Table 3.3.1-3: Reflector Reactivity With 60.96 cm Water Backing						
H/Pu	$k_{eff} + 2\sigma$ For Reflectors Examined					
	Nb	Gypsum	Sn	100% Poly	25% Water/ 75% Poly	50% Water/ 50% Poly
500	0.9101	0.9078	0.8946	0.9101	0.9055	0.9062
550	0.9237	0.9217	0.9041	0.9175	0.9140	0.9156
600	0.9327	0.9298	0.9169	0.9257	0.9226	0.9215
650	0.9381	0.9352	0.9263	0.9330	0.9275	0.9265
700	0.9420	0.9380	0.9314	0.9377	0.9321	0.9273
750	0.9454	0.9392	0.9367	0.9372	0.9347	0.9300
800	0.9465	0.9416	0.9390	0.9355	0.9372	0.9377
850	0.9507	0.9412	0.9446	0.9375	0.9365	0.9306
900	0.9505	0.9476	0.9439	0.9396	0.9352	0.9358
950	0.9459	0.9426	0.9441	0.9376	0.9389	0.9368
1000	0.9471	0.9424	0.9433	0.9389	0.9385	0.9341
1050	0.9459	0.9428	0.9410	0.9371	0.9348	0.9329
1100	0.9403	0.9380	0.9392	0.9337	0.9374	0.9320
1150	0.9385	0.9404	0.9366	0.9297	0.9338	0.9251
1200	0.9387	0.9310	0.9385	0.9311	0.9264	0.9267
1250	0.9366	0.9295	0.9378	0.9289	0.9261	0.9240
1300	0.9321	0.9304	0.9299	0.9194	0.9244	0.9210
1350	0.9299	0.9233	0.9299	0.9185	0.9156	0.9157
1400	0.9260	0.9190	0.9234	0.9162	0.9159	0.9121
1450	0.9228	0.9172	0.9212	0.9106	0.9164	0.9134
1500	0.9191	0.9149	0.9181	0.9066	0.9061	0.9078

Figure 3.3.1-3: Reflector Reactivity at 100% Density

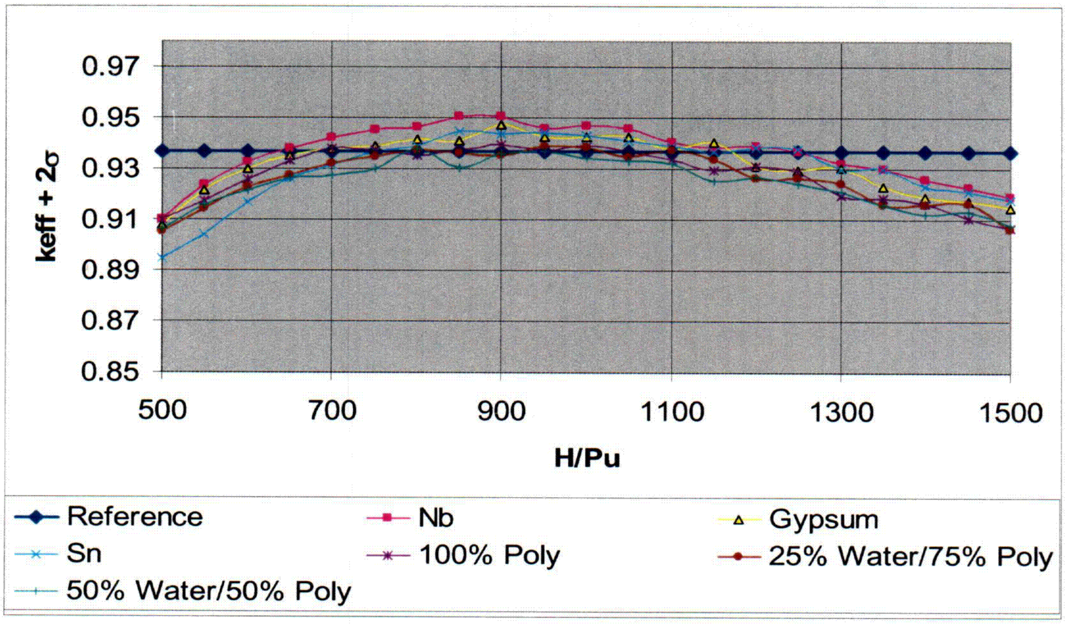

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Table 3.3.1-4: Reflector Reactivity As a Function of Thickness at the Optimum H/Pu

Thickness (in.)	$k_{eff} + 2\sigma$ For Reflectors Examined									
	Be	BeO	C	D_2O	MgO	Pb	Ni	Inconel	SS304	Zr
24	1.1903	1.1900	1.1233	1.0787	1.0468	1.0319	1.0272	1.0233	1.0091	1.0006
12	1.1823	1.1758	1.1082	1.0548	1.0446	1.0089	1.0244	1.0195	1.0067	0.9886
6	1.1574	1.1429	1.0727	1.0336	1.0198	0.9804	1.0021	1.0022	0.9835	0.9704
3	1.0953	1.0866	1.0308	1.0061	0.9996	0.9612	0.9665	0.9686	0.9471	0.9524
1	0.9991	0.9976	0.9766	0.9641	0.9638	0.9447	0.9088	0.9077	0.8894	0.9388

Figure 3.3.1-4: Reactivity as a Function of Reflector Thickness and Material

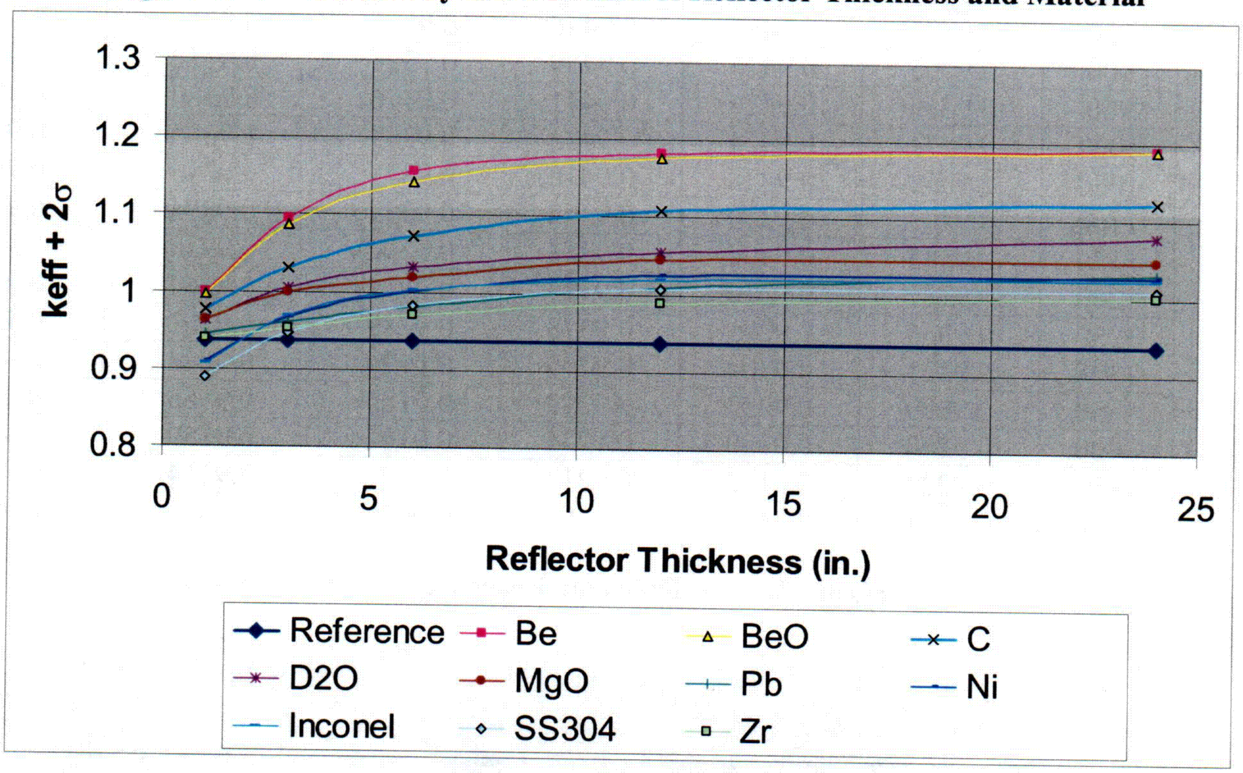

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Table 3.3.1-5: Reflector Reactivity As a Function of Thickness at the Optimum H/Pu										
Thickness (in.)	$k_{eff} + 2\sigma$ For Reflectors Examined									
	Bi	Cu	Fe	V	Cr	SiO_2	Concrete	Mo	Co	Mn
24	0.9959	0.9908	0.9845	0.9781	0.9711	0.9710	0.9648	0.956	0.9533	0.9518
12	0.9739	0.9851	0.9774	0.976	0.9569	0.9595	0.9590	0.9514	0.9482	0.9450
6	0.9658	0.9723	0.9614	0.9517	0.9363	0.9496	0.9613	0.9457	0.9345	0.9236
3	0.9516	0.9435	0.9325	0.9216	0.9084	0.9433	0.9501	0.9237	0.9026	0.9005
1	0.9376	0.8912	0.8898	0.8796	0.8761	0.9347	0.9378	0.8929	0.8474	0.8581

Figure 3.3.1-5: Reactivity as a Function of Reflector Thickness and Material

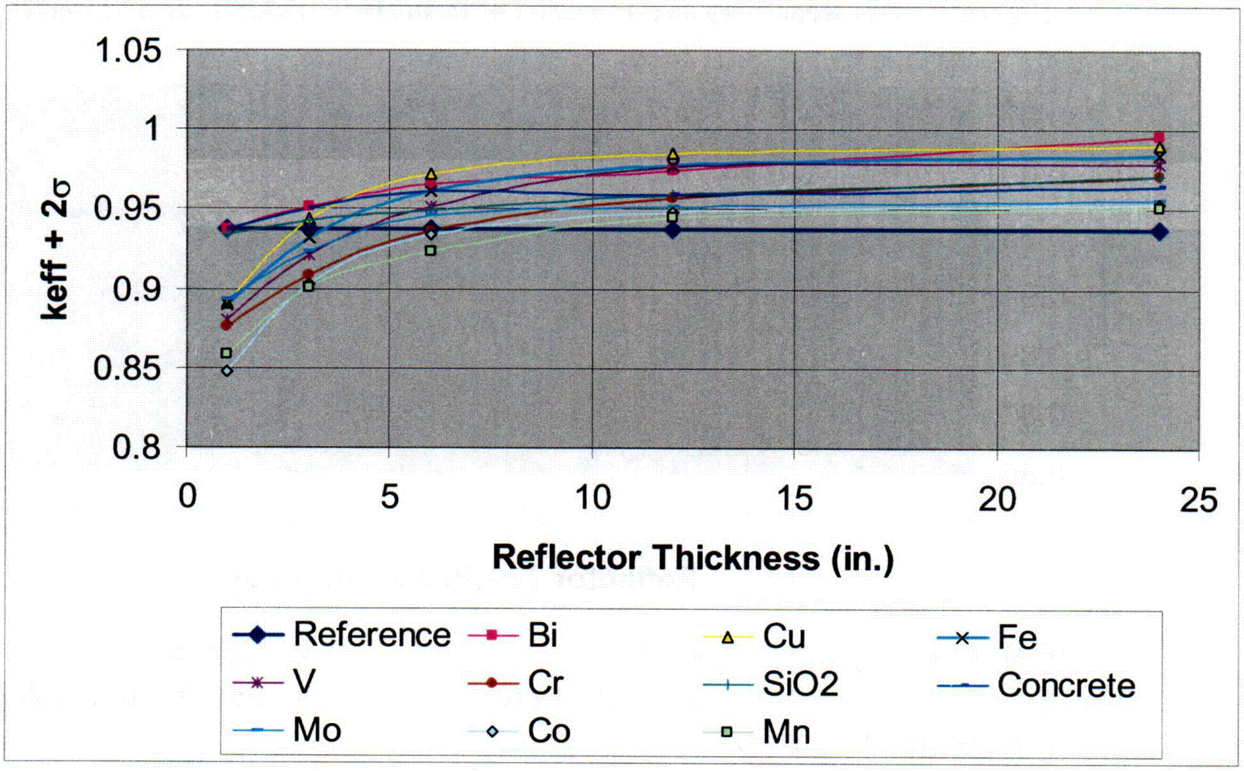

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Table 3.3.1-6: Reflector Reactivity As a Function of Thickness at the Optimum H/Pu						
Thickness (in)	$k_{eff} + 2\sigma$ For Reflectors Examined					
	Nb	Gypsum	Sn	100% Poly	25% Water/ 75% Poly	50% Water/ 50% Poly
24	0.9507	0.9476	0.9446	0.9396	0.9389	0.9377
12	0.9500	0.9435	0.9327	0.9412	0.9388	0.9326
6	0.9366	0.9416	0.9248	0.9413	0.9343	0.9359
3	0.9193	0.9403	0.9165	0.9407	0.9341	0.9364
1	0.9090	0.9322	0.9159	0.9336	0.9337	0.9321

Figure 3.3.1-6: Reactivity as a Function of Reflector Thickness and Material

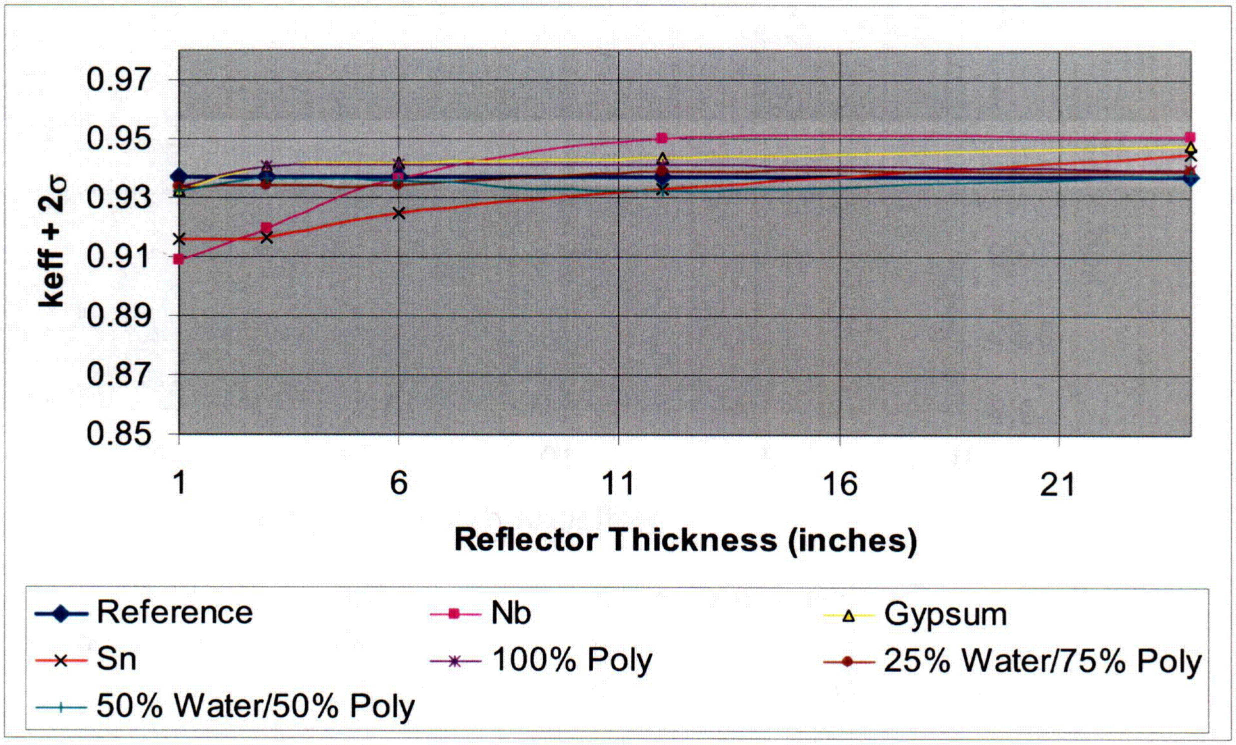

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Table 3.3.1-7: Reflectors With Eigenvalues > than that of 25% Poly/75% Water Mixture and Equivalent Thickness (Reflectors Backed With 60.96 cm of Water)

Reflector Material	Optimum H/Pu	$k_{eff} + 2\sigma$	Equivalent Thickness (in.)
Be	550	1.1903	0.28
BeO	600	1.1900	0.24
C	750	1.1237	0.18
D_2O	700	1.0787	0.24
MgO	800	1.0489	0.26
Pb	800	1.0319	0.63
Ni	700	1.0272	1.82
Inconel	800	1.0233	1.85
SS304	700	1.0091	2.71
Zr	950	1.0006	0.76
Bi	950	0.9959	0.94
Cu	800	0.9908	2.93
Fe	850	0.9845	3.62
V	850	0.9781	4.29
Cr	800	0.9711	6.24
SiO_2	1050	0.9710	2.04
Concrete (Oak Ridge)	800	0.9648	1.24
Mo	750	0.9560	4.84
Co	750	0.9533	8.16
Mn	850	0.9518	9.37
Nb	850	0.9507	5.85
Gypsum	900	0.9476	2.04
Sn	850	0.9446	18.91
CH_2	900	0.9396	5.36
75% Poly/ 25% Water	950	0.9389	24.00*
50% Poly/50% Water	800	0.9377	24.00*
25% Poly/ 75% Water (Ref)	800	0.9370	24.00

* Histories Increased to 1000000.

3.3.2 Reactivity As a Function of ReflectorVolume Fraction For Non-Fissile Materials

The analyses to this point has assumed that the reflecting material around the fissile mass is geometrically perfect in the sense that it is a tight fitting continuous piece with no holes. However, it is not credible for discrete particles to completely enclose the fissile waste material without some porosity since the maximum achievable packing fraction for any arrangement of particles is approximately 74.048% (face-centered cubic). This maximum packing fraction assumes that all particles are identical in size and are arranged in a perfect face-centered cubic configuration. Typically a tightly packed configuration ranges from 50% (simple cubic is 52.36%) to 70% (body-centered cubic is 68.02%). As the particles sizes vary and randomize in their location, the maximum theoretical packing fraction drops to approximately 64%, with a nominal value of 50% generally considered the maximum achievable packing fraction with varying size particles. For example, tap densities of uranium or other powders that are vibrated and/or shaken reach approximately 50% of the theoretical density. To determine the reactivity effect of a reflector composed of discrete particles, a calculation was performed in which the reflector packing fraction was assumed to be at a maximum theoretical achievable limit of 70%. To simulate a water immersion event, the 30% void volume was filled with water and the whole system was backed with 2 ft. of water. Tables 3.3.2-1 through 3.3.2-3 and Figure 3.3.2-1 through 3.3.2-3 illustrate the calculation. In addition, Table 3.3.2-4 tabulates the equivalent thickness of those reflectors whose k_{eff} exceeds that of the reference reflector (25% polyethylene/75% water). It is that noteworthy that many of the metallic reflectors that were more reactive than the reference cases at 100% packing fraction are less reactive than the reference case at 70% packing fraction with intervening water in the void spaces. Physically, the water modifies the neutron spectrum within the reflector so that reflector becomes more parasitic to the neutrons, and thereby reducing the system reactivity.

