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CALCULATION OF Pu SOLUTIONS BASED ON JEF2 FILES ANALYSIS OF THE VALDUC BENCHMARK EXPERIMENTS

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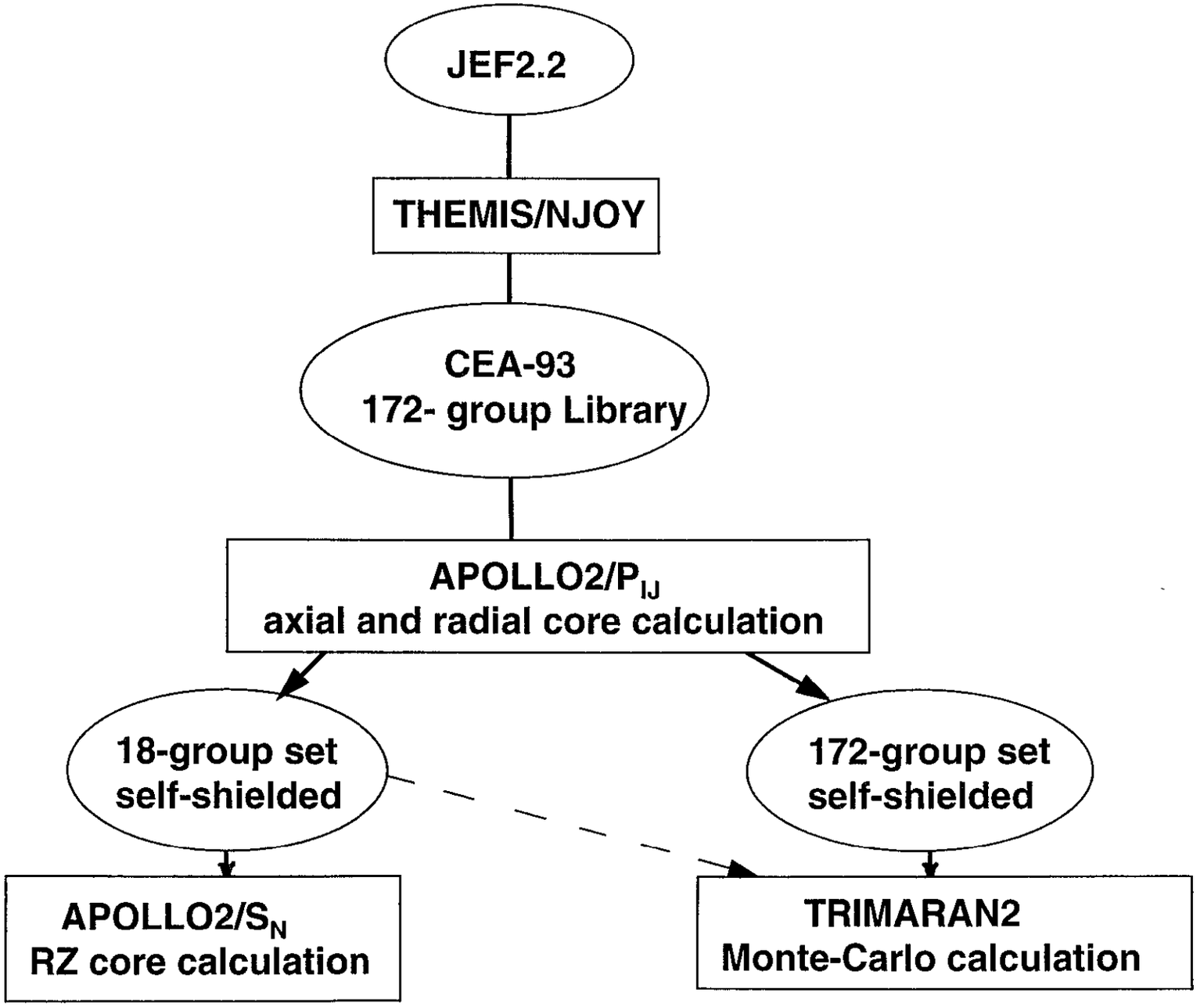
Calculation scheme based on APOLLO2-TRIMARAN2 package



I BACKGROUND

Although MOX fuelled lattice experiments are well predicted by codes using JEF2.2 library, the calculations of plutonium nitrate solutions seem to be discrepant : the AEA calculations of Pu solution experiments point out a strong overestimation of the reactivity with an average calculated Keff = 1.015 [1].

In order to obtain a first trend and to contribute to JEF2 validation, we analysed the recent Pu-U solution conducted at PNL-Critical Mass Laboratory [2]. The calculation results, obtained from the multigroup Monte-Carlo code TRIMARAN-2, were presented at the previous JEF Meeting (Paris 11-12 June 1995) : a slight overestimation of the computed multiplication factor of these Pu-U solutions was pointed out [3].

