEACRP-A-1063

Active and Passive Non-Destructive Measurements for  
Nuclear Monitoring of Spent Assemblies  
October 1990  
G. Bignan, L. Martin-Deidier  
Session B 2.5

## NEACRP-A-1064

NEACRP Beta-effective Benchmark Measurements at MASURCA.  
Proposal for the Experimental Program  
October 1990  
M. Martini, J.C. Gauthier, G. Granget, R. Soule  
Session B 3.8

## NEACRP-A-1065

Proposal for Benchmark Calculations of Power Distribution  
within an Assembly using Standard or Nodal Diffusion Schemes  
October 1990  
J.C. Lefebvre, J. Mondot, J.P. West and al.  
Session B 3.10

## NEACRP-A-1066

Plutonium Generation Boiling Water Reactor Concept  
October 1990  
Renzou Takeda, Motoo Aoyama, Yoshihiko Ishii, Osamu Yokomizo,  
Kazuya Ishii, Noriyuki Sadaoka, Sadao Uchikawa  
Session B 1.1

NEACRP-A-1067

Utilization of MOX Fuel Assembly Containing Gd203 in ATR  
October 1990  
Norio Kawata, Toshio Wakabayashi  
Session B 1.1

NEACRP-A-1068

Study of Enhanced Safety Core Characteristics of Nitride Fuel FBR  
October 1990  
Y. Ohkubo, T. Wakabayashi  
Session B 1.3

NEACRP-A-1069

Integral Experiments to Improve Tritium Breeding Ratio  
October 1990  
Akito Takahashi, Ken Yamanaka, Kenji Sumita  
Session B 1.5

NEACRP-A-1070

Phase-IIIA Experiment of the JAERI/USDOE Collaborative Program on  
Fusion Neutronics  
October 1990  
Y. Oyama, C. Konno, Y. Ikeda, H. Maekawa, K. Kosako, T. Nakamura  
Session B 1.5

NEACRP-A-1071

Benchmark Test of Be Nuclear Data in JENDL-3 Through Analyses of  
Time-of-Flight and Integral Experiments on Be Assemblies at FNS  
October 1990  
Hiroshi Maekawa, Yukio Oyama, Kazuaki Kosako  
Session B 1.5

NEACRP-A-1072

Prediction Accuracies of Safety Related Core Design Parameters  
for FBR  
October 1990  
Keisho Shirakata, Toshio Sanda  
Session B 2.1

## NEACRP-A-1073

Measurement of Void Reactivity Worth of HTTR Mockup  
Control Rod Hole in VHTRC-1 Core  
October 1990  
F. Akino, T. Yamane, M. Takeuchi, Y. Kaneko  
Session B 2.2

## NEACRP-A-1074

Analysis of Temperature Effect of Reactivity for VHTRC and SHE  
with Nuclear Design Code System for High Temperature  
Engineering Test Reactor (HTTR)  
October 1990  
Isao Murata, Kiyonobu Yamashita, Ryuichi Shindo  
Session B 2.2

## NEACRP-A-1075

Study of TRU Transmutation Plant with Proton Accelerator  
October 1990  
T. Nishida, I. Kanno, H. Takada, T. Takizuka, M. Mizumoto,  
M. Akabori, Y. Nakahara, Y. Okumura, H. Yasuda, Y. Kaneko  
Session B 2.3

## NEACRP-A-1076

TRU Transmutation in an LMFBR  
October 1990  
M. Ishikawa, M. Yamaoka, T. Wakabayashi, T. Kawakita  
Session B 2.3

## NEACRP-A-1077

A Study of Regional Oscillation with TOSDYN-2  
October 1990  
Y. Takigawa, Y. Takeuchi, H. Namba, S. Ebata,  
S. Kasai, T. Anegawa  
Session B 2.4