Table 3.3.2-1: Reflector Reactivity - 70% Packing Fraction; 60.96 cm Water Backing									
H/Pu	$k_{eff} + 2\sigma$ For Reflectors Examined								
	Be	BeO	C	MgO	D_2O	Pb	Bi	Zr	Concrete
500	1.0466	1.0454	1.0007	0.9670	0.9653	0.9354	0.9267	0.9302	0.9175
550	1.0578	1.0484	1.0047	0.9797	0.9796	0.9493	0.9363	0.9374	0.9222
600	1.0601	1.0541	1.0125	0.9812	0.9857	0.9547	0.9471	0.9405	0.9353
650	1.0583	1.0583	1.0142	0.9836	0.9827	0.9583	0.9485	0.9489	0.9414
700	1.0611	1.0534	1.0149	0.9866	0.9882	0.9640	0.9555	0.9538	0.9507
750	1.0626	1.0557	1.0197	0.9943	0.9891	0.9621	0.9591	0.9557	0.9496
800	1.0579	1.0510	1.0181	0.9966	0.9892	0.9664	0.9594	0.9550	0.9473
850	1.0510	1.0521	1.0154	0.9956	0.9904	0.9662	0.9616	0.9610	0.9519
900	1.0526	1.0470	1.0147	0.9926	0.9913	0.9687	0.962	0.9579	0.9501
950	1.0511	1.0427	1.0152	0.9897	0.9863	0.9670	0.9621	0.9574	0.9510
1000	1.0450	1.0411	1.0106	0.9856	0.9880	0.9665	0.9587	0.9572	0.9514
1050	1.0408	1.0417	1.0089	0.9856	0.9814	0.9696	0.9578	0.9538	0.9471
1100	1.0394	1.0331	1.0039	0.9793	0.9814	0.964	0.9556	0.9532	0.9448
1150	1.0322	1.0224	0.9985	0.9747	0.9748	0.9556	0.9510	0.9492	0.9445
1200	1.0255	1.0235	0.9942	0.9743	0.9753	0.9562	0.9504	0.9463	0.9408
1250	1.0208	1.0226	0.9922	0.9651	0.9699	0.9532	0.9493	0.9438	0.9379
1300	1.0136	1.0117	0.9869	0.9688	0.9669	0.9532	0.9448	0.9439	0.9338
1350	1.0104	1.0073	0.9834	0.9649	0.9586	0.9461	0.9446	0.9391	0.9308
1400	1.0018	1.0019	0.9763	0.9569	0.9564	0.9380	0.9373	0.9306	0.9276
1450	1.0014	0.9976	0.9710	0.9529	0.9512	0.9385	0.9329	0.9301	0.9243
1500	0.9944	0.9916	0.9680	0.9517	0.9493	0.9341	0.9306	0.9261	0.9187

Figure 3.3.2-1: Reflector Reactivity at 70% Packing Fraction

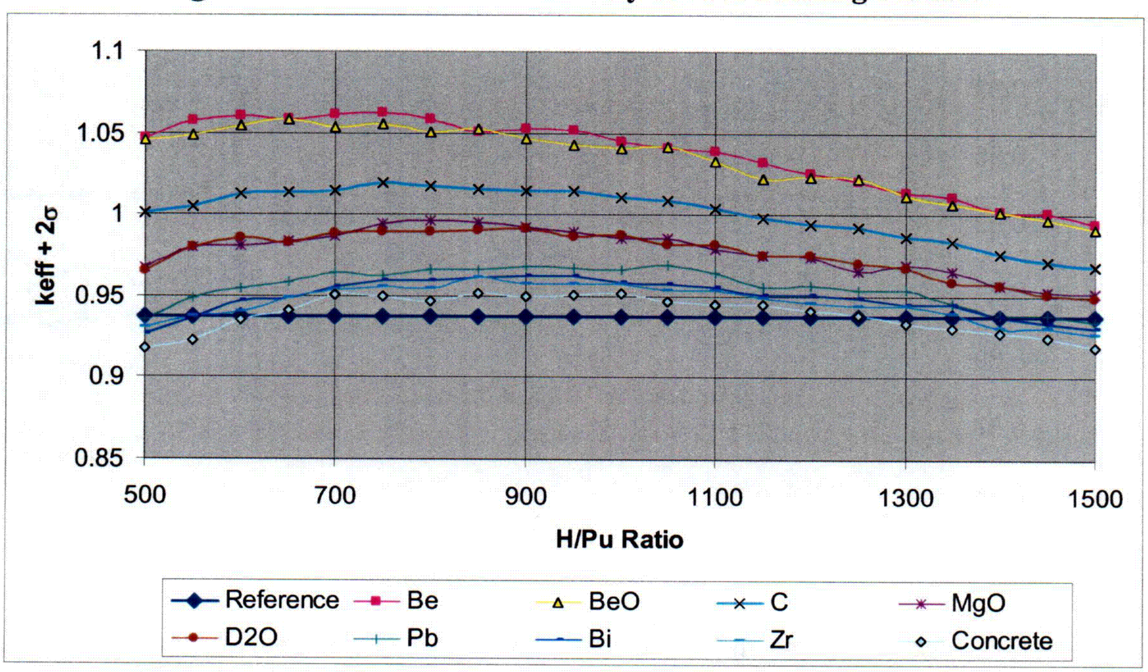

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Table 3.3.2-2: Reflector Reactivity - 70% Packing Fraction; 60.96 cm Water Backing								
H/Pu	$k_{eff} + 2\sigma$ For Reflectors Examined							
	Gypsum	Ni	Inconel	SS304	Sn	Fe	Cu	Nb
500	0.9084	0.9108	0.9034	0.8893	0.8758	0.8860	0.8793	0.8745
550	0.9174	0.9149	0.9108	0.8986	0.8920	0.9000	0.8891	0.8867
600	0.9272	0.9228	0.9187	0.9060	0.8959	0.9076	0.8969	0.8916
650	0.9277	0.9290	0.9235	0.9114	0.9055	0.9118	0.9065	0.8965
700	0.9343	0.9337	0.9251	0.9218	0.9128	0.9187	0.9136	0.9035
750	0.9364	0.9375	0.9343	0.9209	0.9150	0.9184	0.9131	0.9087
800	0.9357	0.9359	0.9316	0.9241	0.9164	0.9227	0.9122	0.9144
850	0.9399	0.9373	0.9340	0.9252	0.9185	0.9189	0.9185	0.9172
900	0.9430	0.9341	0.9319	0.9236	0.9245	0.9218	0.9200	0.9164
950	0.9379	0.9368	0.9317	0.9275	0.9233	0.9241	0.9187	0.9146
1000	0.9377	0.9352	0.9348	0.9227	0.9193	0.9238	0.9161	0.9164
1050	0.9357	0.9314	0.9287	0.9199	0.9238	0.9218	0.9112	0.9180
1100	0.9359	0.9294	0.9299	0.9174	0.9226	0.9171	0.9113	0.9122
1150	0.9350	0.9263	0.9276	0.9185	0.9198	0.9158	0.9123	0.9132
1200	0.9292	0.9248	0.9200	0.9123	0.9164	0.9156	0.9124	0.9111
1250	0.9270	0.9200	0.9190	0.9132	0.9149	0.9138	0.9044	0.9091
1300	0.9252	0.9130	0.9148	0.9101	0.9111	0.9093	0.9015	0.9086
1350	0.9212	0.9120	0.9156	0.9051	0.9100	0.9061	0.9005	0.9021
1400	0.9169	0.9101	0.9093	0.9023	0.9049	0.9014	0.8985	0.8971
1450	0.9140	0.9070	0.9049	0.8992	0.9057	0.8991	0.8970	0.8927
1500	0.9121	0.8998	0.9024	0.8979	0.8970	0.8920	0.8872	0.8903

Figure 3.3.2-2: Reflector Reactivity at 70% Packing Fraction

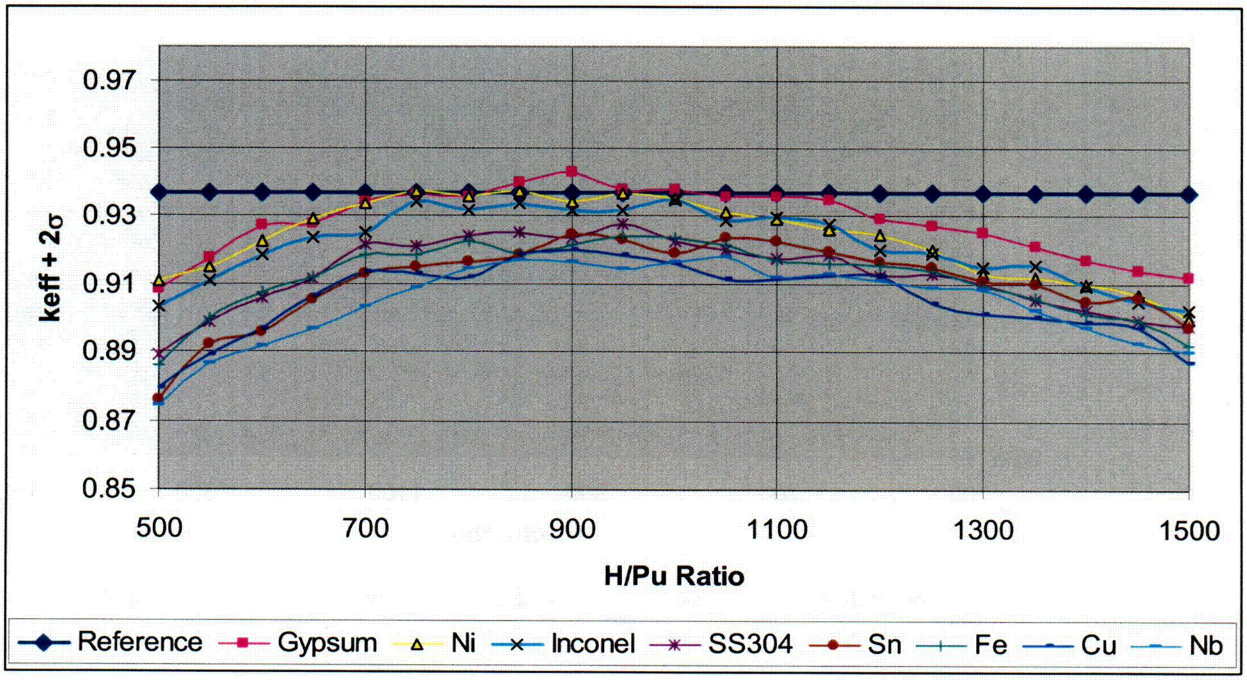

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Table 3.3.2-3: Reflector Reactivity -70% Packing Fraction; 60.96 cm Water Backing					
H/Pu	$k_{eff} + 2\sigma$ For Reflectors Examined				
	Mo	Cr	V	Mn	Co
500	0.8696	0.8717	0.8646	0.8346	0.8235
550	0.8796	0.8757	0.8757	0.8507	0.8394
600	0.8837	0.8812	0.8864	0.8615	0.8459
650	0.8943	0.8920	0.8936	0.8647	0.8552
700	0.9011	0.9019	0.8948	0.8715	0.8629
750	0.9018	0.9045	0.9047	0.8722	0.8683
800	0.9097	0.9031	0.9021	0.8813	0.8709
850	0.9054	0.9053	0.9060	0.8842	0.8722
900	0.9077	0.9058	0.9034	0.8810	0.8789
950	0.9085	0.9084	0.9067	0.8861	0.8761
1000	0.9126	0.9096	0.9030	0.8854	0.8770
1050	0.9073	0.9056	0.9043	0.8853	0.8751
1100	0.9094	0.9052	0.9044	0.8863	0.8789
1150	0.9143	0.9061	0.9044	0.8811	0.8769
1200	0.9024	0.9041	0.9003	0.8828	0.8743
1250	0.9006	0.8985	0.8983	0.8834	0.8723
1300	0.8926	0.8970	0.8950	0.8790	0.8743
1350	0.8922	0.8932	0.8919	0.8774	0.8683
1400	0.8928	0.8910	0.8909	0.8718	0.8659
1450	0.8859	0.8839	0.8854	0.8700	0.8650
1500	0.8865	0.8858	0.8794	0.8644	0.8615

Figure 3.3.2-3: Reflector Reactivity at 70% Packing Fraction

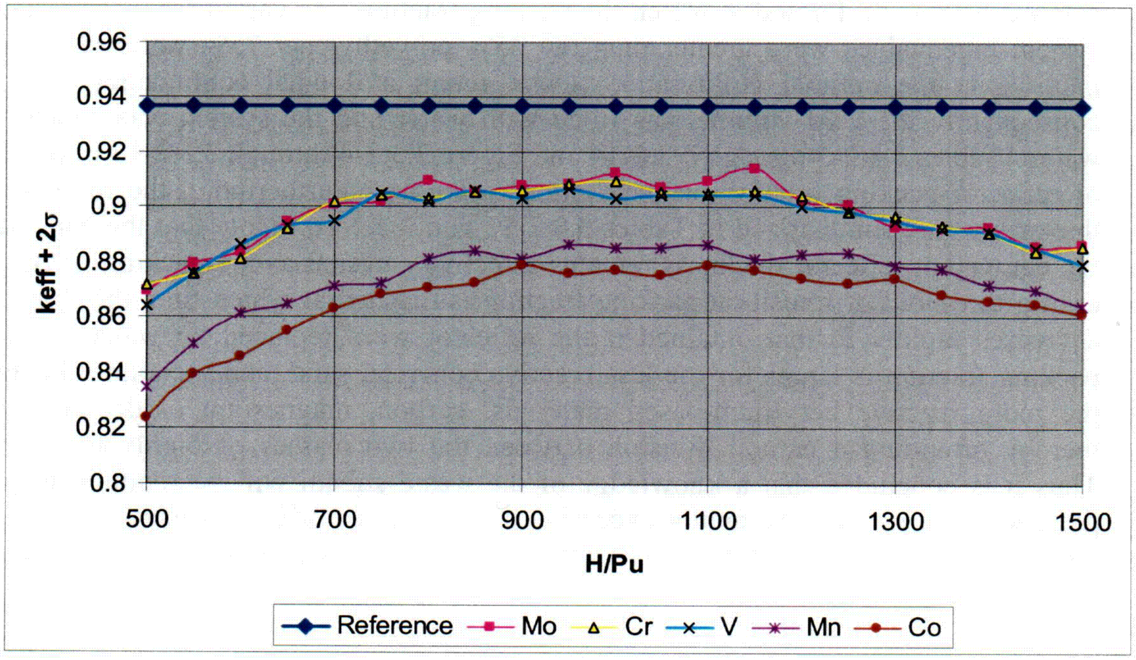

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Table 3.3.2-4: Equivalent Thickness For Reflectors With 70% Packing Fraction and Backed With 60.96 cm of Water			
Reflector Material	**Optimum H/Pu**	**$k_{eff} + 2\sigma$ at 24 in Thickness**	**Equivalent Thickness (in)**
Be	750	1.0626	0.12
BeO	650	1.0583	0.16
C	750	1.0197	0.25
D_2O	800	0.9966	0.27
MgO	900	0.9913	0.33
Pb	1050	0.9696	0.72
Bi	950	0.9621	0.86
Zr	850	0.9610	0.87
Concrete (Oak Ridge)	850	0.9519	1.52
SiO_2	850	0.9512	1.65
Gypsum	900	0.9430	6.97
Ni	900	0.9397	24.00
Reference 25% Poly/ 75% at 100% packing fraction	800	0.9370	24.00

The computational analyses for reflectors composed of discrete pieces has been bounding in that the calculation was performed at the maximum packing fraction limit of 70%. As discussed previously, the waste dunnage will be composed of a myriad of materials sizes ranging from small particles to large chunks packed in a random order, consequently the reflector packing may vary over a wide range of values. Thus it is instructive to determine the effect of the reflector packing fraction on the reactivity of the fissile mass. In this regard, a calculation was performed in which the packing fraction was varied for those reflectors whose system eigenvalues were greater than the 25% polyethylene/ 75% water reference reflector material at the optimal H/Pu ratio. Once again, a flooded contingency was considered, consequently the void volume was filled with water and the system was backed by 2 ft. of water. Tables 3.3.2-5 through 3.3.2-14 and Figure 3.3.2-4 through 3.3.2-13 illustrate the effect of reflector packing fraction on the system reactivity. Furthermore, the reflector equivalent thicknesses are summarized in Tables 3.3.2-15 and 3.3.2-16. Note that the data indicates that the equivalent reflector thickness remains effective constant as the packing fraction decreases until a threshold or transition packing fraction is reached at which time the system reactivity decreases rapidly to that obtained if the reflector were replaced by water. This transition packing fraction is larger for the less reactive concrete, sand, and metallic reflectors than for the more reactive beryllium-based materials, carbon, magnesium oxide, and heavy water thereby providing a natural division between the two classes of highly reactive reflectors. Thus it is concluded that a knowledge of the waste stream will be required to preclude the presence of large amounts and/or excessive thicknesses of highly reflective material, in a form that would allow these materials to tightly surround the fissile mixture, prior to shipment.

