ADK/M20/90

JEF INTEGRAL BENCHMARK TESTING IN THE UK

A preliminary programme for the integral benchmark testing of JEF2 in the UK has been formulated on the basis of the present level of resources. Further support from Government Departments and industry is currently being pursued. The JEF2 validation effort will be co-ordinated by a joint AEA-industry committee.

The main task for 1990/91, in line with the timescales specified in JEF/DOC-296, is the generation of the group constant libraries and, where possible, the associated uncertainty files. Also during this period however, it is proposed to continue the specification of suitable experiments in a quality assured format suitable for independent analysis. These include a ZEBRA low reactivity sodium-void benchmark experiment in an annular heterogeneous assembly, the CADENZA cores and the DIMPLE S06 series.

The precise definition of the integral benchmark experiments and the preparation of the JEF2 libraries for the calculation analysis are at different stages of advance for thermal reactors, fast reactors and the various fuel cycle applications. A summary of the measurements identified as key benchmarks for analysis during 1991/92, or currently being examined as potential benchmarks, is attached.

A D KNIPE
AEA Technology
Winfrith

24 May 1990

WIMS LIBRARY VALIDATION BENCHMARK LATTICE EXPERIMENTS

(1) Homogeneous Metal Experiments

Two experiments to determine the enrichment of solid uranium metal required to give $k_\infty = 1$ by Kajanskij et al and Darrouzet et al.

(2) Homogeneous Oxide Experiments

Two experiments to determine the UO_2 enrichment required to give $k_\infty = 1$ by Dulin et al and Darrouzet et al.

(3) The Snell Experiment

Natural uranium exponential experiment.

(4) ORNL Spheres

Five experiments.

(5) Wurenlingen Natural Uranium/D_2O Single Rod Lattice

Three exponential experiments with natural uranium pins (V_m/V_f of 19, 45 and 80) in heavy water.

(6) Savannah River Natural Uranium/D_2O Single Rod Lattice

Four critical lattices with natural uranium pins (V_m/V_f of 53, 71, 95 and 161) in heavy water.

(7) Westinghouse TRX 1.3% Uranium Metal/H_2O Single Rod Lattices

Two experiments, TRX1 (V_m/V_f of 2.35) and TRX2 (V_m/V_f of 4.02).

(8) Winfrith DIMPLE 3% Enriched UO_2/H_2O Single Rod Lattices

Range of experiments.

(9) Brookhaven 3% UO_2/H_2O Lattices

Eleven experiments with range of V_m/V_f and boric acid concentrations.

(10) Winfrith BICEP U Metal/Graphite Lattices

Two experiments; BICEP 2/7 and 10/7.

DECAY HEAT

(1) **Tobias Best Fits**

SHIELDING

(1)	**NESTOR-ASPIS**	Iron Benchmark
(2)	**NESTOR-ASPIS**	Graphite Benchmark
(3)	**NESTOR-ASPIS**	Oak Ridge PCA Replica
(4)	**NESTOR-ASPIS**	JANUS Stainless-Steel Benchmark
(5)	**NESTOR-ASPIS**	JANUS B_4C/Steel Benchmark
(6)	**NESTOR-ASPIS**	JANUS Sodium/Steel Benchmark
(7)	**HARMONIE**	Sodium Streaming Benchmark
(8)	**^{252}Cf Sources**	Winfrith Water Benchmark

DIMPLE

Core Physics and Criticality Lattice Benchmarks

Assembly	Description
S01A (Rebuild of R1/100H)	1565 3% enriched UO_2 pins on 13.2mm pitch Cylindrical assembly.
S02	3% enriched UO_2 pins on 17.9mm pitch within CAGR boron steel skip insert (1 critical and 13 sub-critical configurations).
S03	7% enriched UO_2 pins on 13.2mm pitch Cylindrical assembly.
S04A	7% enriched UO_2 pins on 13.2mm pitch in annulus around central light water zone.
S04C	As S04A with central heavy water zone.
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.
S06A	3072 3% enriched UO_2 pins on 12.5cm pitch. Clean cruciform assembly without baffle.
S06B	As S06A with ~25mm stainless-steel radial baffle.
S06C	As S06B with discrete borosilicate poison pin and water mesh arrays (eleven configurations).

Irradiated Fuel Benchmarks

The 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.

The following range of irradiated fuels provide an integrated experimental data base comprising the DIMPLE reactivity, neutron source and gamma spectra measurements, coupled with chemical and isotopic analyses

(i) high enriched, high burn-up fuel
(ii) CAGR 2.0% and 2.5% enriched 20GWd/t
(iii) PWR 3% enriched 20GWd/t
(iv PWR 4.3% enriched 50GWd/t

ZEBRA Assemblies

Assembly Number	Description
1	Small (89 elements) 9.7% vol. U235 core with nat. U reflector (repeat of ZPR-III Assemblies 11 and 22)
2	173 element U235 core with graphite diluent to give softer spectrum than Assembly 1
3	Small 57 element Pu/Unat assembly Critical mass 81kg
4	Similar to Assembly 2 4A - radial blanket study for PFR 4B and 4C - heterogenous axial reflector study for PFR
5	Mixed critical assembly used primarily for hot loop Doppler coefficient measurements
6	Pu-fuelled fast critical assembly with uranium, graphite and sodium diluents Critical mass of 190kg (Pu239 + Pu241)
7	Full scale PFR mock-up (Pu239 + U235)
8	Series of seven test zones of plate cells with k_∞ close to unity and fast/intermediate neutron-spectra Other versions were also built, eg 8G/2 to examine pin-plate difference
9	Pu core with steel diluent and nat. U reflector. 217 and 221 core element versions 221 element version ~310kg (Pu239 + Pu241)
10	Pu core with oxygen diluent and nat. U reflector 241 element version ~303kg (Pu239 + Pu241)
11	MZA assembly Pu single zone core with sodium diluent 318kg (Pu239 + Pu241)

ZEBRA Assemblies

Assembly Number	Description
12	MZB - optimum representation of clean MONJU reactor 794kg (Pu239 + Pu241) MZC - MONJU mock-up with control rods 960kg (Pu239 + Pu241)
13	Equilibrium PFR mock-up with singularities (nine different loadings)
14	Assembly 13 with modified singularity loadings (two different loadings)
15	BZA - large conventional two zone reactor with 19 simulated control rod channels. Inner core enrichment (Pu/Pu+U) 16%; outer core enrichment 21%
16	BZB - extension of BZA with 27 simulated control rod channels and part inserted B_4C absorbers (4 versions)
17	BZC - large heterogenous design with 15 UO_2-Na fertile elements in "salt-and-pepper" arrangement. Fissile enrichment (Pu/Pu+U) 24%. 16 simulated control rod positions with followers in BZC/1 and B_4C absorbers in BZC/2.
18	BZD/1 - extension of BZC with fertile elements collected together to form central fertile zone. 12 simulated control rod positions containing ½ inserted B_4C absorbers.
19	BZD/1-A - derived from Assembly 18 with reduced central fertile zone (241 to 121 lattice positions) and relocating 90 fertile elements in thin ring at approximately mid-radius of fissile annulus.
20	BZD/2 - as Assembly 18 but with followers in simulated control rod positions.
21	BZD/3 - as Assembly 18 but with uniform fissile region without singularities.

ZEBRA Assemblies

Assembly Number	Description
22	CADENZA - Pu metal plate-geometry assembly with sodium.
23	CADENZA - Pu mixed-oxide assembly with sodium.
24	CADENZA - Pu metal plate-geometry assembly without sodium.
25	CADENZA - Pu mixed-oxide assembly without sodium.