ADK/90/M53

JEF WORKING GROUP ON BENCHMARK TESTING
NEA DATA BANK, 5 DECEMBER 1990

UK Progress

The overall benchmarking programme, identified in Table 1, has been divided into six broad areas. During the current period, from April 1990 to March 1991, the programme is progressing as planned. The scope of the benchmarking programme from April 1991 to March 1992 is totally dependent on current discussions with Government Departments and industry. On the assumption that all activities are fully resourced, a major part of the benchmark calculation programme will be performed during this period.

Table 1 - Overall Benchmarking Programme until 1992

Period	Fast	Thermal	Irradiated Fuel	Criticality	Decay Heat	Shielding
4/90 to 3/91	Data processing (Cadarache) CRECCO support (Winfrith) Establishing suitable ZEBRA benchmarks for ECCO calculations (Winfrith) Preparation of ZEBRA assembly descriptions for SNEDAX data bank (Winfrith)	Test NJOY processing (Winfrith) Simple homogeneous benchmark calculation (Winfrith) Preparing DIMPLE benchmarks (Winfrith)		Define criticality benchmarks (Winfrith)	Analysis of SPX test (Winfrith)	Gamma ray production data (Winfrith) Establishing benchmarks (Winfrith)
4/91 to 3/92	NJOY processing (Harwell) ECCO-ZEBRA benchmark calculations (Winfrith) Establishing suitable CCRR/ ERANOS-ZEBRA benchmarks (Winfrith)	NJOY processing for WIMS library (Winfrith) WIMS benchmark calculations (Winfrith) Additional DIMPLE benchmarks (Winfrith)	Benchmark calculations of DIMPLE irradiated fuel experiments (Winfrith)	NJOY processing into 8000 groups (Winfrith) Benchmark calculations (Winfrith)	Benchmarking with Tobias best fits (Winfrith) Defining further benchmarks (NEA Task Force)	NJOY processing into 8000 groups (Winfrith) Processing uncertainty information (Winfrith) Benchmark calculations (Winfrith)

Specific points regarding the overall status of the programme and future plans are as follows:

The BZD/1 low reactivity sodium void experiment has been specified in a Quality Assured format suitable for independent

analysis. A similar report is in preparation for the CADENZA assemblies. The identification of other ZEBRA assemblies from the list provided in JEF/DOC-311 has not been completed. However, top priority for proposed JEF2-ECCO calculations are the ZEBRA-8 k_∞ series. Other key potential benchmarks are those used in the production of the adjusted FGL5 fine group cross-section library (ie ZEBRA 1, 2, 3, 6A, 9, 10, 11).

A major effort is underway to prepare ZEBRA assembly descriptions for incorporation into the SNEDAX data bank. From ZEBRA-15 onwards, core plans were stored for each reactor start-up on the Winfrith mainframe computer. These comprised the date, assembly number, start-up number, total number of elements and, for each x-y location, an element name, type and sheath number. A directory of element name and type identify the component specification. A further data bank provides the compositions and dimensions for each component. The quantity of compressed core-plan data is about 23.2 Mbytes, of which 20 Mbytes has now been successfully retrieved from the mainframe.

The following issues remain to be resolved before the data can be incorporated into SNEDAX:

(1) Retrieval of 94 core plans for Assembly 16, 139 for Assembly 17 and 6 for Assembly 18.

(2) Identification of key post-ZEBRA-15 assemblies for transfer to SNEDAX (ie only a fraction of the 4000 retrieved are required for benchmarking).

(3) Identification and specification of pre-ZEBRA-15 assemblies.

(4) Specification of experimental results (reaction-rates, k-values, uncertainties etc).

(5) Update of ZEBRA fuel composition data. As a result of changes in half-lives over the years it is necessary to re-assess the composition data based on the values now in circulation (Table 2).

Table 2 - Half Life Data

Isotope	Fuel Accounting Values	AEEW - R1407 (1981) and JEF-2 (1989)	IAEA (1986)
^{238}Pu	87.789	87.7±0.2	87.7±0.3
^{239}Pu	24083	24113±40	24110±30
^{240}Pu	6537	6550±20	6563±7
^{241}Pu	14.355	14.4±0.5	14.4±0.1
^{242}Pu	373570	375000±3000	373500±1100

The consequences of the choice between these particular values is considered to be negligible. The most significant value (^{241}Pu) is currently being re-evaluated at Winfrith. The accounting value adopted for ^{241}Pu is a recent experimental result from Parker et al of Los Alamos which, although it appears the most accurate measurement to-date (±0.04y), is only one of approximately thirty values being considered.