Figure 3.3.2-4: Beryllium Reflector Reactivity as a Function of Packing Fraction

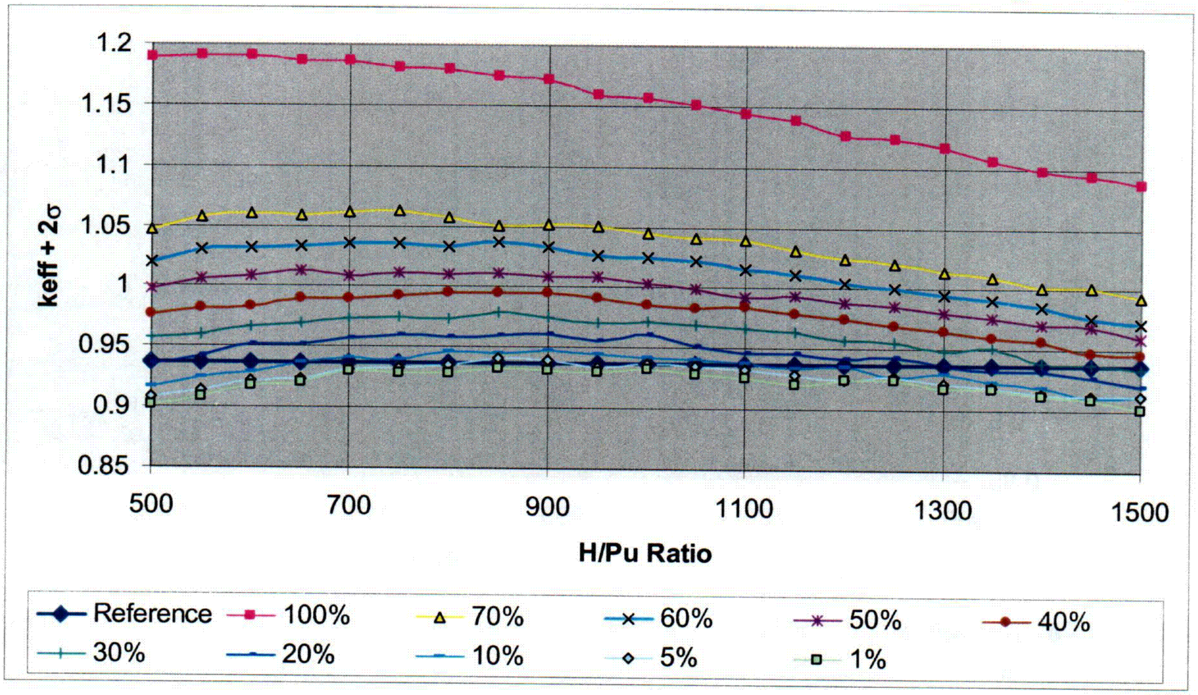

Table 3.3.2-5: Be Reflector Reactivity as a Function of Packing Fraction										
H/Pu	k_{eff} at Various Packing Fractions									
	100%	70%	60%	50%	40%	30%	20%	10%	5%	1%
500	1.1886	1.0466	1.0189	0.9984	0.9756	0.9570	0.9360	0.9168	0.9089	0.9016
550	1.1903	1.0578	1.0299	1.0054	0.9821	0.9599	0.9426	0.9251	0.9133	0.9089
600	1.1899	1.0601	1.0324	1.0090	0.9835	0.9660	0.9511	0.9285	0.9213	0.9185
650	1.1870	1.0583	1.0335	1.0131	0.9894	0.9694	0.9513	0.9374	0.9234	0.9207
700	1.1858	1.0611	1.0352	1.0087	0.9901	0.9732	0.9571	0.9410	0.9318	0.9305
750	1.1808	1.0626	1.0363	1.0113	0.9929	0.9746	0.9601	0.9398	0.9325	0.9291
800	1.1797	1.0579	1.0325	1.0106	0.9950	0.9735	0.9586	0.9463	0.9357	0.9283
850	1.1736	1.0510	1.0370	1.0108	0.9948	0.9790	0.9595	0.9455	0.9404	0.9325
900	1.1711	1.0526	1.0325	1.0086	0.9951	0.9745	0.9607	0.9476	0.9396	0.9308
950	1.1597	1.0511	1.0267	1.0093	0.9909	0.9703	0.9561	0.9444	0.9345	0.9307
1000	1.1560	1.0450	1.0247	1.0034	0.9856	0.9719	0.9607	0.9418	0.9363	0.9323
1050	1.1509	1.0408	1.0228	0.9992	0.9823	0.9693	0.9523	0.9412	0.9348	0.9284
1100	1.1449	1.0394	1.0157	0.9927	0.9838	0.9671	0.9463	0.9387	0.9326	0.9254
1150	1.1391	1.0322	1.0112	0.9940	0.9783	0.9637	0.9457	0.9335	0.929	0.9211
1200	1.1273	1.0255	1.0041	0.9883	0.9754	0.9568	0.9416	0.9353	0.9246	0.9247
1250	1.1239	1.0208	1.0012	0.9850	0.9700	0.9557	0.9442	0.9269	0.9270	0.9244
1300	1.1166	1.0136	0.9958	0.9801	0.9647	0.9495	0.9374	0.9295	0.9217	0.9183
1350	1.1069	1.0104	0.9911	0.9755	0.9594	0.9514	0.9324	0.9228	0.9192	0.9176
1400	1.0988	1.0018	0.9852	0.9713	0.9574	0.9394	0.9333	0.9197	0.9144	0.9126
1450	1.0944	1.0014	0.9765	0.9695	0.9476	0.9375	0.9270	0.9113	0.9123	0.9096
1500	1.0869	0.9944	0.9726	0.9595	0.9462	0.9343	0.9208	0.9118	0.9126	0.9016

Figure 3.3.2-5: Beryllium Oxide Reflector Reactivity as a Function of Packing Fraction

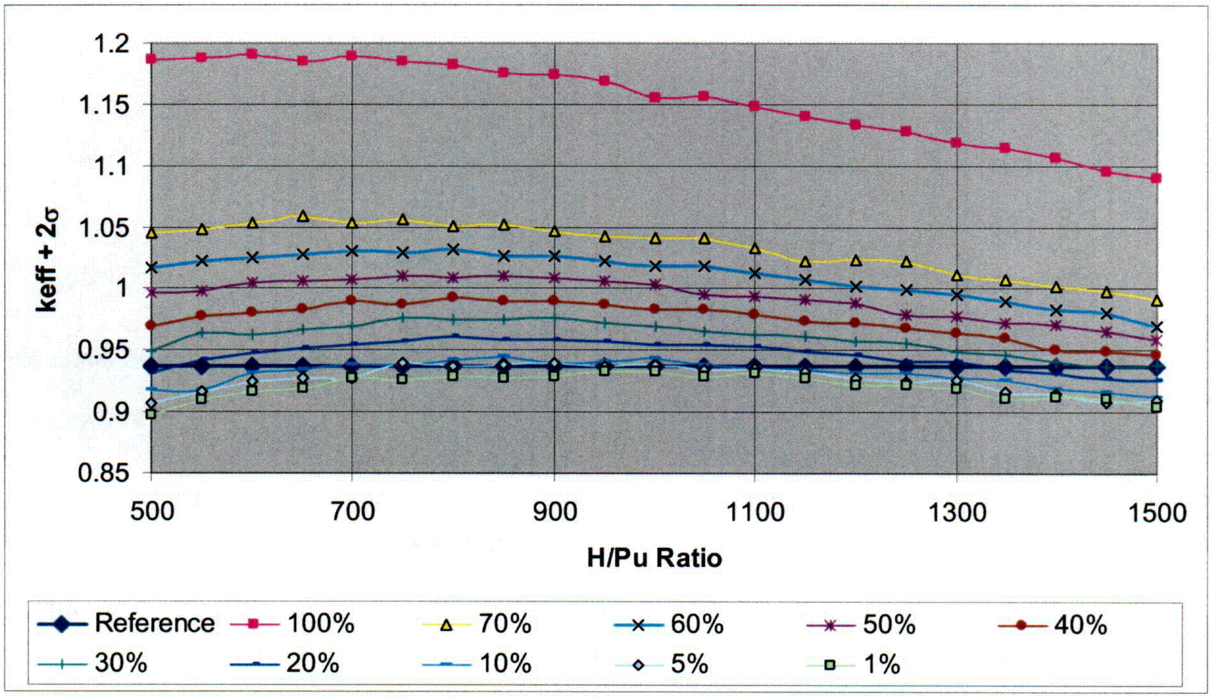

Table 3.3.2-6: BeO Reflector Reactivity as a Function of Packing Fraction										
H/Pu	k_{eff} at Various Packing Fractions									
	100%	70%	60%	50%	40%	30%	20%	10%	5%	1%
500	1.1866	1.0454	1.0166	0.9959	0.9693	0.9484	0.9314	0.9184	0.9076	0.8981
550	1.1878	1.0484	1.0218	0.9980	0.9776	0.9635	0.9421	0.9177	0.9164	0.9098
600	1.1900	1.0541	1.0245	1.0041	0.9804	0.9624	0.9474	0.9315	0.9241	0.9161
650	1.1857	1.0583	1.0275	1.0058	0.9831	0.9673	0.9519	0.9336	0.9270	0.9197
700	1.1885	1.0534	1.0309	1.0076	0.9901	0.9700	0.9540	0.9388	0.9273	0.9276
750	1.1853	1.0557	1.0293	1.0102	0.9874	0.9757	0.9578	0.9386	0.9399	0.9265
800	1.1824	1.0510	1.0318	1.0093	0.9921	0.9743	0.9610	0.9425	0.9372	0.9292
850	1.1757	1.0521	1.0270	1.0098	0.9898	0.9752	0.9584	0.9446	0.9376	0.9275
900	1.1741	1.0470	1.0268	1.0087	0.9895	0.9756	0.9587	0.9398	0.9399	0.9289
950	1.1691	1.0427	1.0228	1.0066	0.9867	0.9716	0.9574	0.9413	0.9366	0.9323
1000	1.1551	1.0411	1.0183	1.0037	0.9828	0.9698	0.9545	0.9434	0.9384	0.9328
1050	1.1564	1.0417	1.0187	0.9946	0.9832	0.9647	0.9543	0.9388	0.9335	0.9288
1100	1.1479	1.0331	1.0123	0.9935	0.9791	0.9632	0.9529	0.9356	0.9351	0.9313
1150	1.1408	1.0224	1.0077	0.9910	0.9731	0.9606	0.9492	0.9342	0.9322	0.9276
1200	1.1332	1.0235	1.0016	0.9883	0.9720	0.9568	0.9463	0.9319	0.9269	0.9222
1250	1.1275	1.0226	0.9995	0.9788	0.9676	0.9556	0.9415	0.9310	0.9249	0.9222
1300	1.1185	1.0117	0.9952	0.9778	0.9637	0.9488	0.9403	0.9275	0.9253	0.9190
1350	1.1145	1.0073	0.9901	0.9715	0.9600	0.9465	0.9338	0.9254	0.9170	0.9108
1400	1.1066	1.0019	0.9831	0.9710	0.9510	0.9409	0.9316	0.9196	0.9155	0.9124
1450	1.0952	0.9976	0.9805	0.9653	0.9485	0.9372	0.9277	0.9168	0.9090	0.9108
1500	1.0900	0.9916	0.9700	0.9584	0.9468	0.9384	0.9260	0.9122	0.9092	0.9043

Figure 3.3.2-6: Carbon Reflector Reactivity as a Function of Packing Fraction

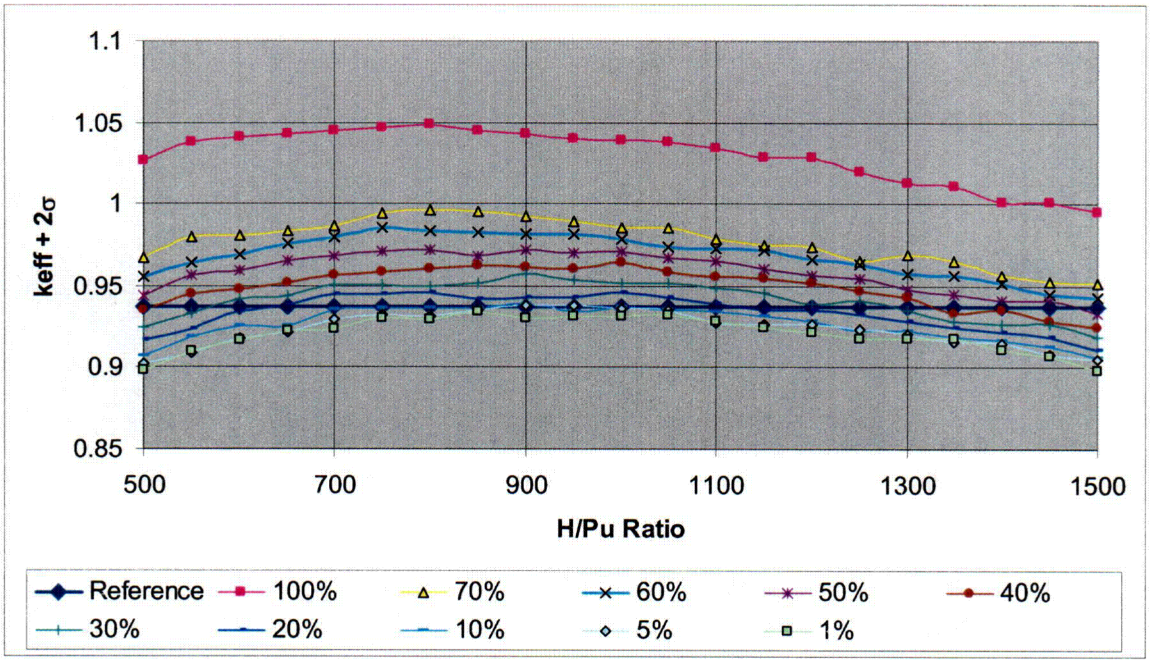

Table 3.3.2-7: Carbon Reflector Reactivity as a Function of Packing Fraction										
H/Pu	k_{eff} at Various Packing Fractions									
	100%	70%	60%	50%	40%	30%	20%	10%	5%	1%
500	1.1101	1.0007	0.9778	0.962	0.9446	0.9357	0.9238	0.9128	0.9068	0.9015
550	1.1105	1.0047	0.9877	0.9703	0.9538	0.9411	0.9293	0.9177	0.9174	0.9100
600	1.1166	1.0125	0.9928	0.9776	0.9658	0.9517	0.9346	0.9320	0.9212	0.9170
650	1.1211	1.0142	0.9957	0.9805	0.9664	0.9512	0.9408	0.9343	0.9310	0.9207
700	1.1230	1.0149	0.9994	0.9852	0.9695	0.9543	0.9456	0.9331	0.9254	0.9269
750	1.1237	1.0197	1.0008	0.9842	0.9689	0.9578	0.9468	0.9378	0.9334	0.9325
800	1.1214	1.0181	1.0062	0.9851	0.9768	0.9604	0.9473	0.9419	0.9386	0.9310
850	1.1192	1.0154	1.0010	0.9843	0.9725	0.9613	0.9495	0.9410	0.9346	0.9313
900	1.1155	1.0147	0.9975	0.9849	0.9713	0.9599	0.9522	0.9382	0.9351	0.9315
950	1.1128	1.0152	0.9968	0.9820	0.9652	0.9607	0.9496	0.9398	0.9354	0.9324
1000	1.1059	1.0106	0.9955	0.9789	0.9707	0.9518	0.9439	0.9398	0.9368	0.9293
1050	1.1020	1.0089	0.9904	0.9755	0.9668	0.9589	0.9467	0.9371	0.9317	0.9327
1100	1.0992	1.0039	0.9881	0.9798	0.9672	0.9518	0.9424	0.9360	0.9327	0.9295
1150	1.0910	0.9985	0.9863	0.9721	0.9616	0.9498	0.9416	0.9352	0.9292	0.9268
1200	1.0837	0.9942	0.9824	0.9689	0.9579	0.9493	0.9361	0.9319	0.9209	0.922
1250	1.0796	0.9922	0.9762	0.9638	0.9536	0.9435	0.9324	0.9293	0.9227	0.9205
1300	1.0713	0.9869	0.9754	0.9629	0.9496	0.9372	0.9307	0.9235	0.9201	0.9170
1350	1.0708	0.9834	0.9653	0.9572	0.9486	0.9366	0.9275	0.9186	0.9138	0.9167
1400	1.0662	0.9763	0.9623	0.9552	0.9402	0.9337	0.9246	0.9160	0.9109	0.9095
1450	1.0544	0.9710	0.9593	0.9513	0.9405	0.9296	0.9223	0.9117	0.9086	0.9111
1500	1.0499	0.9680	0.9506	0.9431	0.9345	0.9207	0.9164	0.9119	0.9036	0.9050

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Figure 3.3.2-7: Magnesium Oxide Reflector Reactivity as a Function of Packing Fraction

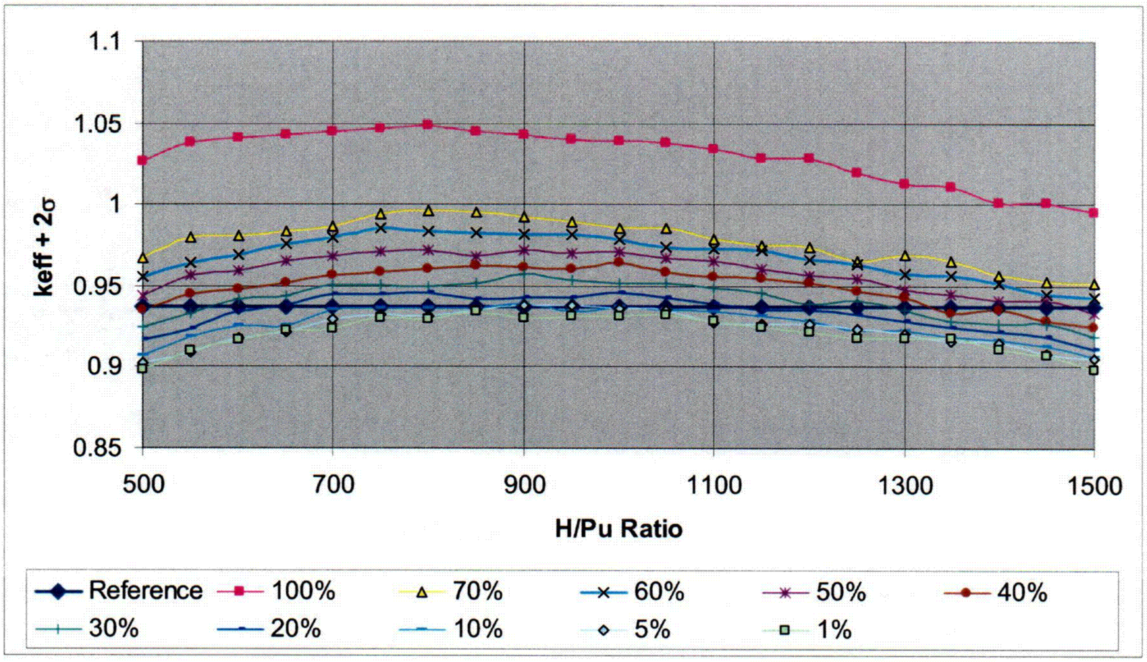

Table 3.3.2-8: MgO Reflector Reactivity as a Function of Packing Fraction										
H/Pu	k_{eff} at Various Packing Fractions									
	100%	70%	60%	50%	40%	30%	20%	10%	5%	1%
500	1.0268	0.9670	0.9559	0.9444	0.9348	0.9248	0.9168	0.9071	0.9023	0.8987
550	1.0378	0.9797	0.9645	0.9568	0.9453	0.9329	0.9232	0.9184	0.9087	0.9101
600	1.0408	0.9812	0.9692	0.9592	0.9482	0.9421	0.9342	0.9256	0.9178	0.9170
650	1.0424	0.9836	0.9756	0.9650	0.9520	0.9441	0.9379	0.9254	0.9216	0.9224
700	1.0450	0.9866	0.9799	0.9680	0.9562	0.9509	0.9449	0.9352	0.9294	0.9240
750	1.0468	0.9943	0.9852	0.9707	0.9590	0.9507	0.9454	0.9365	0.9319	0.9301
800	1.0489	0.9966	0.9838	0.9721	0.9608	0.9499	0.9463	0.9360	0.9317	0.9296
850	1.0452	0.9956	0.9829	0.9681	0.9620	0.9520	0.9423	0.9366	0.9349	0.9341
900	1.0428	0.9926	0.9815	0.9723	0.9611	0.9576	0.9429	0.9394	0.9380	0.9302
950	1.0401	0.9897	0.9819	0.9702	0.9608	0.9541	0.9429	0.9343	0.9379	0.9316
1000	1.0390	0.9856	0.9784	0.9715	0.9641	0.9515	0.9464	0.9368	0.9358	0.9311
1050	1.0379	0.9856	0.9742	0.9674	0.9588	0.9522	0.9426	0.9348	0.9356	0.9320
1100	1.0340	0.9793	0.9729	0.9649	0.9560	0.9492	0.9387	0.9345	0.9278	0.9288
1150	1.0280	0.9747	0.9717	0.9601	0.9550	0.9464	0.9353	0.9314	0.9263	0.9247
1200	1.0284	0.9743	0.9667	0.9564	0.9516	0.9391	0.9356	0.9286	0.9268	0.9219
1250	1.0200	0.9651	0.9635	0.9548	0.9472	0.9409	0.9323	0.9227	0.9239	0.9175
1300	1.0132	0.9688	0.9580	0.9479	0.9429	0.9350	0.9285	0.9228	0.9205	0.9175
1350	1.0113	0.9649	0.9564	0.9449	0.9338	0.9288	0.9245	0.9190	0.9161	0.9177
1400	1.0011	0.9569	0.9516	0.9413	0.9353	0.9269	0.9221	0.9173	0.9147	0.9109
1450	1.0007	0.9529	0.9446	0.9407	0.9287	0.9267	0.9191	0.9131	0.9086	0.9075
1500	0.9956	0.9517	0.9433	0.9330	0.9242	0.9189	0.9112	0.9064	0.9057	0.8986

