JEF Working Group on Benchmark Testing
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UK Programme/Progress

N T Gulliford

The proposed benchmarking programme for the current period of April 1992 to March 1993 is summarised in Table 1. Some revisions have been made to meet sponsors requirements and changed priorities.

In the area of Fast Reactor Physics all the items listed are nearing completion. ECCO C/E values for ZEBRA Core show reasonable agreement with an RMS deviation in Kinf of 1.0% for a range of cell types with fast to intermediate neutron spectra. Further calculations using ERANOS should also be completed in the current period. Funding in this area has effectively been reduced to zero from March 1993 with the recent decision by the UK Government to withdraw from the EFR collaboration.

Benchmarking of the DIMPLE Thermal Reactor Physics experiments has commenced using the JEF2.2 172group library. C/E values for Keff show good agreement (0.3%) for several DIMPLE cores although some unexpected trends apparently related to leakage are observed. Further benchmarking work in this area is planned for 1993/94.

Benchmarking of the DIMPLE Irradiated Fuel experiments using JEF2.2 is now planned for 1993/94.

In the Criticality area the JEF2 fine group library is now released and being benchmarked against DIMPLE experiments (S02 & S05 Core series) using Monte-Carlo methods. Provisional results show a fairly consistent underprediction in Keff by about 0.8-1.0%. This type of benchmarking will continue in 1993/94 with analysis of experiments from other critical facilities.

Benchmarking in the Decay Heat area awaits resolution of problems with the recently released JEF Decay Data file. Current planning is for benchmark calculations on a ZEBRA BZD experiment, using FISPIN and JEF data, to be made before the end of the period.

Analysis of the ASPIS sodium deep penetration shielding benchmark using JEF 1 data is completed and a final report will be issued shortly. The results show fairly good agreement for epithermal and threshold reaction rates (C/E 0.8) at up to 1m penetration, degrading to C/E values of about 0.6 at 2m penetration. Benchmarking of other ASPIS single-material experiments using the JEF 2 fine group library is underway and should be completed before the end of the period. This work will continue in 1993/94 with analysis of the material-array ASPIS benchmark experiments.

The proposed benchmarking programme for 1993/94 is presented in Table 2. Most of the areas covered in 1992/93 should be continued, with the exception of Fast Reactor Physics which currently has no funding. The DIMPLE critical assembly is used in much of the UK benchmarking work. Table 3 lists the

programmes completed and planned during this and the next financial year. Further details of the irradiated fuel programme are given in Table 4.

N T Gulliford
Experimental Reactor Physics Department
Reactor Services

Winfrith Technology Centre

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Table 1

Summary of Proposed Benchmarking Programme for 1992/93

Fast Reactor Physics	Thermal Reactor Physics	Irradiated Fuel/ Burn-up	Criticality	Decay Heat	Shielding
Install JEF2/ECCO fine and broad group libraries and the ERANOS data base	Generate JEF2 fine group library (8000g) for U^5, U^8, H, O	Analysis of DIMPLE PWR irradiated fuel experiments using 172g JEF2 library	Generate complete JEF2 fine group library (800g)	Benchmark testing against Tobias best fits	Analysis of ASPIS water slot benchmark using current fine group UKNDL
JEF2/ECCO-ZEBRA benchmark calculations	Comparison of fine group and 172g libraries for simple homogeneous benchmarks to check resonance shielding		Commencement of JEF2 benchmark testing with current validation set		Analysis of ASPIS sodium deep penetration benchmark (Phase 8) using JEF1
Establish suitable CCRR/ ERANOS-ZEBRA benchmarks	Extend the 172g JEF2 library to cover all nuclides needed for validation benchmarks including new DIMPLE benchmarks		Analysis of DIMPLE benchmarks not included in current validation set using JEF2		Generate complete JEF2 fine group library (8000g)
Inclusion of ZEBRA assembly descriptions into the SNEDAX data bank	Comparison of 172g library with CEA equivalent				Commencement of JEF2 benchmark testing against shielding experiments identified in JEF/DOC-311
	Completion of benchmark testing 172g JEF2 library against validation experiments identified in JEF/DOC-311				
	Analysis of DIMPLE benchmarks not included in current WIMS validation set using 172g JEF2 library				

