Fast Reactor Benchmarks Using JEF-2.2

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We have been testing the MATXS/TRANSX/TWODANT system for our fast reactor project. At first, we have processed JEF-2.2 data and generated MATXS-format neutron 80-group library using NJOY94. And we have carried out benchmark test through the CSEWG benchmark problems.

● Generation and Benchmark Test

☆ Basic source data : JEF-2.2
☆ Processing code : NJOY94
☆ Library data format : MATXS-format

● The basic reactor model with which the 18 critical assemblies were analyzed was a 1-D transport calculation in spherical geometry. The exception to this was ZPPR-2, in which case the model was a 1-D cylinder. The 1-D to 2-D and heterogeneity correction factors from Hardie's paper[*N.S.E.* 57, 222(1975)] were applied to calculated $k_{eff.}$'s.

It is not clear whether those correction factors are still appropriate.

Table 1. 1-D. Spherical Model, P_3S_{16}, 80-group Calculation (C/E)

Assembly	$k_{eff.}$	*Corrected	F28/F25	F49/F25	F40/F25	C28/F25	C28/F49
VERA-11A	0.97754	0.98104	0.87799	0.99646	1.10726	0.74786	
ZEBRA-3	0.98552	0.98492	0.98420	0.98917	1.00006		
SNEAK-7A	0.99765	0.99925	0.94045	0.97031		0.96840	1.00123
ZPR-3-54	0.97619	0.98279	1.14811	0.94110	1.19749		
ZPR-3-53	0.99167	0.99967	1.13113	0.93779	1.18187		
SNEAK-7B	0.99521	0.99731	0.98739	0.99214		1.01267	1.02423
ZPR-3-50	0.99080	0.99950	1.12619	0.99116	1.32257		
ZPR-3-48	0.98414	1.00154	1.01825	0.99397	1.03954	0.96164	0.97017
ZPR-3-49	1.00042	1.00232	1.05215	1.01061			
ZPR-3-56B	1.00146	0.99506	0.95966	0.94887	0.83437		
ZPPR-2	1.01853	1.03633**	1.05463	0.98193	1.07916		
ZPR-6-7	0.98506	0.99966	0.97585	0.97703		1.05622	1.08146
Average	Plutonium	0.99482	1.02133	0.97755	1.09529	0.94936	1.01927
Ave. Dev.	Core	0.00588+	0.06708	0.02422	0.13670	0.07820	0.03419
VERA-1B	0.99458	0.99838	0.91020	0.95549	1.20825	0.92566	0.89334
ZPR-3-6F	1.00815	1.00535	0.98370	1.01739	0.99198	0.95604	0.94241
ZPR-3-12	1.00547	1.00457	1.04505	0.99253		0.96761	0.97331
ZPR-3-11	1.00490	1.00500	1.04405	0.98212	1.02707	0.95022	0.96874
ZEBRA-2	1.00337	1.00267	1.01787	1.00033	1.05165	0.94952	0.94777
ZPR-6-6A	1.00324	1.00924	0.97170			1.01742	
Average	Uranium	1.00420	0.99543	0.98957	1.06974	0.96108	0.94511
Ave. Dev.	Core	0.00474	0.04023	0.01752	0.07375	0.04473	0.05489
Average	Total	0.99813	1.01270	0.98108	1.08677	0.95575	0.97807
Ave. Dev.	Core	0.00548	0.05813	0.02225	0.11571	0.05994	0.04569

* Correction using 1- to 2-D and heterogeneity factors from Hardie's paper[*N.S.E.* 57, 222(1975)]

** This value was excluded from averaging of $k_{eff.}$

\+ Average $| k_{eff.} - 1 |$

ZPPR-2 : The buckling height was used for ONEDANT calculation.
[$B^2=5.92 \times 10^{-4} = (\Pi/H)^2$]

Table 2. 2-D Cylindrical, 25-group, P_3S_8 (2-D Coarse mesh group collapsing)(C/E)

Assembly	$k_{eff.}$	*Corrected	F28/F25	F49/F25	F40/F25	C28/F25	C28/F49
VERA-11A	0.98004	0.98004	0.87258	0.99495	1.09899	0.74933	
ZEBRA-3	0.98579	0.98579	0.98169	0.98835	0.99618		
SNEAK-7A	1.00435	0.99985	0.93306	0.96829		0.97081	1.00582
ZPR-3-54	0.96771	0.99071	1.15462	0.94027	1.19927		
ZPR-3-53	0.97817	1.00117	1.14242	0.93829	1.18557		
SNEAK-7B	1.00063	0.99853	0.98269	0.99085		1.01447	1.02738
ZPR-3-50	0.97840	1.00040	1.13844	0.99220	1.32919		
ZPR-3-48	0.98468	1.00298	1.01692	0.99299	1.03553	0.96339	0.97289
ZPR-3-49	0.98832	1.00412	1.06188	1.01165			
ZPR-3-56B	0.98865	0.99885	0.97046	0.95093	0.84129		
ZPPR-2	0.98782	1.00532	1.07063	0.98342	1.09047		
ZPR-6-7	0.98384	0.99904	0.98852	0.97749		1.05462	1.07932
Average	Plutonium	0.99723	1.02616	0.97747	1.09706	0.95052	1.02135
Ave. Dev.	Core	0.00510	0.07133	0.02447	0.13769	0.07711	0.03491
VERA-1B	0.99852	0.99852	0.90377	0.95317	1.19631	0.92846	0.89822
ZPR-3-6F	1.00870	1.00870	0.97871	1.01584	0.98512	0.95844	0.94623
ZPR-3-12	1.00530	1.00530	1.04426	0.99187		0.96869	0.97505
ZPR-3-11	1.00571	1.00571	1.04299	0.98167	1.02500	0.95081	0.96978
ZEBRA-2	1.00335	1.00335	1.01888	0.99999	1.05034	0.95009	0.94867
ZPR-6-6A	1.00336	1.01006	0.97296			1.01788	
Average	Uranium	1.00527	0.99360	0.98851	1.06419	0.96240	0.94759
Ave. Dev.	Core	0.00577	0.04178	0.01783	0.07163	0.04357	0.05241
Average	Total	0.99991	1.01530	0.98072	1.08611	0.95700	0.98037
Ave. Dev.	Core	0.00532	0.06148	0.02252	0.11567	0.05881	0.04463

* Correction using heterogeneity factors from Hardie's paper

Table 3. Differences (2D – 1D) of k-effective values

Assembly	$k_{eff.}$ Difference (2D - 1D)
VERA-11A	-0.001
ZEBRA-3	0.00087
SNEAK-7A	0.0006
ZPR-3-54	0.00792
ZPR-3-53	0.0015
SNEAK-7B	0.00122
ZPR-3-50	0.0009
ZPR-3-48	0.00144
ZPR-3-49	0.0018
ZPR-3-56B	0.00379
ZPPR-2	
ZPR-6-7	-0.00062
VERA-1B	0.00014
ZPR-3-6F	0.00335
ZPR-3-12	0.00073
ZPR-3-11	0.00071
ZEBRA-2	0.00068
ZPR-6-6A	0.00082