Figure 3.3.2-8: Heavy Water Reflector Reactivity as a Function of Packing Fraction

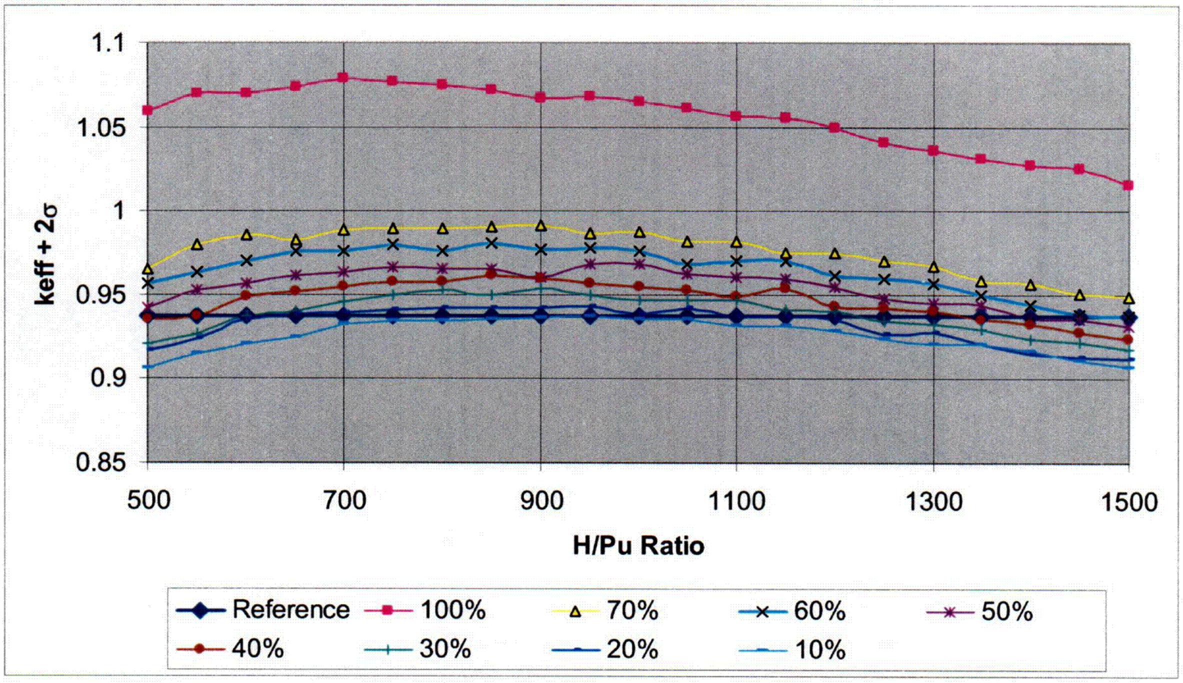

Table 3.3.2-9: D_2O Reflector Reactivity as a Function of Packing Fraction								
H/Pu	k_{eff} at Various Packing Fractions							
	100%	70%	60%	50%	40%	30%	20%	10%
500	1.0595	0.9653	0.9569	0.942	0.9353	0.9212	0.9170	0.9061
550	1.0697	0.9796	0.9634	0.9528	0.9371	0.9270	0.9235	0.9153
600	1.0697	0.9857	0.9701	0.9569	0.9488	0.9375	0.9354	0.9206
650	1.0739	0.9827	0.9756	0.9612	0.9517	0.9399	0.9386	0.9245
700	1.0787	0.9882	0.9756	0.9630	0.9546	0.9462	0.9389	0.9321
750	1.0766	0.9891	0.9803	0.9659	0.9580	0.9502	0.9411	0.9345
800	1.0747	0.9892	0.9764	0.9651	0.9578	0.9531	0.9416	0.9341
850	1.0723	0.9904	0.9806	0.9652	0.9611	0.9496	0.9422	0.9348
900	1.0666	0.9913	0.9766	0.9602	0.9594	0.9541	0.9419	0.9365
950	1.0678	0.9863	0.9779	0.9680	0.9568	0.9495	0.9435	0.9370
1000	1.0654	0.9880	0.9761	0.9680	0.9550	0.9473	0.9378	0.9353
1050	1.0614	0.9814	0.9682	0.9627	0.9525	0.9467	0.9424	0.9357
1100	1.0561	0.9814	0.9699	0.9604	0.9487	0.9465	0.9373	0.9310
1150	1.0551	0.9748	0.9698	0.9595	0.9535	0.9412	0.9376	0.9314
1200	1.0499	0.9753	0.9614	0.9548	0.9426	0.9401	0.9348	0.9282
1250	1.0405	0.9699	0.9591	0.9477	0.9419	0.9342	0.9268	0.9241
1300	1.0357	0.9669	0.9568	0.9445	0.9399	0.9321	0.9274	0.9210
1350	1.0311	0.9586	0.9498	0.9441	0.9354	0.9299	0.9208	0.9203
1400	1.0276	0.9564	0.9443	0.9359	0.9327	0.9236	0.9152	0.9164
1450	1.0254	0.9512	0.9378	0.9351	0.9274	0.9213	0.9132	0.9109
1500	1.0158	0.9493	0.9368	0.9314	0.9233	0.9182	0.9124	0.9067

Figure 3.3.2-9: Lead Reflector Reactivity as a Function of Packing Fraction

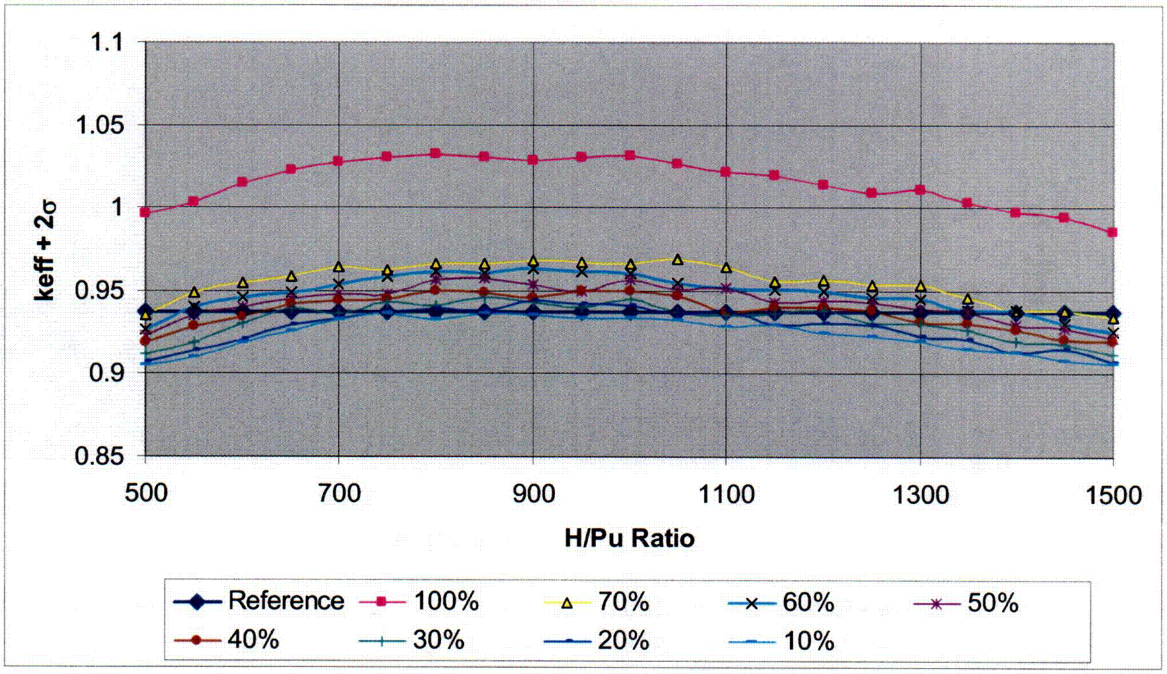

Table 3.3.2-10: Lead Reflector Reactivity as a Function of Packing Fraction								
H/Pu	k_{eff} at Various Packing Fractions							
	100%	70%	60%	50%	40%	30%	20%	10%
500	0.9966	0.9354	0.9266	0.9231	0.9184	0.9123	0.9071	0.9050
550	1.0035	0.9493	0.9397	0.9351	0.9286	0.9191	0.9143	0.9101
600	1.0149	0.9547	0.9456	0.9397	0.9341	0.9300	0.9205	0.9187
650	1.0220	0.9583	0.9488	0.9447	0.9419	0.9388	0.9291	0.9251
700	1.0276	0.9640	0.954	0.9475	0.9442	0.9359	0.9332	0.9319
750	1.0304	0.9621	0.9589	0.9477	0.9454	0.9432	0.9372	0.9361
800	1.0319	0.9664	0.9612	0.9566	0.9498	0.9409	0.9396	0.9328
850	1.0300	0.9662	0.9603	0.9574	0.9493	0.9457	0.9385	0.9364
900	1.0280	0.9687	0.9638	0.9534	0.9463	0.9429	0.9437	0.9357
950	1.0299	0.9670	0.9610	0.9494	0.9497	0.9402	0.9423	0.9333
1000	1.0311	0.9665	0.9606	0.9568	0.9498	0.9445	0.9413	0.9332
1050	1.0264	0.9696	0.9542	0.9508	0.9473	0.9368	0.9364	0.9319
1100	1.0211	0.9640	0.9520	0.9518	0.9369	0.9357	0.9382	0.9281
1150	1.0193	0.9556	0.9505	0.9432	0.9403	0.9364	0.9295	0.9297
1200	1.0137	0.9562	0.9498	0.9442	0.9406	0.9378	0.9305	0.9246
1250	1.0085	0.9532	0.9458	0.9431	0.9385	0.9309	0.9291	0.9223
1300	1.0110	0.9532	0.9451	0.9392	0.9317	0.9307	0.9231	0.9197
1350	1.0029	0.9461	0.9381	0.9368	0.9306	0.9267	0.9209	0.9153
1400	0.9977	0.9380	0.9381	0.9294	0.9262	0.9201	0.9134	0.9127
1450	0.9940	0.9385	0.9308	0.9274	0.9204	0.9183	0.9151	0.9086
1500	0.9853	0.9341	0.9256	0.9219	0.9194	0.9123	0.9071	0.9058

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Figure 3.3.2-10: Zirconium Reflector Reactivity as a Function of Packing Fraction

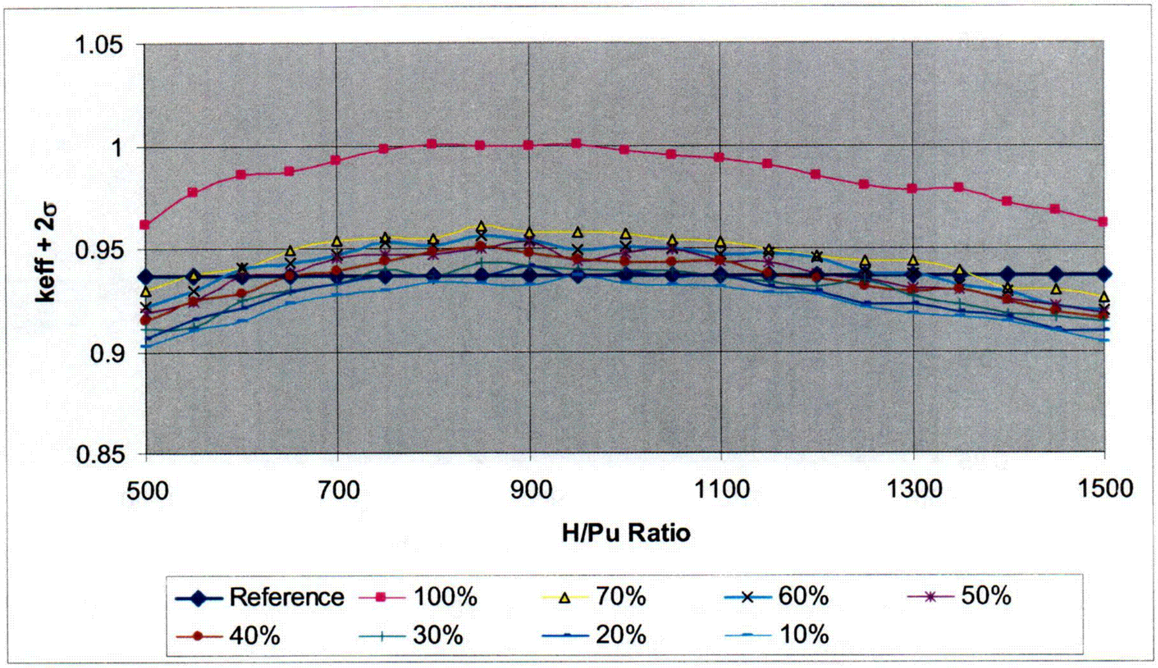
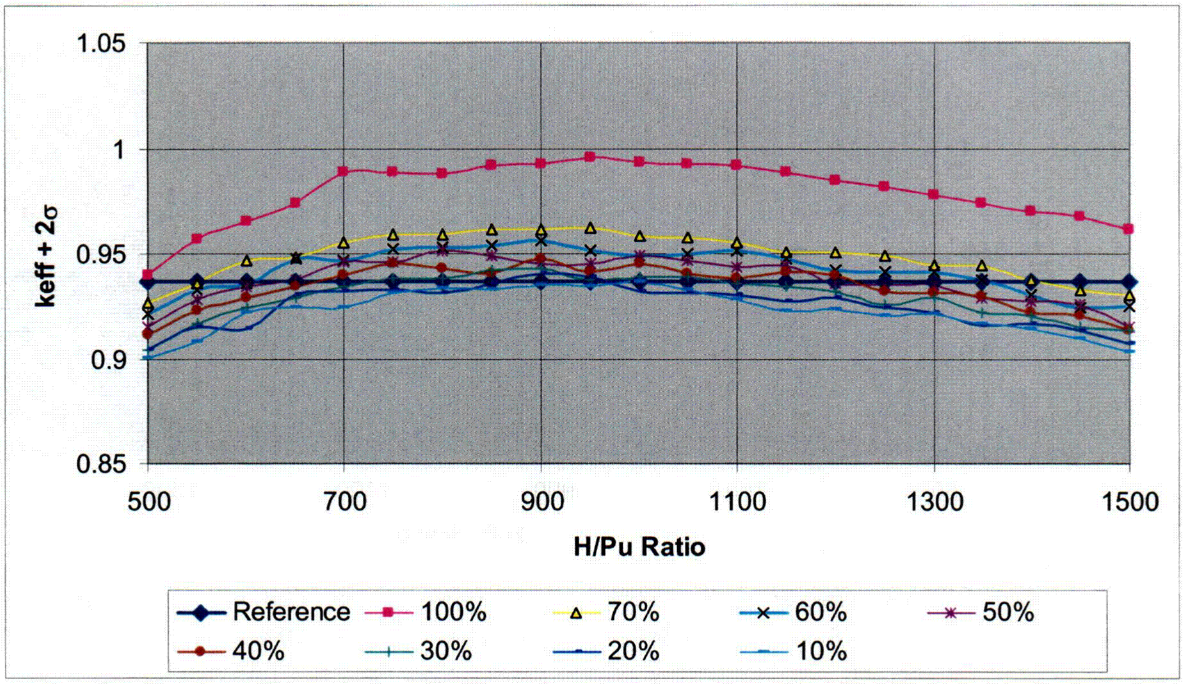


Table 3.3.2-11: Zirconium Reflector Reactivity as a Function of Packing Fraction								
H/Pu	**k_{eff} at Various Packing Fractions**							
	100%	**70%**	**60%**	**50%**	**40%**	**30%**	**20%**	**10%**
500	0.9617	0.9302	0.9221	0.9191	0.9150	0.9109	0.9066	0.9025
550	0.9770	0.9374	0.9295	0.9242	0.9245	0.9122	0.9162	0.9102
600	0.9857	0.9405	0.9410	0.9370	0.9281	0.9252	0.9211	0.9155
650	0.9872	0.9489	0.9429	0.9384	0.9365	0.9297	0.9292	0.9233
700	0.9924	0.9538	0.9472	0.9454	0.9388	0.9326	0.9326	0.9275
750	0.9979	0.9557	0.9530	0.9470	0.9436	0.9399	0.9366	0.9302
800	1.0002	0.9550	0.9516	0.9471	0.9485	0.9369	0.9369	0.9337
850	0.9999	0.9610	0.956	0.9497	0.9508	0.9428	0.9369	0.9328
900	1.0000	0.9579	0.9535	0.9534	0.9474	0.9417	0.9411	0.9324
950	1.0006	0.9574	0.9493	0.9439	0.9444	0.9401	0.9359	0.9368
1000	0.9976	0.9572	0.9509	0.9480	0.9432	0.9390	0.9381	0.9333
1050	0.9949	0.9538	0.9502	0.9491	0.9433	0.9391	0.9360	0.9320
1100	0.9937	0.9532	0.9467	0.9440	0.9441	0.9362	0.9371	0.9313
1150	0.9905	0.9492	0.9479	0.9429	0.9377	0.9340	0.9311	0.9286
1200	0.9845	0.9463	0.9451	0.9375	0.9352	0.9312	0.9293	0.9273
1250	0.9803	0.9438	0.9382	0.9355	0.9316	0.9344	0.9232	0.9214
1300	0.9782	0.9439	0.9373	0.9305	0.9288	0.9271	0.9228	0.9183
1350	0.9786	0.9391	0.9319	0.9299	0.9299	0.9229	0.9188	0.9167
1400	0.9715	0.9306	0.9287	0.9252	0.9241	0.9184	0.9170	0.9143
1450	0.9681	0.9301	0.9223	0.9223	0.9188	0.9164	0.9108	0.9099
1500	0.9617	0.9261	0.9201	0.9183	0.9156	0.9144	0.9094	0.9040