## NEACRP-A-1078

Examination of Nuclear Thermal Hydraulic Oscillation Modes  
in BWR Core.  
October 1990  
O. Yokomizo, I. Sumida, T. Anegawa, Y. Yoshimoto, T. Fukahori  
Session B 2.4

## NEACRP-A-1079

Development of Non-Destructive Measuring Techniques for Trace Amount of Fissile and Fertile Materials in Drum-Sized Waste  
October 1990  
H. Gotoh, M. Haruyama, N. Wakayama  
Session B 2.5

## NEACRP-A-1080

International Comparison on Measuring Techniques of Tritium Production Rate for Fusion Neutronics Experiments  
October 1990  
Summarized by Hiroshi Maekawa  
Session B 3.6

## NEACRP-A-1081

Progress Report on 3-D Neutron Transport Benchmark Problems  
October 1990  
T. Takeda, H. Ikeda, M. Tamitani  
Session B 3.7

## NEACRP-A-1082

Viewgraphs on the Activities of the Committee on the Safety of Nuclear Installations (CSNI)  
October 1990  
CSNI Secretariat  
Session B 4.1

## NEACRP-A-1083

Summary of Activities of the Nuclear Development Committee (NDC)  
October 1990  
NDC Secretariat  
Session B 4.1

## NEACRP-A-1084

Quality Assurance (QA) for Neutronics Codes at ANL  
October 1990  
ALN Secretariat  
Session B 1.2

## NEACRP-A-1085

Requirements for Validating (LWR) Neutronics Codes  
October 1990  
David J. Diamond  
Session B 1.2

NEACRP-A-1086

A Measurement Based Method for Predicting Margins and  
Uncertainties for Unprotected Accidents in the Integral  
Fast Reactor (IFR)

R.B. Vilim

Session B 1.3

NEACRP-A-1087

High Neutron Flux Fusion Materials Test Facility

L.G. LeSage

Session B 1.4

NEACRP-A-1088

Sensitivity/Uncertainties Analyses for Fusion Applications

September 1990

ANL Secretariat

Session B 1.5

NEACRP-A-1089

Pin Power and Depletion in EBR-II

October 1990

W.S. Yang, R.D. McKnight

Session B 2.1

NEACRP-A-1090

Hazard Quantification for LWR Spent Fuel

October 1990

R. N. Hill

Session B 2.3

NEACRP-A-1091

A Review of Reactor Physics Uncertainties and Validation  
Requirements for the Modular High-Temperature Gas-Cooled Reactor

May 1990

A.M. Baxter, R.K. Lane, E. Hettergott, W. Lefler

(General Atomics)

Session B 1.2

NEACRP-A-1092

Reaction Rate Distributions and Related Data in the  
FNS Phase II Experiments: Comparison of Measured and  
Calculated Data

July 1990

R.T. Santoro, R.G. Alsmiller, Jr., J.M. Barnes (ORNL)

Session B 1.5

NEACRP-A-1093

Considerations for a Shielding Experimental Benchmark  
Data Base

October 1990

W.W. Engle, Jr., D.T. Ingersoll (ORNL)

Session B 3.1

NEACRP-A-1094

Verification of the Shutdown System Software at the  
Darlington Nuclear Generating Station

September 1990

G.N. Archivoff et al.

Session B 1.2 (NOT RECEIVED)

NEACRP-A-1095

The Canadian Process for Regulatory Approval of  
Safety Critical Software in Nuclear Power Reactors

September 1990

G.J.K. Asmis et al.

Session B 1.2 (NOT RECEIVED)

NEACRP-A-1096

Licensing Safety Critical Software.

Public Opinion and the Full Power of the Mind.

G.H. Archinoff, R.A. Brown.

Hans Y. Tammemagi

Session B 1.2

NEACRP-A-1097

The Advanced MAPLE Concept

September 1990

R.F. Lilstone et al.