In the thermal reactor field, infinite dilute cross-sections have been generated for ^{235}U, ^{238}U, H in H_2O, O, Fe and ^{135}Xe by Winfrith and Cadarache. The results of a comparison of the two data sets being performed at Cadarache are expected by the end of the year. The next stage, to generate a small WIMS library containing ^{235}U, ^{238}U, H, O and other isotopes in order to perform a simple homogeneous benchmark calculation, will be completed by April 1991. The main JEF-2 benchmarking programme will include all the lattice experiments employed in the validation of the existing WIMS nuclear data library as listed in JEF/DOC-311.

A common 8000g library for criticality and shielding Monte Carlo calculations is to be established. It is proposed to perform a Monte Carlo calculation of the simple homogeneous benchmark for comparison with WIMS.

Table 3 shows the current status of the shielding benchmark programme. JEF-2 data in the VITAMIN-J scheme will be used for shielding multigroup calculations. The only major comment with regards the proposals in JEF/DOC-315 is that it would be helpful if all the constituents in concrete were given priority 3 status.

The current status of the DIMPLE core physics, criticality and irradiated fuel benchmarks is given in Table 4. The irradiated fuel experiments were designed for the validation of burn-up predictions and actinide and fission product nuclear data relevant to (a) reactor fuel management; (b) burn-up credit and criticality assessment; (c) shielding and accident analyses source data.

A D KNIPE
Experimental Reactor Physics Department
Winfrith Technology Centre

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					CODE	McBEND JEF1	SNAPSII ADC E	CCRR PROPANE D2	DLS ENDFBIV&V	McBEND UKNDL	MCNP JEF1	MCNP JEF1	ANISN	DOT 3.5	FENDER
TRANSMISSION DATA															
					EXPERIMENT						ENEA	UK			
IRON BENCHMARK	MS				✓	✓				✓	✖	✖	✖	✖	✖
STAINLESS STEEL BENCHMARKS	Phase1	SS	NESTOR PLATES		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Phase 2	SS	NESTOR PLATES		✓	✓		✓	✓	✓	✖	✖	✖	✖	✖
ASPIS SLAB GEOMETRY BENCHMARKS	Phase 3	SS 25	JASON PLATES		✓	✓		✓		✓	✖	✖	✖	✖	✖
		SS	B4C	SS											
	Phase 4	10	5	10	✓	✓		✓	✓	✓	✖	✖	✖	✖	✖
	Phase 5	15	5	5	✓	✓				✓	✖	✖	✖	✖	✖
	Phase 6	10	10	5	✓						✖	✖	✖	✖	✖
	Phase 7	B4C 45									✖	✖	✖	✖	✖
	Phase 8	NA DEEP PENETRATION									✖	✖	✖	✖	✖
	Phase 9	NA 120	B4C 5	NA 162							✖	✖	✖	✖	✖
	Phase 10	NA 120	B4C 5	NA 162							✖	✖	✖	✖	✖

Table 3 - Status of Shielding Benchmark Programme

Table 4 - DIMPLE Core Physics, Criticality and Irradiated Fuel Benchmarks

Assembly	Description	Status: Benchmark Report and Analysis with Current Methods and Data	Status: JEF-2
S01A	1565 3% enriched UO_2 pins on 13.2 pitch. Cylindrical assembly.	Completed	1992/93
S02	3% enriched UO_2 pins on 17.9mm pitch within CAGR boron steel skip insert. (1 critical and 13 sub-critical configurations).	1991/92	1992/93
S03	7% enriched UO_2 pins on 13.2mm pitch. Cylindrical assembly.	1991/92	1992.93
S04A	7% enriched UO_2 pins on 13.2mm pitch in annulus around central light water zone.	Low priority	Low priority
S04C	As S04A with central heavy water zone.	Low priority	Low priority
S05	Extension of S02 CAGR boron steel skip insert studies. Gross loading error of a 7% enriched cluster-configuration with edge cluster and configuration with middle cluster.	1991/92	1992/93
S06A	3072 3% enriched UO_2 pins on 12.5cm pitch. Clean cruciform assembly without baffle.	To be completed 3/91	1992/93
S06B	As S06A with stainless-steel radial baffle.	To be completed 3/91	1992/93
S06C	As S06B with discrete borosilicate poison pin and water mesh arrays (eleven configurations).	To be completed 3/91	1992/93
Irradiated Fuel Phase I	High enriched, high burn-up fuel.	Commercial	
Irradiated Fuel Phase II	CAGR 2.0% and 2.5% enriched 20GWd/t.	Completed	1992/93
Irradiated Fuel Phase III	PWR 3% enriched 20GWd/t PWR 4.3% enriched 50GWd/t	1991/92 1991/92	1992/93 1992/93