Figure 3.3.2-11: Bismuth Reflector Reactivity as a Function of Packing Fraction



H/Pu	k_{eff} at Various Packing Fractions							
	100%	70%	60%	50%	40%	30%	20%	10%
500	0.9400	0.9267	0.9217	0.9155	0.9109	0.9046	0.9039	0.9001
550	0.9568	0.9363	0.9333	0.9283	0.9225	0.9166	0.9155	0.9080
600	0.9652	0.9471	0.9357	0.9345	0.9291	0.9241	0.9146	0.9223
650	0.9738	0.9485	0.9475	0.9376	0.9342	0.9288	0.9305	0.9245
700	0.9885	0.9555	0.9466	0.9459	0.9397	0.9348	0.9323	0.9246
750	0.9884	0.9591	0.9526	0.9458	0.9453	0.9381	0.9328	0.9314
800	0.9883	0.9594	0.9533	0.9514	0.9430	0.9383	0.9316	0.9337
850	0.9919	0.9616	0.9537	0.9492	0.9410	0.9420	0.9360	0.9330
900	0.9923	0.9620	0.9562	0.9450	0.9474	0.9434	0.9404	0.9354
950	0.9959	0.9621	0.9512	0.9452	0.9412	0.9379	0.9388	0.9342
1000	0.9931	0.9587	0.9495	0.9494	0.9457	0.9391	0.9324	0.9365
1050	0.9923	0.9578	0.9498	0.9466	0.9404	0.9390	0.9316	0.9326
1100	0.992	0.9556	0.9513	0.9441	0.9384	0.9358	0.9303	0.9284
1150	0.9884	0.9510	0.9474	0.9449	0.9415	0.9347	0.9277	0.9232
1200	0.9846	0.9504	0.9426	0.9361	0.9403	0.9324	0.9288	0.9233
1250	0.9816	0.9493	0.9413	0.9350	0.9321	0.9262	0.9247	0.9207
1300	0.9778	0.9448	0.9414	0.9350	0.9314	0.9290	0.9218	0.9211
1350	0.9743	0.9446	0.9377	0.9289	0.9296	0.9223	0.9160	0.9168
1400	0.9705	0.9373	0.9307	0.9273	0.9218	0.9208	0.9169	0.9142
1450	0.9681	0.9329	0.9246	0.9261	0.9209	0.9155	0.9134	0.9094
1500	0.9617	0.9306	0.9251	0.9153	0.9134	0.9136	0.9074	0.9035

Table 3.3.2-12: Bismuth Reflector Reactivity as a Function of Packing Fraction

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Figure 3.3.2-12: Wet Sand Reflector Reactivity as a Function of Packing Fraction

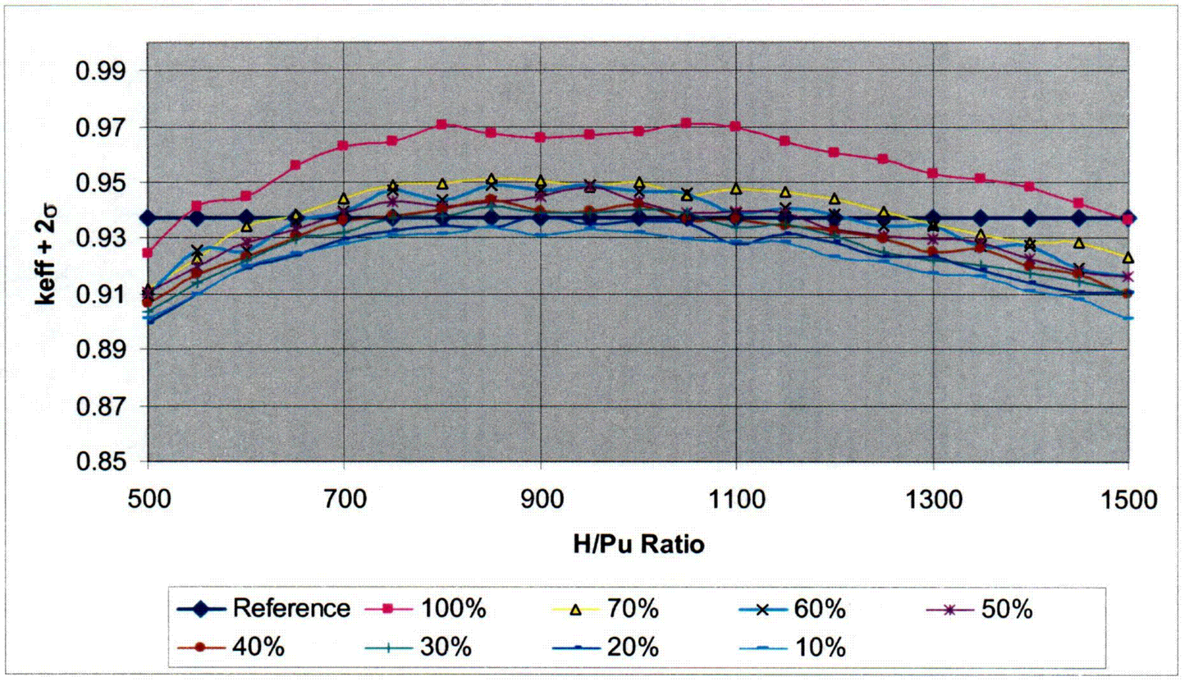

Table 3.3.2-13: Wet Sand Reflector Reactivity as a Function of Packing Fraction								
H/Pu	k_{eff} at Various Packing Fractions							
	100%	70%	60%	50%	40%	30%	20%	10%
500	0.9245	0.9117	0.9091	0.9107	0.9062	0.9037	0.8997	0.9011
550	0.9415	0.9228	0.9255	0.9200	0.9169	0.9142	0.9101	0.9096
600	0.9448	0.9343	0.9256	0.9286	0.9234	0.9219	0.9193	0.9195
650	0.9560	0.9383	0.9362	0.9332	0.9304	0.9298	0.9240	0.9246
700	0.9625	0.9443	0.9396	0.9390	0.9361	0.9319	0.9298	0.9280
750	0.9648	0.9490	0.9469	0.9429	0.9380	0.9373	0.9325	0.9307
800	0.9702	0.9495	0.9438	0.9415	0.9401	0.9378	0.9341	0.9316
850	0.9676	0.9512	0.9490	0.9430	0.9436	0.9415	0.9338	0.9339
900	0.9658	0.9506	0.9470	0.9447	0.9398	0.9391	0.9377	0.9306
950	0.9667	0.9482	0.9487	0.9481	0.9397	0.9389	0.9349	0.9333
1000	0.9680	0.9499	0.9465	0.9430	0.9417	0.9402	0.9358	0.9320
1050	0.9710	0.9451	0.9461	0.9387	0.9369	0.9389	0.9357	0.9297
1100	0.9700	0.9478	0.9389	0.9397	0.9368	0.9335	0.9278	0.9283
1150	0.9646	0.9463	0.9409	0.9388	0.9341	0.9351	0.9316	0.9283
1200	0.9606	0.9441	0.9383	0.9334	0.9328	0.9308	0.9282	0.9233
1250	0.9579	0.9398	0.9343	0.9306	0.9295	0.9249	0.9233	0.9216
1300	0.9528	0.9347	0.9343	0.9295	0.9248	0.9223	0.9235	0.9177
1350	0.9512	0.9316	0.9271	0.9283	0.9264	0.9205	0.9184	0.9160
1400	0.9483	0.9283	0.9276	0.9226	0.9200	0.9176	0.9142	0.9111
1450	0.9423	0.9287	0.9192	0.9180	0.9168	0.9147	0.9102	0.9082
1500	0.9368	0.9232	0.9160	0.9160	0.9096	0.9103	0.9104	0.9014

Figure 3.3.2-13: Concrete Reflector Reactivity as a Function of Packing Fraction

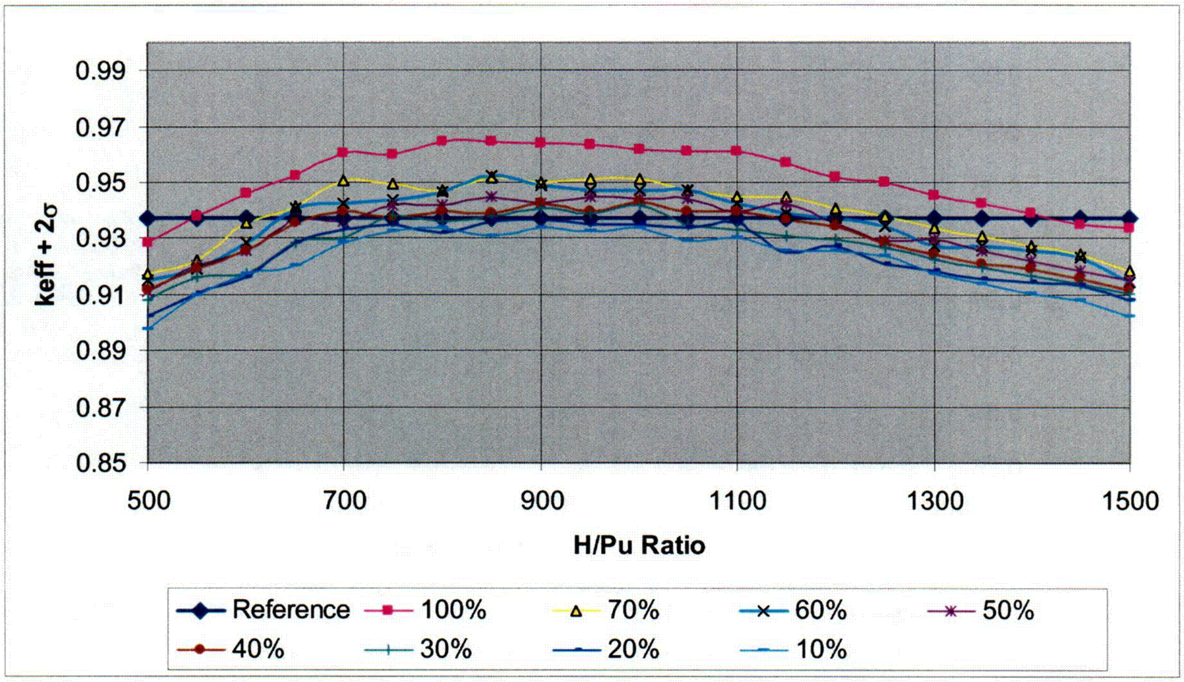

Table 3.3.2-14: Concrete Reflector Reactivity as a Function of Packing Fraction								
H/Pu	k_{eff} at Various Packing Fractions							
	100%	70%	60%	50%	40%	30%	20%	10%
500	0.9285	0.9175	0.9151	0.9113	0.9114	0.9079	0.9026	0.8979
550	0.9377	0.9222	0.9194	0.9204	0.9189	0.9165	0.9104	0.9098
600	0.9461	0.9353	0.9284	0.9256	0.9257	0.9176	0.9163	0.9177
650	0.9523	0.9414	0.9405	0.9367	0.9352	0.9283	0.9283	0.9206
700	0.9602	0.9507	0.9427	0.9361	0.9394	0.9301	0.9329	0.9285
750	0.9597	0.9496	0.9437	0.9418	0.9372	0.9376	0.9350	0.9326
800	0.9648	0.9473	0.9468	0.9419	0.9396	0.9360	0.9321	0.9339
850	0.9645	0.9519	0.9521	0.9447	0.9392	0.9375	0.9360	0.9309
900	0.9639	0.9501	0.9488	0.9423	0.9424	0.9408	0.9366	0.9337
950	0.9635	0.9510	0.9473	0.9447	0.9395	0.9390	0.9350	0.9328
1000	0.9616	0.9514	0.9470	0.9441	0.9428	0.9419	0.9346	0.9340
1050	0.9610	0.9471	0.9469	0.9442	0.9397	0.9351	0.9340	0.9292
1100	0.9608	0.9448	0.9425	0.9398	0.9397	0.9332	0.9352	0.9302
1150	0.9567	0.9445	0.9392	0.9427	0.9366	0.9309	0.9248	0.9256
1200	0.9517	0.9408	0.9371	0.9356	0.9345	0.9299	0.9271	0.9256
1250	0.9502	0.9379	0.9341	0.9293	0.9285	0.9270	0.9211	0.9236
1300	0.9454	0.9338	0.9276	0.9299	0.9247	0.9229	0.9184	0.9175
1350	0.9425	0.9308	0.9272	0.9257	0.9211	0.9195	0.9159	0.9138
1400	0.9392	0.9276	0.9258	0.9222	0.9193	0.9168	0.9143	0.9107
1450	0.9350	0.9243	0.9231	0.9185	0.9159	0.9137	0.9136	0.9080
1500	0.9338	0.9187	0.9146	0.9150	0.9118	0.9103	0.9083	0.9024

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Table 3.3.2-15: Reflector Equivalent Thicknesses as a Function of Packing Fraction								
Reflector	Equivalent Thickness at Various Packing Fractions (inches)							
	60%	50%	40%	30%	20%	10%	5%	1%
Be	0.13	0.18	0.22	0.29	0.48	1.12*	> 24	> 24
BeO	0.17	0.23	0.27	0.38	0.54	1.22*	> 24	> 24
C	0.27	0.35	0.43	0.58	0.73	5.15*	> 24	> 24
D_2O	0.32	0.38	0.47	0.64	1.09*	> 24	> 24	> 24
MgO	0.37	0.40	0.48	0.70	1.40*	> 24	> 24	> 24
Pb	0.74	1.10	1.26	1.78*	> 24	> 24	> 24	> 24
Zr	0.92	1.21	1.53	1.85*	> 24	> 24	> 24	> 24
Bi	1.04	1.45	1.75	2.03*	> 24	> 24	> 24	> 24
Wet Sand	1.75	1.80	3.32*	> 24	> 24	> 24	> 24	> 24
Concrete	1.76	1.84	3.39*	> 24	> 24	> 24	> 24	> 24

* Transition packing fraction (equivalent thickness = 24" between this packing fraction and the next lower one)

Table 3.3.2-16: Packing Fractions Which Give an Equivalent Thickness of 24" for Those Reflectors With Eigenvalues > that of 25% Poly/75% Water Mixture	
Reflector Material	**Packing Fraction (Nearest Percent)**
Be	7
BeO	7
C	9
D_2O	14
MgO	15
Pb	21
Zr	24
Bi	26
SiO_2 (Wet Sand)	33
Concrete (Oak Ridge)	34

3.3.3 Reactivity As a Function of ReflectorVolume Fraction For Depleted Uranium

Since depleted uranium is a very good shield material that may be used in the TRUPACT-II package, it is important to determine the reactivity of the system as a function of reflector packing fraction for various ^{235}U enrichments in a depleted uranium reflector. Following suit with the analyses performed in the previous sections for non-fissile reflectors, the system eigenvalue will be determined for a series of packing fractions ranging from 100% to 1%, where appropriate. For each packing fraction under consideration, the ^{235}U content in the depleted uranium reflector was varied from natural to 0.1 wt.%. To simulate flooded conditions, the reflector void volume was filled with water and the system was backed by 2 ft. of water. Tables 3.3.3-1 through 3.3.3-9 and Figure 3.3.3-1 through 3.3.3-9 illustrate the effect of reflector packing fraction on the system reactivity for the selected enrichments. Furthermore, the reflector equivalent thickness is summarized in Table 3.3.3-10. The results of the analyses suggest that utilization of depleted uranium tails as a shield material in the TRUPACT-II package should be limited to ^{235}U enrichments of less than 0.3% or the fissile mass limit reduced.