To obtain a final status of Pu solution calculations based on JEF2, a benchmark was proposed by A. NOURI corresponding to Pu solution experiments achieved in the CEA-IPSN Valduc facility [4]. This paper presents the analysis of this experimental benchmark based on the APOLLO2-JEF2 package.

II CALCULATION SCHEME BASED ON JEF2

These Valduc experiments were calculated with the APOLLO2-TRIMARAN2 package based on the CEA93 multigroup library (synoptic presented on the next page). The CEA93 croos-sections were derived from NJOY/THEMIS processing of the JEF2.2 library.

The self-shielded cross-sections are obtained from APOLLO2 calculations, using the P_{IJ} method. Cell homogenization or/and group condensation can be carried out within this step. The corresponding output cross-section sets are automatically handled by the Sn modules of APOLLO2, or by the multigroup Monte-Carlo code TRIMARAN2.

III CALCULATION RESULTS

The Calculation-Experiment comparison based on the deterministic route, i.e. APOLLO2-SN, is summarized in Table I.

The whole experimental cases, with Pu content in the range 13-20 g/l, stress an overestimation of the multiplication factor which amounts to about + 800 pcm ($10^{-5}\ \frac{\Delta k}{k}$). The core configurations with no reflections supply a less reliable experimental information because of the room return effect (C-E values in table I are corrected, using the monte-carlo calculations of the building).

The cases with high amount of plutonium, i.e C= 52.7 g/l and C=105 g/l, give a less relevant information on the reactivity of Pu solutions due to the high leakage level in this flat cores. The case N° 14 with no water reflection is characterized by a large uncertainty linked to the 1500 pcm room return correction.

The calculation-Experiment comparison based on the multigroup Monte-Carlo route, i.e., APOLLO2-TRIMARAN2 package, is shown on Table II. The statistical calculation results were obtained within ± 100 pcm in one standard deviation. The Keff results are consistent with the deterministic values, within the 95% confident interval. The critical configurations are calculated with overestimated Keff, ranging from 1.005 up to 1.0096.

IV CONCLUSION

Our analysis of the Valduc Pu solution experiments have shown that calculations based on JEF2 library overestimate by 800 pcm the reactivity of Pu solution characterized by 19% ^{240}Pu enrichment. Sensitivity analysis, based on various fissile solution experiments, is in progress in order to derive trends on JEF2 nuclear data.

TABLE 1 :

ANALYSIS OF VALDUC Pu NITRATE SOLUTION EXPERIMENTS USING CRISTAL/SN-JEF2 PACKAGE

Plutonium concentration (g/l)	6 sides water reflected		5 sides water reflected		No close water reflection	
	cases	$\frac{C-E}{E} \pm \sigma_{exp}$*	cases	$\frac{C-E}{E} \pm \sigma_{exp}$*	cases	$\frac{C-E}{E} \pm \sigma_{exp}$**
105			6	+635±123		
52.7			8	+463±155	14	-406±471
21.7			11		17	+385±447
19.7	1	+655±429	12	+611±429	18	+364±462
17.7	2	+572±474			19	+498±488
14.7	4	+743±522			21	+738±530
13.2	5	+953±581	13	+958±583	23	+976±584

* Experimental uncertainty corresponding to solution and critical height measurement

** Experimental uncertainty including the supplementary uncertainty due to the room return assessment

TABLE 2 :

ANALYSIS OF VALDUC Pu NITRATE SOLUTION EXPERIMENTS USING MONTE-CARLO CALCULATION BASED ON JEF2 MULTIGROUP LIBRARY (172 G)

Pu Concentration (g/l)	6 sides water reflected		5 sides water reflected		No close water reflection	
	cases	$\frac{C-E}{E} \pm \sigma^*$	cases	$\frac{C-E}{E} \pm \sigma^*$	cases	$\frac{C-E}{E} \pm \sigma^{**}$
105			6	+640 ± 120		
52.7			8	+640 ±160	14	
19.7	1	+560 ± 440	12	+530 ± 430	18	+480 ±470
16.7	3	+780 ±490			20	+730 ±500
14.7	4	+510 ±530			21	+790 ±540
13.2	5	+800 ± 600	13	+960 ± 590	23	+930 ±590

*** Experimental uncertainty corresponding to solution and critical height measurement and statistic uncertainty due to Monte-Carlo calculation.**

**** Experimental uncertainty including the supplementary uncertainty due to the room return assessment and statistic uncertainty due to Monte-Carlo calculation.**

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