Session B 1.4 (NOT RECEIVED)

## NEACRP-A-1098

Neutronic Decoupling and Coolant Void Reactivity  
in CANDU

September 1990

V.K. Mohindra, A.R. Dastur

Session B 2.4

## NEACRP-A-1099

SMDKIN - A Code for Time-Dependent Three-Dimensional Neutronics  
Calculations in CANDU-PHW Reactors Based on Modal Kinetics  
Theory - Application to Loss of Coolant Accidents

September 1990

M. Gold, J.C. Luxat

Session B 2.4

## NEACRP-A-1100

28th NEANDC meeting: Report on matters of interest to NEACRP

October 1990

E. Fort

Session B 4.1

## NEACRP-A-1101

ANITA - Analysis of Neutron Induced Transmutation  
and Activation

April 1990

C. Ponti, S. Stramaccia, (JRC Ispra)

Session B 1.5

## NEACRP-A-1102

BWR Stability Investigation in Ringhals 1.

Measurement Data from October 26, 1989

(Summary of Studsvik Report NI-90/17)

October 1990

Bengt-Goeran Bergdahl, Ritsuo Oguma

Session B 2.4

## NEACRP-A-1103

PHYSOR'90: Conference Summary

May 1990

John L. Rowlands

Session B 5.1

## NEACRP-A-1104

Summary Record of the Twenty-eighth NEANDC Meeting  
Harwell, 26-30 March 1990, (Technical Minutes)  
Herbert Vonach, IRK  
Session B 4.1

## NEACRP-A-1105

Overview of the IAEA Reactor Physics Activities 1989/1990  
October 1990  
M. Crijns, IAEA  
Session B 4.1

## NEACRP-A-1106

Activity Report of the OECD/NEA Data Bank for the NEACRP Meeting  
October 1990  
NEA Data Bank Secretariat  
Session B 4.1

## NEACRP-A-1107

Status Report on the Intercomparison of Shielding Codes  
for Transport Flasks  
October 1990  
A. F. Avery  
Session B 3.3

## NEACRP-A-1108

Status Report of the NEACRP HCLWR Benchmark Working Group  
October 1990  
W. Bernnat, E. Sartori  
Session B 3.5

## NEACRP-A-1109

On Actinides Transmutation Possibility in Fast Reactors with Various Coolants  
October 1990  
D.F. Tzurickov, A.N. Shmelyov, A.G. Morozov, V.B. Glebov, G.G. Koulickov,  
V.V. Kuznetzov  
Session B 2.3

## NEACRP-A-1110

Experimental and Calculational Investigation on HCLWR Physics  
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IPPE, Obninsk and IAE, Moscow Secretariats  
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## NEACRP-A-1111

Sensitivities to Nuclear Constants and Related Computational Errors in Safety Characteristics of Fast Reactors with Different Coolants

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G.G. Kulikov, V.B. Glebov, A.G. Morozov, I.V. Kurchatov

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## NEACRP-A-1112

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S.M. Bednyakov, V.A. Dulin, L.V. Korobeinikova, G.N. Manturov, I.P. Matveenko

A.M. Tsibulya / D.F. Tzurickov, A.N. Shmelyov, A.G. Morozov, V.B. Glebov,

G.G. Koulickov, V.V. Kuznetsov

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V.V. Afanasiev, A.G. Belevitin, Y.M. Verzilov, V.L. Romodanov,

V.V. Khromov, D.V. Markovshij, G.E. Shatalov

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## NEACRP-A-1114

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G. Elliott Whitesides, E. Sartori

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## NEACRP-A-1115

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Akihiro Hara, Kastuya Kinjo

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## NEACRP-A-1116

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F.U. Schlemmer, G.J. Schlosser, W.D. Krebs, H.P. Fuchs, R. Manzel,

H.W. Wiese

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Benchmark 3-D Neutron Transport Calculations

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L.N. Yaroslavtseva, P.A. Fomichenko, L.L. Kononova

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V.I. Bryzgalov, V.V. Korobeiynikov, A.D. Rogov, M.S. Yudkevich

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