Table 3.3.3-1: Depleted Uranium Reflector -100% Packing Fraction; 60.96 cm Water Backing

H/Pu	$k_{eff} + 2\sigma$ For ^{235}U Enrichments Examined								
	U(Nat)	U(0.6%)	U(0.5%)	U(0.4%)	U(0.3%)	U(0.2%)	U(0.1%)	U(0.05%)	U(0.01%)
500	1.0040	0.9967	0.9875	0.9805	0.9743	0.9670	0.9525	0.9501	0.9392
550	1.0153	1.0085	1.0032	0.9923	0.9852	0.9750	0.9618	0.9564	0.9523
600	1.0229	1.0110	1.0075	1.0012	0.9928	0.9855	0.9734	0.9654	0.9572
650	1.0298	1.0238	1.0160	1.0061	0.9987	0.9860	0.9754	0.9680	0.9656
700	1.0316	1.0290	1.0177	1.0086	1.0038	0.9923	0.9841	0.9728	0.9669
750	1.0374	1.0256	1.0272	1.0149	1.0061	0.9958	0.9842	0.9755	0.9721
800	1.0414	1.0319	1.0241	1.0171	1.0078	0.9973	0.9877	0.9772	0.9715
850	1.0411	1.0313	1.0223	1.0184	1.0132	0.9979	0.9865	0.9782	0.9689
900	1.0457	1.0367	1.0286	1.0189	1.0072	1.0009	0.9838	0.9745	0.9707
950	1.0403	1.0353	1.0283	1.0137	1.0080	0.9985	0.9847	0.9755	0.9692
1000	1.0418	1.0332	1.0264	1.0192	1.0072	0.9979	0.9838	0.9771	0.9632
1050	1.0383	1.0281	1.0286	1.0135	1.0064	0.9928	0.9807	0.9733	0.9631
1100	1.0383	1.0313	1.0214	1.0160	1.0056	0.9947	0.9783	0.9714	0.9641
1150	1.0320	1.0283	1.0210	1.0128	1.0064	0.9903	0.9793	0.9736	0.9610
1200	1.0284	1.0267	1.0223	1.0072	1.0002	0.9836	0.9801	0.9620	0.9569
1250	1.0312	1.0199	1.0160	1.0051	0.9989	0.9818	0.9705	0.9609	0.9555
1300	1.0322	1.0200	1.0136	1.0017	0.9922	0.9815	0.9678	0.9575	0.9526
1350	1.0266	1.0162	1.0080	1.0014	0.9868	0.9766	0.9631	0.9535	0.9420
1400	1.0211	1.0123	1.0030	0.9937	0.9871	0.9744	0.9600	0.9511	0.9447
1450	1.0149	1.0115	0.9994	0.9921	0.9811	0.9690	0.9535	0.9447	0.9412
1500	1.0138	1.0036	0.9974	0.9904	0.9818	0.9681	0.9529	0.9420	0.9343

Figure 3.3.3-1: Depleted Uranium Reflector at 100% Density

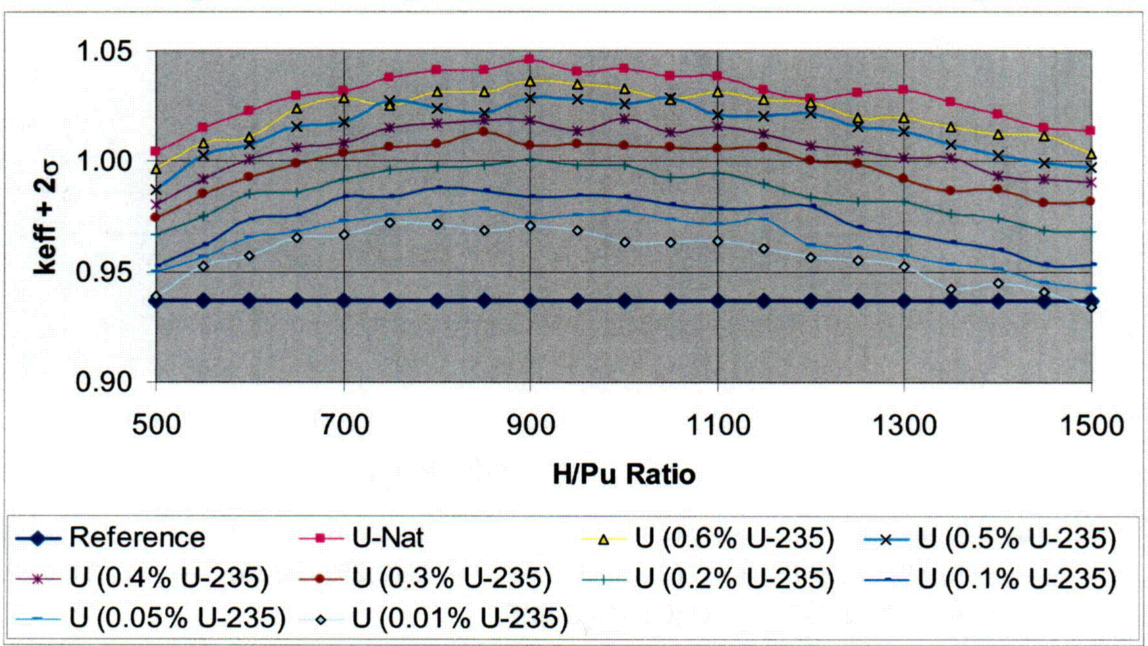

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Table 3.3.3-2: Depleted Uranium Reflector -70% Packing Fraction; 60.96 cm Water Backing									
H/Pu	**$k_{eff} + 2\sigma$ For ^{235}U Enrichments Examined**								
	U(Nat)	**U(0.6%)**	**U(0.5%)**	**U(0.4%)**	**U(0.3%)**	**U(0.2%)**	**U(0.1%)**	**U(0.05%)**	**U(0.01%)**
500	0.9886	0.9727	0.9651	0.9522	0.9403	0.9211	0.9057	0.8875	0.8830
550	0.9909	0.9855	0.9765	0.9602	0.9489	0.9340	0.9106	0.9049	0.8912
600	1.0036	0.9902	0.9773	0.9699	0.9589	0.9387	0.9166	0.9102	0.9013
650	1.0097	0.9954	0.9820	0.9773	0.9599	0.9425	0.9268	0.9190	0.9086
700	1.0155	1.0015	0.9899	0.9812	0.9682	0.9470	0.9311	0.9231	0.9128
750	1.0175	1.0016	0.9887	0.9848	0.9684	0.9549	0.9329	0.9261	0.9163
800	1.0132	1.0140	0.9970	0.9873	0.9691	0.9593	0.9451	0.9263	0.9168
850	1.0122	1.0087	0.9987	0.9929	0.9773	0.9569	0.9365	0.9236	0.9199
900	1.0189	1.0071	0.9993	0.9858	0.9766	0.9647	0.9383	0.9326	0.9218
950	1.0203	1.0083	0.9992	0.9845	0.9740	0.9631	0.9386	0.9314	0.9204
1000	1.0163	1.0073	1.0006	0.9886	0.9778	0.9601	0.9448	0.9312	0.9215
1050	1.0164	1.0065	0.9986	0.9799	0.9728	0.9579	0.9396	0.9311	0.9209
1100	1.0146	1.0133	0.9977	0.9771	0.9700	0.9588	0.9361	0.9272	0.9182
1150	1.0077	1.0043	0.9951	0.9838	0.9671	0.9565	0.9344	0.9226	0.9183
1200	1.0118	1.0047	0.9960	0.9733	0.9684	0.9515	0.9329	0.9262	0.9150
1250	1.0088	1.0023	0.9969	0.9783	0.9695	0.9493	0.9314	0.9210	0.9142
1300	1.0070	0.9987	0.9865	0.9771	0.9619	0.9499	0.9307	0.9164	0.9097
1350	1.0068	0.9922	0.9852	0.9739	0.9617	0.9439	0.9256	0.9146	0.9069
1400	1.0036	0.9862	0.9813	0.9652	0.9574	0.9417	0.9184	0.9147	0.9015
1450	1.0010	0.9919	0.9788	0.9645	0.9494	0.9357	0.9166	0.9086	0.9033
1500	0.9927	0.9848	0.9729	0.9658	0.9469	0.9304	0.9146	0.9048	0.8968

Figure 3.3.3-2: Depleted Uranium Reflector at 70% Packing Fraction

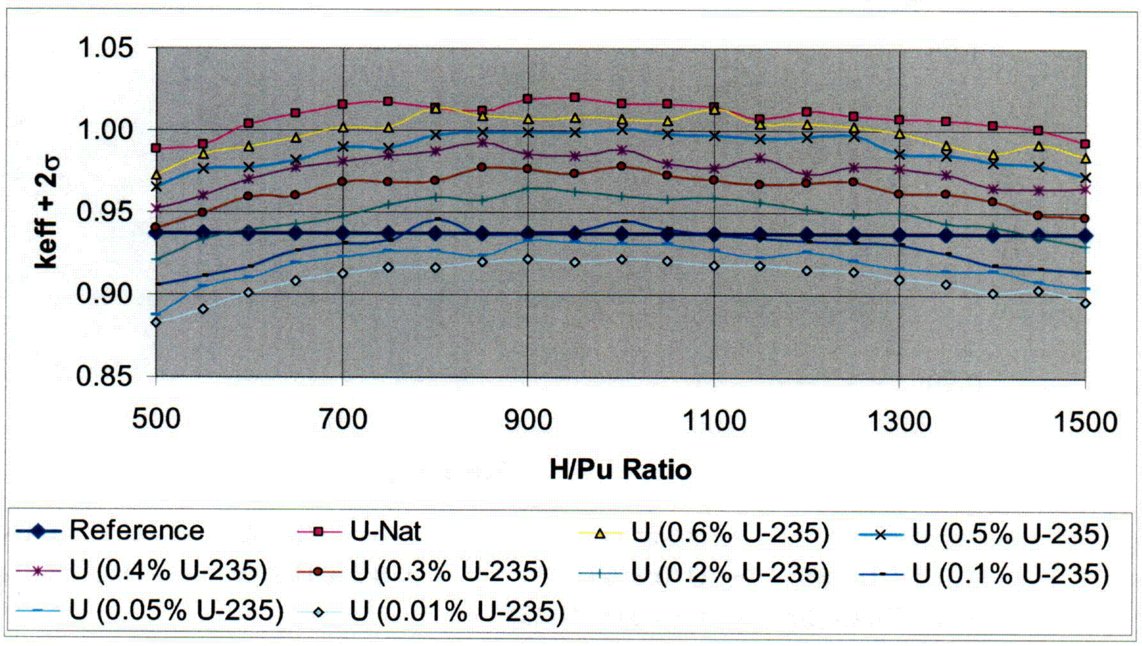

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Table 3.3.3-3: U_{Nat} Reflector Reactivity as a Function of Packing Fraction										
H/Pu	k_{eff} at Various Packing Fractions									
	100%	70%	60%	50%	40%	30%	20%	10%	5%	1%
500	1.0040	0.9886	0.9857	0.9914	1.0042	0.9958	1.0037	0.9651	0.9421	0.9071
550	1.0153	0.9909	0.9964	1.0088	1.0127	1.0071	0.9982	0.9731	0.9455	0.9167
600	1.0229	1.0036	1.0046	1.0094	1.0154	1.0130	1.0028	0.9837	0.953	0.9265
650	1.0298	1.0097	1.0076	1.0163	1.0231	1.0242	1.0144	0.9861	0.9598	0.9275
700	1.0316	1.0155	1.0156	1.0208	1.0237	1.0225	1.0128	0.9858	0.9674	0.9307
750	1.0374	1.0175	1.0172	1.0238	1.0238	1.0239	1.0224	0.9879	0.9695	0.9354
800	1.0414	1.0132	1.0203	1.0217	1.0280	1.0290	1.0241	0.9948	0.9670	0.9356
850	1.0411	1.0122	1.0173	1.0218	1.0325	1.0248	1.0223	0.9975	0.9641	0.9341
900	1.0457	1.0189	1.0234	1.0229	1.029	1.0345	1.0233	0.9952	0.9718	0.9341
950	1.0403	1.0203	1.0213	1.0286	1.0356	1.0304	1.0223	0.9929	0.9644	0.9359
1000	1.0418	1.0163	1.0219	1.0246	1.0339	1.0363	1.0259	1.0004	0.9695	0.9363
1050	1.0383	1.0164	1.0205	1.0272	1.0265	1.0280	1.0174	0.9905	0.9627	0.9384
1100	1.0383	1.0146	1.0201	1.0266	1.0231	1.0259	1.0170	0.9925	0.9671	0.9326
1150	1.032	1.0077	1.0160	1.0206	1.0184	1.0190	1.0068	0.9856	0.9616	0.9328
1200	1.0284	1.0118	1.0154	1.0147	1.0214	1.0194	1.0166	0.9833	0.9601	0.9299
1250	1.0312	1.0088	1.0116	1.0161	1.0124	1.0199	1.0091	0.9806	0.9572	0.9254
1300	1.0322	1.0070	1.0064	1.0132	1.0082	1.0204	1.0128	0.9787	0.9514	0.9239
1350	1.0266	1.0068	1.0078	1.0144	1.0148	1.0153	0.9984	0.9734	0.9512	0.9182
1400	1.0211	1.0036	1.0047	1.0146	1.0129	1.0095	0.9995	0.9725	0.9440	0.9152
1450	1.0149	1.0010	0.9977	1.0069	1.0106	1.0067	1.0045	0.9684	0.9456	0.9136
1500	1.0138	0.9927	1.0010	1.0013	1.0024	1.0097	0.995	0.9688	0.9396	0.9094

Figure 3.3.3-3: U_{Nat} Reflector Reactivity as a Function of Packing Fraction

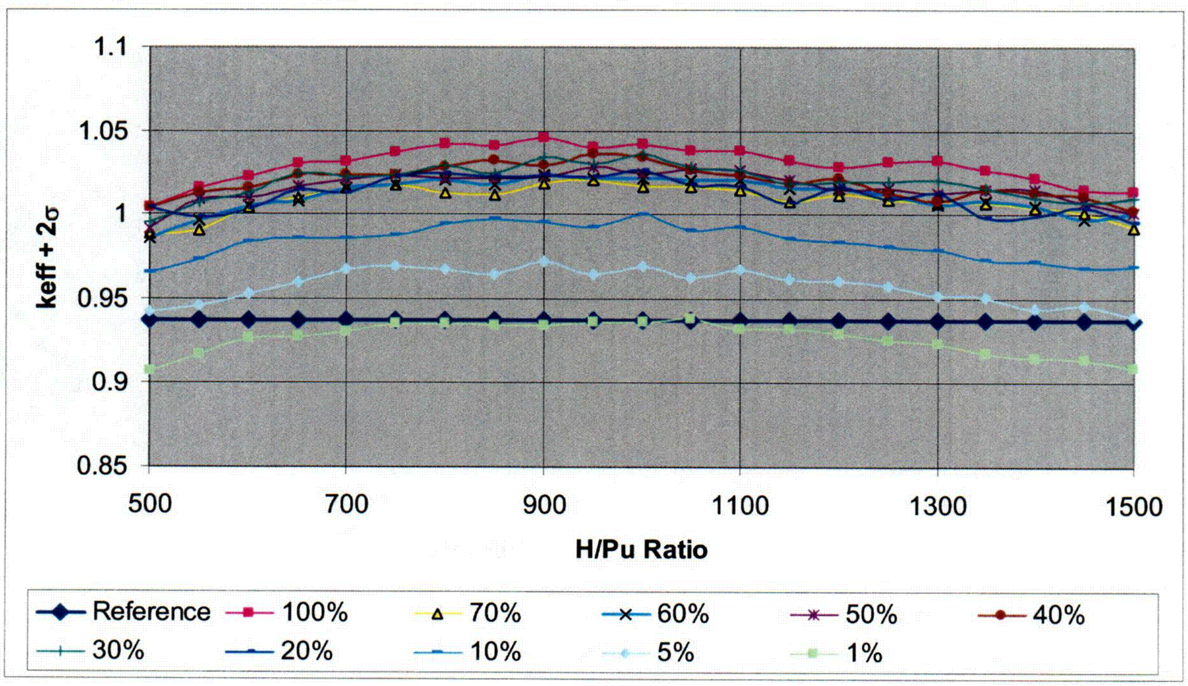

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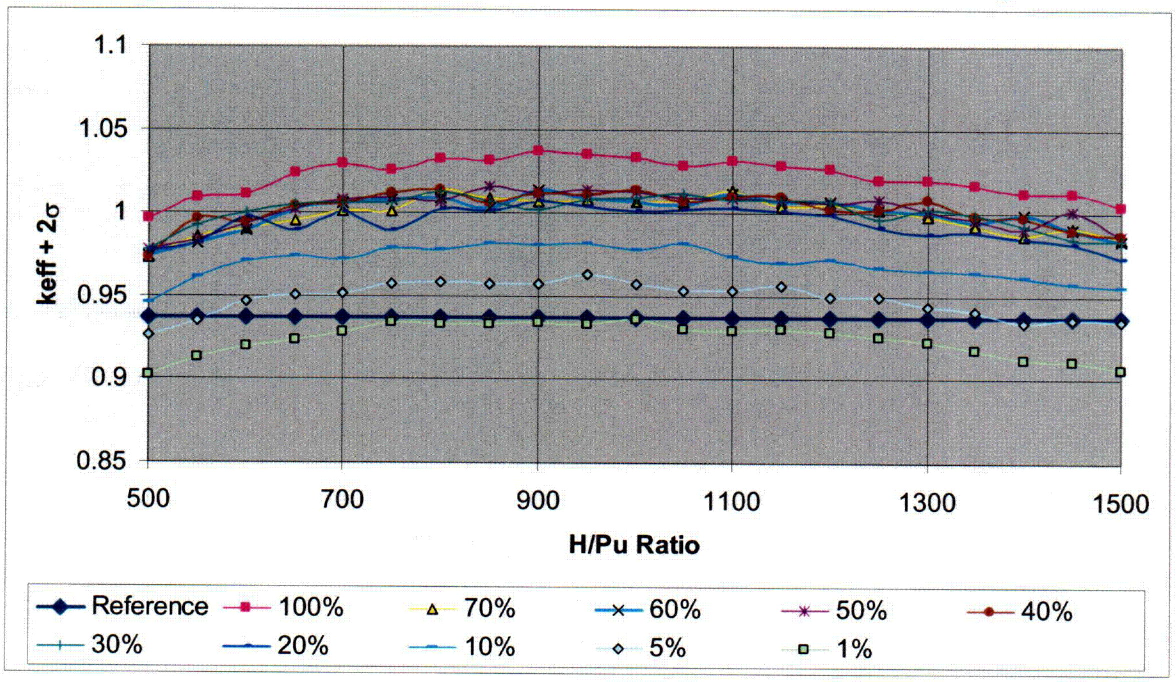
Table 3.3.3-4: 0.6% ^{235}U Reflector Reactivity as a Function of Packing Fraction										
H/Pu	**k_{eff} at Various Packing Fractions**									
	100%	**70%**	**60%**	**50%**	**40%**	**30%**	**20%**	**10%**	**5%**	**1%**
500	0.9967	0.9727	0.9744	0.9778	0.9726	0.9783	0.9766	0.9464	0.9262	0.9024
550	1.0085	0.9855	0.9817	0.9842	0.9959	0.9923	0.9819	0.9612	0.9357	0.9129
600	1.0110	0.9902	0.9900	0.9935	0.9939	0.9998	0.9975	0.9716	0.9471	0.9195
650	1.0238	0.9954	1.0026	1.0017	1.0036	1.0051	0.9899	0.9738	0.9508	0.9236
700	1.0290	1.0015	1.0058	1.0080	1.0057	1.0059	0.9998	0.9719	0.9519	0.9287
750	1.0256	1.0016	1.0078	1.0093	1.0120	1.0056	0.9897	0.9784	0.9580	0.9340
800	1.0319	1.0140	1.0091	1.0067	1.0136	1.0131	1.0021	0.9782	0.9586	0.9333
850	1.0313	1.0087	1.0035	1.0156	1.0063	1.0065	1.0014	0.9822	0.9571	0.9335
900	1.0367	1.0071	1.0142	1.0115	1.0120	1.0023	1.0072	0.9807	0.9580	0.9347
950	1.0353	1.0083	1.0089	1.0137	1.0104	1.0078	1.0036	0.9817	0.9631	0.9334
1000	1.0332	1.0073	1.0069	1.0124	1.0134	1.0093	1.0008	0.9781	0.9580	0.9363
1050	1.0281	1.0065	1.0052	1.0091	1.0066	1.0118	1.0019	0.9814	0.9538	0.9309
1100	1.0313	1.0133	1.0115	1.0092	1.0102	1.0075	1.0031	0.9744	0.9541	0.9299
1150	1.0283	1.0043	1.0069	1.0078	1.0101	1.0079	1.0013	0.9702	0.9567	0.9309
1200	1.0267	1.0047	1.0070	1.0061	1.0025	1.0067	0.9993	0.9722	0.9496	0.9285
1250	1.0199	1.0023	1.0018	1.0082	1.0025	0.9962	0.9914	0.9676	0.9498	0.9255
1300	1.0200	0.9987	1.0005	1.0011	1.0078	1.0026	0.9878	0.9655	0.9438	0.9223
1350	1.0162	0.9922	0.9941	0.9962	0.9983	0.9990	0.9881	0.9642	0.9407	0.9177
1400	1.0123	0.9862	0.9989	0.9907	0.9977	0.9927	0.9850	0.9617	0.9346	0.9123
1450	1.0115	0.9919	0.9904	1.0014	0.9900	0.9845	0.9816	0.9580	0.9366	0.9113
1500	1.0036	0.9848	0.9842	0.9870	0.9864	0.9840	0.9734	0.9553	0.9350	0.9064