Table 2

Summary of Proposed Benchmarking Programme for 1993/94

Thermal Reactor Physics	Irradiated Fuel/ Burn-up	Criticality	Shielding
Improve existing JEF2 library in light of 1992/93 Benchmarking Results	Generate JEF2 Multitemperature data for use in thermal power reactor calculations Revise Energy Release and Decay Data	Improve existing JEF2 library in light of 1992/93 Benchmarking Results	Generate group cross-sections for heating calculations in shields
Add JEF2 Thermal Scattering Data		Continuation of JEF2 benchmark testing with current validation set	Analysis of ASPIS graphite slot benchmark using current fine group UKNDL and JEF2
Comparison of 172g library with CEA equivalent	Analysis of DIMPLE PWR irradiated fuel experiments using 172g JEF2 library	Analysis of critical assembly benchmarks not included in current validation set using JEF2	Comparisons with ASPIS Steel and Water slot benchmarks.
Analysis of DIMPLE benchmarks not included in current WIMS validation set using 172g JEF2 library	Analysis of DIMPLE Fission Product Simulant Experiments using 172g JEF2 library		Continuation of JEF2 benchmark testing against shielding experiments identified in JEF/DOC-311 (Material Arrays)

Table 3

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	1993/94
S02	3% enriched UO_2 pins on 17.9mm pitch within CAGR boron steel skip insert. (1 critical and 13 sub-critical configurations).	Completed	1992/93
S03	7% enriched UO_2 pins on 13.2mm pitch. Cylindrical assembly.	1992/93	1993/94
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.	Completed	1992/93
S06A	3072 3% enriched UO_2 pins on 12.5cm pitch. Clean cruciform assembly without baffle.	Completed	1992/93
S06B	As S06A with stainless-steel radial baffle.	Completed	1992/93
S06C	As S06B with discrete borosilicate poison pin and water mesh arrays (eleven configurations).	Completed	1992/93
S06D	As S06C with simulated misloaded high enriched fuel arrays and localised moderator voiding/boiling (six configurations)	Completed	Low priority
S03B, S04A, S04B	Assemblies used in Irradiated Fuel Burn-up Credit Reactivity Measurements	1992/93	1993/94

Table 4

DIMPLE Core Physics, Criticality and Irradiated Fuel Benchmarks

Programme	Description	Status: Benchmark Report and Analysis with Current Methods and Data	Status: JEF-2
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	1993/94
Irradiated Fuel Phase III	PWR 3.2% enriched 20.2GWd/t PWR 4.3% enriched 50.8GWd/t	Completed	
CERES Phase I	PWR 3.1% enriched 20.5GWd/t PWR 2.6% enriched 30.0GWd/t PWR 3.1% enriched 49.5GWd/t PWR 3.1% enriched 59.6GWd/t	1992/93	1993/94
CERES Phase II	Fission Product Simulants ^{103}Rh, ^{143}Nd, ^{155}Gd, ^{149}Sm, ^{133}Cs, ^{152}Sm, ^{145}Nd, ^{153}Eu, ^{95}Mo, ^{147}Sm, ^{99}Tc, ^{150}Sm, ^{109}Ag, ^{101}Ru	1993/94	1993/94
CERES Phase III	Actinides and Irradiated MOX fuel		1994/95

Comparisons of $(\frac{C-E}{E})$% for k∞

Cell	ECCO 3D	MURAL 3D
A/2	-1.3±0.6	0.0±0.6
B	0.0±0.3	0.4±0.2
C/2	-1.4±0.4	-0.5±0.4
D	-0.3±0.4	0.3±0.4
E	-1.6±0.7	-0.4±0.7
F/2	-0.3±0.4	1.0±0.4
H	0.8±0.3	-0.5±0.3
RMS Value	1.0%±0.46%	0.52%±0.46%

Comparisons of $(\frac{C-E}{E})$% for $\frac{C8}{F9}$ Reaction-Rate Ratios

Cell	ECCO 3D	MURAL 3D
8A/2	3.1±2.3	-0.1±2.3
8B	0.4±2.1	-0.5±2.1
8C/2	0.8±1.2	-0.8±1.2
8D	1.8±1.8	1.0±1.8
8E	1.2±1.6	-0.2±1.6
8F/2	3.3±1.3	0.8±1.3
8H'	1.5±1.5	3.7±1.5
RMS Value	2.0%±1.73%	1.5%±1.73%