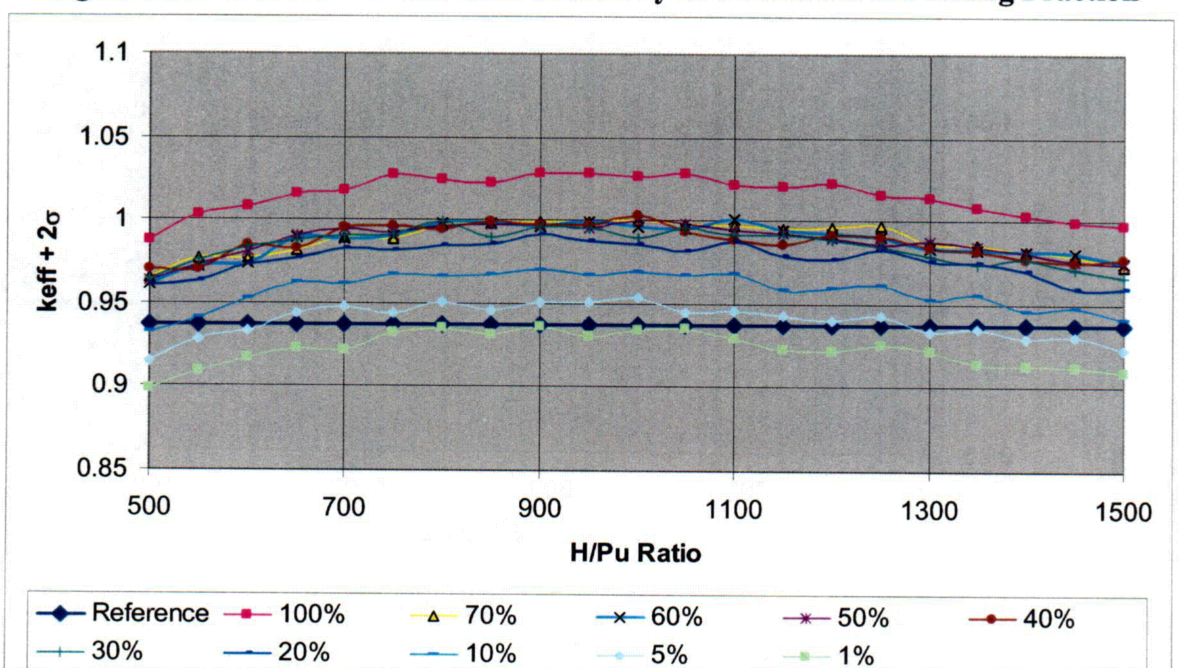
Figure 3.3.3-4: 0.6% ^{235}U Reflector Reactivity as a Function of Packing Fraction



C50

Table 3.3.3-5: 0.5% ^{235}U Reflector Reactivity as a Function of Packing Fraction										
H/Pu	k_{eff} at Various Packing Fractions									
	100%	70%	60%	50%	40%	30%	20%	10%	5%	1%
500	0.9875	0.9651	0.9619	0.9634	0.9697	0.9642	0.9603	0.9323	0.9147	0.8983
550	1.0032	0.9765	0.9721	0.9730	0.9705	0.9763	0.9634	0.9408	0.9284	0.9087
600	1.0075	0.9773	0.9744	0.9808	0.9843	0.9834	0.9726	0.9525	0.9333	0.9169
650	1.0160	0.9820	0.9899	0.9903	0.9830	0.9873	0.9770	0.9628	0.9443	0.9230
700	1.0177	0.9899	0.9887	0.9944	0.9956	0.9902	0.9825	0.9618	0.9481	0.9221
750	1.0272	0.9887	0.9902	0.9920	0.9961	0.9912	0.9820	0.9668	0.9444	0.9321
800	1.0241	0.9970	0.9978	0.9968	0.9944	0.9996	0.9850	0.9665	0.9510	0.9350
850	1.0223	0.9987	0.9983	0.9972	0.9992	0.9898	0.9860	0.9670	0.9456	0.9310
900	1.0286	0.9993	0.9960	0.9977	0.9970	0.9960	0.9913	0.9703	0.9503	0.9361
950	1.0283	0.9992	0.9997	0.9953	0.9970	0.9957	0.9872	0.9677	0.9510	0.9309
1000	1.0264	1.0006	0.9960	0.9998	1.0034	0.9894	0.9860	0.9695	0.9538	0.9340
1050	1.0286	0.9986	0.9957	0.9985	0.9937	0.9957	0.9814	0.9676	0.9450	0.9352
1100	1.0214	0.9977	1.0012	0.9943	0.9890	0.9916	0.9874	0.9687	0.9462	0.9298
1150	1.0210	0.9951	0.9948	0.9921	0.9856	0.9915	0.9787	0.9588	0.9432	0.9228
1200	1.0223	0.9960	0.9920	0.9899	0.9914	0.9885	0.9767	0.9592	0.9399	0.9213
1250	1.0160	0.9969	0.9902	0.986	0.9908	0.9844	0.9824	0.9611	0.9428	0.9256
1300	1.0136	0.9865	0.9836	0.9878	0.9835	0.9784	0.9756	0.9526	0.9335	0.9216
1350	1.0080	0.9852	0.9829	0.9847	0.9817	0.9743	0.9754	0.9561	0.9354	0.9141
1400	1.0030	0.9813	0.9816	0.9810	0.977	0.9774	0.9703	0.9457	0.9294	0.9133
1450	0.9994	0.9788	0.9808	0.9761	0.9749	0.9712	0.9598	0.9475	0.9306	0.9122
1500	0.9974	0.9729	0.9753	0.9744	0.9771	0.9664	0.9591	0.9413	0.9227	0.9089

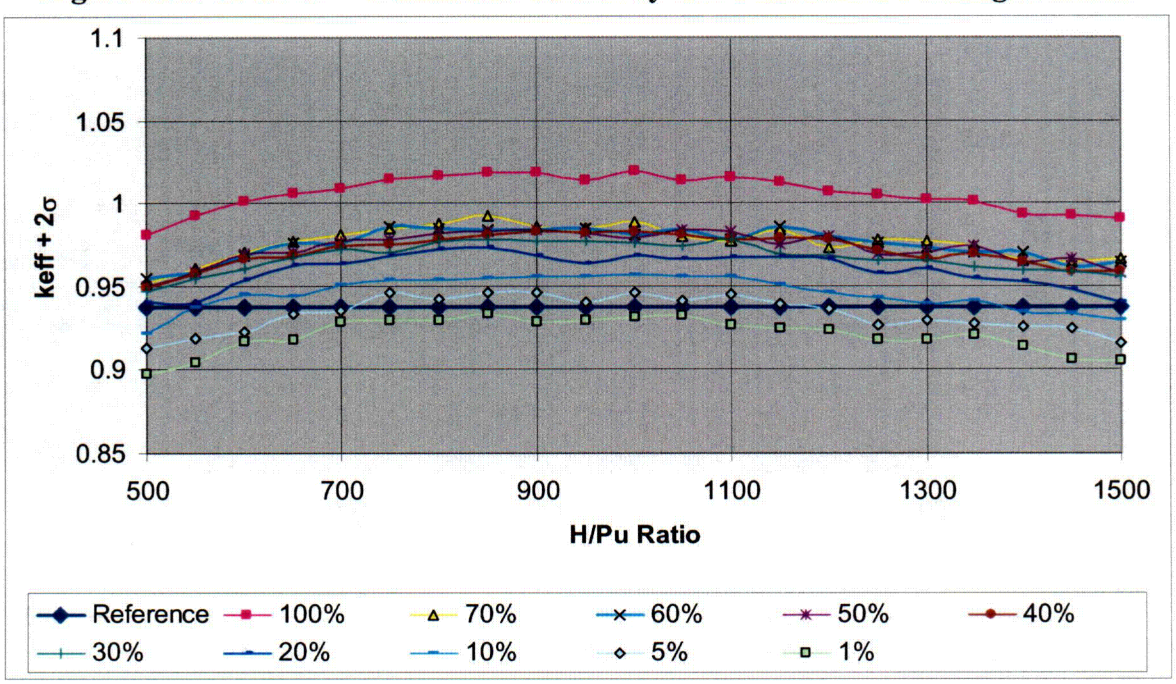
Figure 3.3.3-5: 0.5% ^{235}U Reflector Reactivity as a Function of Packing Fraction



C51

Table 3.3.3-6: 0.4% ^{235}U Reflector Reactivity as a Function of Packing Fraction										
H/Pu	**k_{eff} at Various Packing Fractions**									
	100%	**70%**	**60%**	**50%**	**40%**	**30%**	**20%**	**10%**	**5%**	**1%**
500	0.9805	0.9522	0.9546	0.9495	0.9488	0.9472	0.9401	0.9220	0.9132	0.8976
550	0.9923	0.9602	0.9587	0.9582	0.9576	0.9546	0.9405	0.9371	0.9191	0.9040
600	1.0012	0.9699	0.9686	0.9691	0.9662	0.9607	0.9539	0.9454	0.9222	0.9164
650	1.0061	0.9773	0.9759	0.9701	0.9678	0.9675	0.9621	0.9443	0.9329	0.9181
700	1.0086	0.9812	0.9762	0.9770	0.9737	0.9717	0.9632	0.9510	0.9357	0.9285
750	1.0149	0.9848	0.9858	0.9775	0.9749	0.9702	0.9679	0.9541	0.9456	0.9294
800	1.0171	0.9873	0.9843	0.9814	0.9776	0.9768	0.9719	0.9535	0.9418	0.9291
850	1.0184	0.9929	0.9837	0.9832	0.9805	0.9776	0.9728	0.9550	0.9455	0.9334
900	1.0189	0.9858	0.9840	0.9840	0.9832	0.9770	0.9687	0.9552	0.9455	0.9288
950	1.0137	0.9845	0.9843	0.9813	0.9814	0.9772	0.9635	0.9558	0.9402	0.9292
1000	1.0192	0.9886	0.9812	0.9791	0.9828	0.9763	0.9678	0.9565	0.9458	0.9315
1050	1.0135	0.9799	0.9840	0.9836	0.9810	0.9745	0.9661	0.9556	0.9410	0.9320
1100	1.0160	0.9771	0.9776	0.9825	0.9775	0.9775	0.9672	0.9553	0.9447	0.9270
1150	1.0128	0.9838	0.9853	0.9750	0.9785	0.9694	0.9670	0.9505	0.9392	0.9248
1200	1.0072	0.9733	0.9797	0.9794	0.9775	0.9686	0.9661	0.9459	0.9358	0.9232
1250	1.0051	0.9783	0.9757	0.9694	0.9710	0.9656	0.9578	0.9426	0.9269	0.9183
1300	1.0017	0.9771	0.9733	0.9701	0.9665	0.9652	0.9607	0.9393	0.9294	0.9178
1350	1.0014	0.9739	0.9697	0.9743	0.9694	0.9619	0.9542	0.9414	0.9273	0.9208
1400	0.9937	0.9652	0.9706	0.9642	0.9648	0.9591	0.9525	0.9340	0.9254	0.9135
1450	0.9921	0.9645	0.9615	0.9666	0.9585	0.9581	0.9478	0.9330	0.9249	0.9063
1500	0.9904	0.9658	0.9640	0.9571	0.9587	0.9553	0.9404	0.9296	0.9163	0.9050

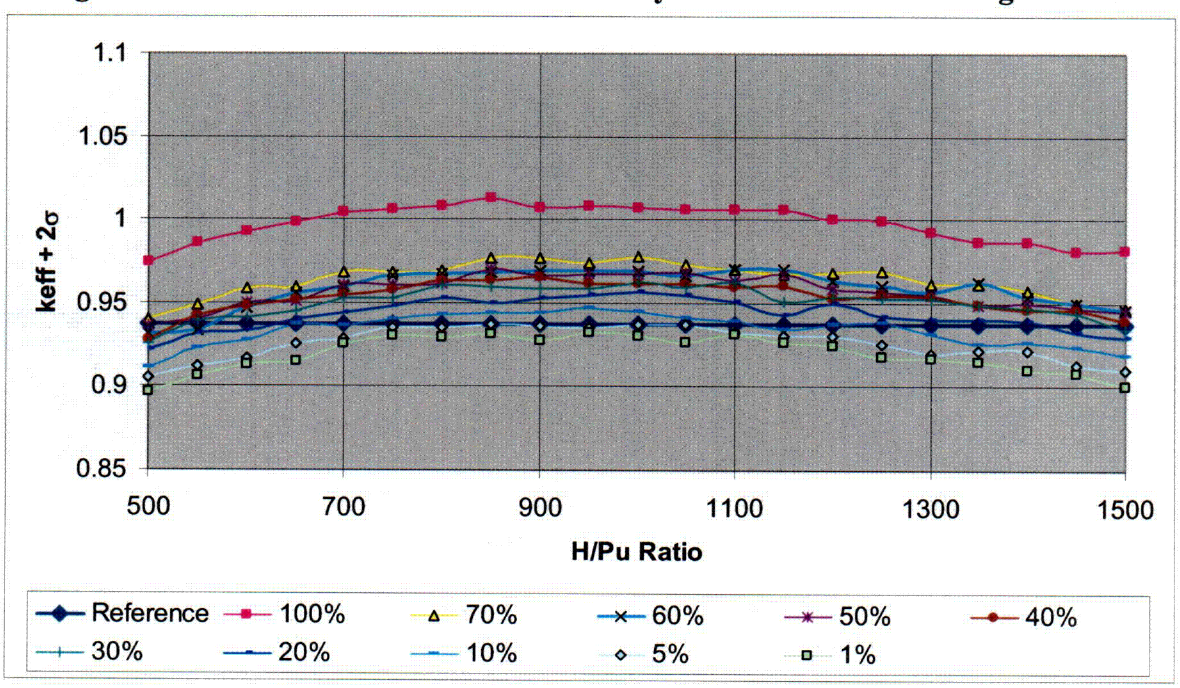
Figure 3.3.3-6: 0.4% ^{235}U Reflector Reactivity as a Function of Packing Fraction



C52

Table 3.3.3-7: 0.3% ^{235}U Reflector Reactivity as a Function of Packing Fraction										
H/Pu	k_{eff} at Various Packing Fractions									
	100%	70%	60%	50%	40%	30%	20%	10%	5%	1%
500	0.9743	0.9403	0.9312	0.9362	0.9277	0.9256	0.9213	0.9107	0.9049	0.8966
550	0.9852	0.9489	0.9337	0.9401	0.9419	0.9391	0.9311	0.9227	0.9122	0.9061
600	0.9928	0.9589	0.9472	0.9494	0.9476	0.9411	0.9336	0.9273	0.9171	0.9134
650	0.9987	0.9599	0.9556	0.9507	0.9519	0.9449	0.9399	0.9372	0.9251	0.9151
700	1.0038	0.9682	0.9598	0.9604	0.9551	0.9527	0.9440	0.9364	0.9285	0.9257
750	1.0061	0.9684	0.9665	0.9603	0.9577	0.9528	0.9474	0.9405	0.9352	0.9300
800	1.0078	0.9691	0.9672	0.9618	0.9634	0.9607	0.9526	0.9428	0.9351	0.9291
850	1.0132	0.9773	0.9679	0.9699	0.9630	0.9593	0.9501	0.9440	0.9372	0.9317
900	1.0072	0.9766	0.9691	0.9664	0.9654	0.9587	0.9529	0.9442	0.9367	0.9274
950	1.0080	0.9740	0.9693	0.9676	0.9617	0.9585	0.9545	0.9469	0.9353	0.9325
1000	1.0072	0.9778	0.9693	0.9677	0.9611	0.9626	0.9566	0.9448	0.9372	0.9302
1050	1.0064	0.9728	0.9667	0.9678	0.9618	0.9591	0.9548	0.9410	0.9374	0.9261
1100	1.0056	0.9700	0.9700	0.9633	0.9594	0.9627	0.9504	0.9395	0.9324	0.9315
1150	1.0064	0.9671	0.9706	0.9670	0.9607	0.9504	0.9433	0.9344	0.9300	0.9265
1200	1.0002	0.9684	0.9633	0.9584	0.9523	0.9540	0.9501	0.9374	0.9302	0.9245
1250	0.9989	0.9695	0.9607	0.9563	0.9547	0.9524	0.9420	0.9386	0.9258	0.9176
1300	0.9922	0.9619	0.9567	0.9543	0.9532	0.9527	0.9398	0.9314	0.9202	0.9172
1350	0.9868	0.9617	0.9622	0.9489	0.9490	0.9490	0.9401	0.9251	0.9221	0.9148
1400	0.9871	0.9574	0.9540	0.9499	0.9464	0.9473	0.9395	0.9268	0.9217	0.9101
1450	0.9811	0.9494	0.9496	0.9472	0.9456	0.9441	0.9321	0.9235	0.9133	0.9078
1500	0.9818	0.9469	0.9457	0.9452	0.9395	0.9344	0.9295	0.9185	0.9103	0.9000

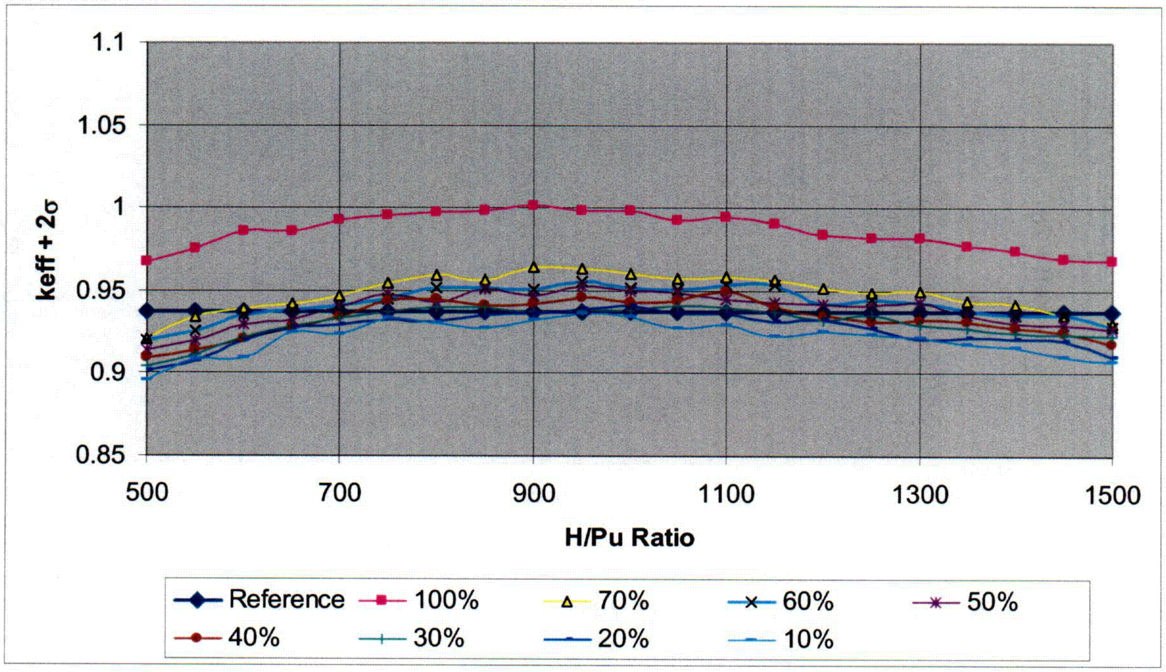
Figure 3.3.3-7: 0.3% ^{235}U Reflector Reactivity as a Function of Packing Fraction