Comparisons of $(\frac{C-E}{E})$% for $\frac{F8}{F9}$ Reaction-Rate Ratios

Cell	ECCO 3D	MURAL 3D
8A/2	1.8±3.1	-0.4±3.1
8B	1.7±2.8	-1.7±2.8
8C/2	3.0±3.2	0.0±3.2
8D	4.5±3.5	3.5±3.5
8E	3.5±4.3	2.9±4.3
8F/2	-5.9±3.3	-6.6±3.3
8H'	2.9±2.0	2.2±2.0
RMS Value	3.6%±3.2%	3.2%±3.2%

Summary of LWRWIMS/JEF2 Benchmarking of DIMPLE Expts.

LWRWIMS-3A Calculations (Provisional)

		1986 WIMS 6 Group	1986 WIMS 69 Group	JEF2.2 6 Group	JEF2.2 69 Group	JEF2.2 172 Group
S01	k-pers	1.058428	1.058428	1.057153	1.057153	1.057153
	k-gog	0.99142	0.99474	0.99540	0.99715	0.99772
	(C-E)/E	-0.00858 -0.86%	-0.00526 -0.53%	-0.00460 -0.46%	-0.00285 -0.29%	-0.00228 -0.23%
R3/100H	k-pers	1.057608	1.057608	1.058268	1.058268	1.058268
	k-gog	0.99126	0.99409	0.99730	0.99897	0.99917
	(C-E)/E	-0.00874 -0.87%	-0.00591 -0.59%	-0.00270 -0.27%	-0.00103 -0.10%	-0.00083 -0.08%
S06A	k-pers	1.118716	1.118716	1.119430	1.119430	1.119430
	k-gog	0.99158	0.99259	0.99742	0.99723	0.99735
	(C-E)/E	-0.00842 -0.84%	-0.00741 -0.74%	-0.00258 -0.26%	-0.00277 -0.28%	-0.00265 -0.27%
S06B (1)	k-pers	1.087031	1.087031	1.089612	1.089612	1.089612
	k-gog	0.99047	0.99271	0.99765	0.99864	0.99887
	(C-E)/E	-0.00953 -0.95%	-0.00729 -0.73%	-0.00235 -0.24%	-0.00136 -0.14%	-0.00113 -0.11%
S06C/8	k-pers	1.081643	1.081643	1.083786	1.083786	1.083786
	k-gog	0.98945	0.99149	0.99568	0.99611	
	(C-E)/E	-0.01055 -1.06%	-0.00851 -0.85%	-0.00432 -0.43%	-0.00389 -0.39%	

The JEF-2.2 Nuclear Data Library

JEF 2-2

Summary of MONK6/JEF2 Benchmarking of Bierman Expts.

Validation Case 1 JEF2 Results

Case	k-effective Run 1	k-effective Run 2	Mean k-effective
1.01	0.9903 (0.0014)	0.9953 (0.0014)	0.9928 (0.0010)
1.02	0.9900 (0.0014)	0.9915 (0.0015)	0.9907 (0.0010)
1.03	0.9932 (0.0015)	0.9899 (0.0014)	0.9914 (0.0010)
1.04	0.9910 (0.0015)	0.9895 (0.0015)	0.9903 (0.0011)
1.05	0.9922 (0.0015)	0.9931 (0.0014)	0.9927 (0.0010)
1.06	0.9954 (0.0015)	0.9903 (0.0014)	0.9927 (0.0010)
1.07	0.9910 (0.0015)	0.9904 (0.0014)	0.9907 (0.0010)
1.08	0.9915 (0.0014)	0.9915 (0.0015)	0.9915 (0.0010)
1.09	0.9905 (0.0014)	0.9903 (0.0014)	0.9904 (0.0010)

Mean k-effective = 0.9915 Standard Error = 0.0004 (-0.85%±0.04%)
External Standard Deviation = 0.0017 ± 0.0003

Compares with DICE results :

Mean k-effective = 1.0046 Standard Error = 0.0004 (+0.46%±0.04%)
External Standard Deviation = 0.0017 ± 0.0003