C53

Table 3.3.3-8: 0.2% ^{235}U Reflector Reactivity as a Function of Packing Fraction								
H/Pu	k_{eff} at Various Packing Fractions							
	100%	70%	60%	50%	40%	30%	20%	10%
500	0.9670	0.9211	0.9201	0.9135	0.9090	0.9044	0.9011	0.8958
550	0.9750	0.9340	0.9254	0.9201	0.9142	0.9109	0.9074	0.9085
600	0.9855	0.9387	0.9350	0.9291	0.9211	0.9220	0.9195	0.9089
650	0.9860	0.9425	0.9378	0.9322	0.9277	0.9286	0.9273	0.9244
700	0.9923	0.9470	0.9415	0.9397	0.9342	0.9337	0.9292	0.9238
750	0.9958	0.9549	0.9445	0.9476	0.9438	0.9370	0.9319	0.9331
800	0.9973	0.9593	0.9522	0.9433	0.9445	0.9397	0.9316	0.9309
850	0.9979	0.9569	0.9518	0.9510	0.9407	0.9400	0.9356	0.9279
900	1.0009	0.9647	0.9503	0.9465	0.9420	0.9374	0.9364	0.9327
950	0.9985	0.9631	0.9560	0.9528	0.9458	0.9385	0.9390	0.9362
1000	0.9979	0.9601	0.9522	0.9495	0.9435	0.9386	0.9408	0.9339
1050	0.9928	0.9579	0.9512	0.9490	0.9438	0.9409	0.9365	0.9277
1100	0.9947	0.9588	0.9539	0.9447	0.9502	0.9399	0.9365	0.9297
1150	0.9903	0.9565	0.9538	0.9431	0.9402	0.9372	0.9315	0.9230
1200	0.9836	0.9515	0.9422	0.9420	0.9356	0.9320	0.9327	0.9251
1250	0.9818	0.9493	0.9445	0.9409	0.9311	0.9355	0.9276	0.9235
1300	0.9815	0.9499	0.9428	0.9427	0.9325	0.9297	0.9210	0.9213
1350	0.9766	0.9439	0.9380	0.9353	0.9316	0.9275	0.9217	0.9179
1400	0.9744	0.9417	0.9349	0.9303	0.9273	0.9249	0.9212	0.9157
1450	0.9690	0.9357	0.9353	0.9299	0.9246	0.9232	0.9193	0.9103
1500	0.9681	0.9304	0.9284	0.9268	0.9182	0.9229	0.9096	0.9068

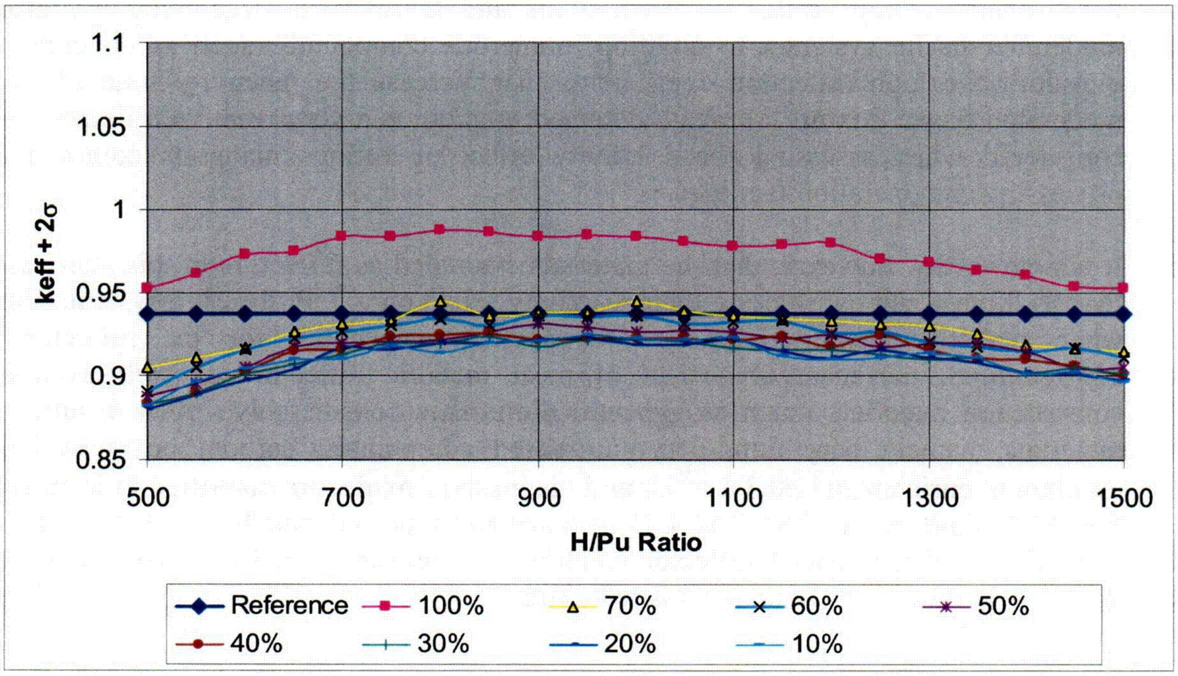
Figure 3.3.3-8: 0.2% ^{235}U Reflector Reactivity as a Function of Packing Fraction



C54

Table 3.3.3-9: 0.1% ^{235}U Reflector Reactivity as a Function of Packing Fraction								
H/Pu	k_{eff} at Various Packing Fractions							
	100%	70%	60%	50%	40%	30%	20%	10%
500	0.9525	0.9057	0.8905	0.8875	0.8832	0.8832	0.8797	0.8816
550	0.9618	0.9106	0.9055	0.8954	0.8899	0.8900	0.8885	0.8965
600	0.9734	0.9166	0.9155	0.9056	0.9028	0.9009	0.8974	0.9044
650	0.9754	0.9268	0.9225	0.9175	0.9149	0.9069	0.9047	0.9098
700	0.9841	0.9311	0.9264	0.9194	0.9159	0.9129	0.9169	0.9099
750	0.9842	0.9329	0.9304	0.9210	0.9239	0.9194	0.9161	0.9175
800	0.9877	0.9451	0.9340	0.9215	0.9242	0.9196	0.9202	0.9140
850	0.9865	0.9365	0.9308	0.9263	0.9255	0.9236	0.9199	0.9202
900	0.9838	0.9383	0.9363	0.9318	0.9219	0.9180	0.9220	0.9206
950	0.9847	0.9386	0.9350	0.9295	0.9230	0.9218	0.9226	0.9246
1000	0.9838	0.9448	0.9359	0.9269	0.9229	0.9220	0.9187	0.9227
1050	0.9807	0.9396	0.9312	0.9274	0.9230	0.9211	0.9189	0.9217
1100	0.9783	0.9361	0.9319	0.9266	0.9216	0.9169	0.9214	0.9224
1150	0.9793	0.9344	0.9333	0.9230	0.9232	0.9155	0.9150	0.9124
1200	0.9801	0.9329	0.9253	0.9243	0.9177	0.9158	0.9110	0.9102
1250	0.9705	0.9314	0.9269	0.9177	0.9245	0.9126	0.9157	0.9107
1300	0.9678	0.9307	0.9203	0.9199	0.9156	0.9105	0.9112	0.9139
1350	0.9631	0.9256	0.9179	0.9202	0.9114	0.9114	0.9077	0.9107
1400	0.9600	0.9184	0.9154	0.9154	0.9100	0.9022	0.9022	0.9014
1450	0.9535	0.9166	0.9172	0.9049	0.9066	0.9048	0.9012	0.9027
1500	0.9529	0.9146	0.9108	0.9051	0.9000	0.9016	0.8970	0.8969

Figure 3.3.3-9: 0.1% ^{235}U Reflector Reactivity as a Function of Packing Fraction



C55

Table 3.3.3-10: Depleted Uranium Reflector Equivalent Parameters			
Enrichment in Depleted Uranium	Equivalent Thickness (in.)		Equivalent Packing Fraction at 24" Reflector
	100% Packing Fraction	70% Packing Fraction	
U(Natural)	0.08	0.10	1
U(0.6% ^{235}U)	0.14	0.18	1
U(0.5% ^{235}U)	0.18	0.28	2
U(0.4% ^{235}U)	0.33	0.51	3
U(0.3% ^{235}U)	0.56	0.73	5
U(0.2% ^{235}U)	0.98	1.50	34
U(0.1% ^{235}U)	1.62	20.00	68
U(0.05 % ^{235}U)	2.01	> 24	N/A
U(0.01 % ^{235}U)	2.81	> 24	N/A

3.4 Neutron Reflector Study Conclusion

The results of the preceding analyses indicate that the reactivity state for an optimally moderated fissile system containing 325 g of ^{239}Pu moderated with a polyethylene-water mixture is highly influenced by the material surrounding the fissile sphere. In particular, it is well known that beryllium oxide, beryllium, carbon and D_2O have very high reflection coefficients and must be considered when setting a fissile mass limit on a waste container. However, other materials, most notability metals such as chromium, manganese, iron, cobalt, nickel, copper, zirconium, niobium, molybdenum, lead, bismuth, vanadium, inconel, steel, etc., have relatively large reflection coefficients and therefore a large reactivity effect on the moderated fissile system. In addition, numerous compounds, such as concrete, sand, and gypsum have high reflection coefficients that increase the reactivity state of an optimally moderated fissile mixture. Finally, depleted uranium is a very reactive reflector, and must be considered when assessing the reactivity effect of various materials common to nuclear processing and operation facilities.

It is noteworthy, however, that the materials evaluated as reflectors in this study are bounded by beryllium when considering their reactivity effect on a ^{239}Pu-bearing system. Furthermore, when realistic packing fractions are taken into account for the reflector geometric configuration, the reactivity effect of most metallic reflectors as well as many of the construction materials (such as gypsum) diminishes considerably. As a result, only a few materials, namely beryllium, beryllium-based compounds, carbon, heavy water, depleted uranium at enrichments $\geq$0.3% ^{235}U, and magnesium oxide, are classified as special reflectors. The FGE limit in the TRUPACT-II package must be reduced below 325 when significant quantities of these special reflector materials are present in a form that would allow these materials to tightly surround the fissile mixture.

4. References

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APPENDIX A
Methodology For Calculating Mixture Parameters

Consider a fissile mixture containing ^{239}Pu and a moderator containing x atoms of hydrogen per molecule of moderator. By definition, the H/Pu ratio is

$$\frac{n_H}{n_{Pu}} = \left(\frac{xN_{Mod}}{N_{Pu}}\right) = \left(\frac{\frac{xC_{Mod}}{M_{Mod}}}{\frac{C_{Pu}}{M_{Pu}}}\right)$$

eq.(A-1)

where

n_α = Number density for α = Mod, Pu
N_α = Number of moles for α = Mod, Pu
C_α = Concentration (g/cc mixture) for α = Mod, Pu
M_α = Molecular weight for α = Mod, Pu

Noting that

$$C_{Mod} = \rho_{Mod}\left(1 - \frac{C_{Pu}}{\rho_{Pu}} - \sum_j \frac{C_j}{\rho_j}\right)$$

eq.(A-2)

then

$$\frac{n_H}{n_{Pu}} = \left(\frac{\frac{x\rho_{Mod}}{M_{Mod}}\left(1 - \frac{C_{Pu}}{\rho_{Pu}} - \sum_j \frac{C_j}{\rho_j}\right)}{\frac{C_{Pu}}{M_{Pu}}}\right)$$

eq.(A-3)

Here ρ_α and C_α for α = Mod, Pu, j are material densities and concentration respectively, and the j^{th} material refers to non-hydrogenous additives to the mixture. Solving for the plutonium concentration gives

$$C_{Pu} = \left(\frac{xM_{Pu}\left(\frac{\rho_{Mod}}{M_{Mod}}\right)\left(1 - \sum_j \frac{C_j}{\rho_j}\right)}{\frac{n_H}{n_{Pu}} + x\left(\frac{M_{Pu}}{\rho_{Pu}}\right)\left(\frac{\rho_{Mod}}{M_{Mod}}\right)}\right)$$

eq.(A-4)

The total mixture concentration then becomes

$$C_{Mix} = C_{Pu} + C_{Mod}$$

eq.(A-5)

The weight fractions of the ^{239}Pu and moderator in the mixture is

$$WF_{Pu} = \frac{C_{Pu}}{C_{Mix}}$$

eq.(A-6)

$$WF_{Mod} = \frac{C_{Mod}}{C_{Mix}} = \frac{\rho_{Mod}}{C_{Mix}}\left(1 - \frac{C_{Pu}}{\rho_{Pu}} - \sum_{j} \frac{C_j}{\rho_j}\right)$$

eq(A-7)

APPENDIX B
Sample Input Files

1. Bounding Moderation States With Polyethylene/Water Mixture

```
#CSAS25   PARM=SIZE=2000000
BASECASE WITH 40% WATER 60% POLY
238GROUPNDF5
INFHOMMEDIUM
ARBMBKGD 0.98259 5 0 0 1 1001  12.63324  8016   36.03079
6012  48.18131 4309   0.00000 94239   3.15466 1 1.0 293 END
H2O    2                                        1.0 293 END
END COMPOSITION
BASECASE WITH 40% WATER 60% POLY
READ PARAMETERS  NSK=50 GEN=250
END PARAMETERS
READ GEOMETRY
UNIT 1
SPHERE      1  1  13.57761
SPHERE      2  1  74.53761
END GEOMETRY
END DATA
END
```

2. Hydrocarbon Based Moderators – Paraffin at H/Pu = 850

```
#CSAS25   PARM=SIZE=2000000
HYDROCARBONS - PARAFFIN
238GROUPNDF5
INFHOMMEDIUM
ARBMBKGD 0.93559 5 0 0 1 6012  81.73847  1001   14.27698
8016   0.00000 7014  0.00000 94239   3.98455 1 1.0 293 END
H2O    2                                       1.0 293 END
END COMPOSITION
HYDROCARBONS - PARAFFIN
READ PARAMETERS  NSK=50 GEN=250
END PARAMETERS
READ GEOMETRY
UNIT 1
SPHERE      1  1  12.76763
SPHERE      2  1  73.72763
END GEOMETRY
END DATA
END
```

3. Hydrocarbon Based Moderators – Fissile Sphere with 31 Pu Spheres at H/X = 900

```
#CSAS25   PARM=SIZE=2000000
HETROGENOUS PU-POLY-WATER SYSTEM; 325 GM PU; 25% POLY PACKING FRACTION;
SPHERICAL CHUNKS.
238GROUPNDF5
INFHOMMEDIUM
ARBMPUH2O   1.07596 3 0 0 1 1001  10.34124  8016   82.04850
                           94239   7.61026 1  1.0  293 END
POLY(H2O)   2  DEN=0.923                      1.0  293 END
```

```
H2O          3  DEN=0.9981                        1.0   293 END
END COMPOSITION
HETROGENOUS PU-POLY-WATER SYSTEM; 325 GM PU; 25% POLY PACKING FRACTION;
SPHERICAL CHUNKS.
READ PARAMETERS  NSK=50 GEN=250
END PARAMETERS
READ GEOMETRY
UNIT 1
SPHERE       2  1   3.15665
UNIT 2
SPHERE       2  1   2.11317
GLOBAL
UNIT 3
SPHERE       1  1  10.80677
HOLE         1      0.00000       0.00000       0.00000
HOLE         2      8.59360       0.00000       0.00000
HOLE         2     -8.59360       0.00000       0.00000
HOLE         2      0.00000       8.59360       0.00000
HOLE         2      0.00000      -8.59360       0.00000
HOLE         2      0.00000       0.00000       8.59360
HOLE         2      0.00000       0.00000      -8.59360
HOLE         2      7.44228       4.29680       0.00000
HOLE         2      4.29680       7.44228       0.00000
HOLE         2     -7.44228       4.29680       0.00000
HOLE         2     -4.29680       7.44228       0.00000
HOLE         2     -7.44228      -4.29680       0.00000
HOLE         2     -4.29680      -7.44228       0.00000
HOLE         2      7.44228      -4.29680       0.00000
HOLE         2      4.29680      -7.44228       0.00000
HOLE         2      7.44228       0.00000       4.29680
HOLE         2      4.29680       0.00000       7.44228
HOLE         2     -7.44228       0.00000       4.29680
HOLE         2     -4.29680       0.00000       7.44228
HOLE         2     -7.44228       0.00000      -4.29680
HOLE         2     -4.29680       0.00000      -7.44228
HOLE         2      7.44228       0.00000      -4.29680
HOLE         2      4.29680       0.00000      -7.44228
HOLE         2      0.00000       7.44228       4.29680
HOLE         2      0.00000       4.29680       7.44228
HOLE         2      0.00000      -7.44228       4.29680
HOLE         2      0.00000      -4.29680       7.44228
HOLE         2      0.00000      -7.44228      -4.29680
HOLE         2      0.00000      -4.29680      -7.44228
HOLE         2      0.00000       7.44228      -4.29680
HOLE         2      0.00000       4.29680      -7.44228
SPHERE       3  1  71.76677
END GEOMETRY
END DATA
END
```

4. Hydrocarbon Based Moderators – 23x23x23 Cubic Model with 12,167 Pu Spheres at H/X = 900

```
=csas25             parm=size=700000
25% Packing Fraction, 23x23x23 cube of spheres, H/X=900
238group infhommedium
'Pu-water mixture
```

```
arbm-puh2o  1.037    3 1 0 0     94239  3.956
            1001    10.747      8016   85.297  1 end
'CH2 for poly spheres - default density of 0.93 g/cm3
poly(h2o)     2                   end
'Water at 0.9982 g/cm3 for reflector
h2o           3                   end
end comp
25% Packing Fraction, 23x23x23 cube of spheres,  H/X=900
read param nsk=50 gen=250 tme=300
end param
read geom
unit 1
com="unit cell of poly sphere surrounded by Pu/water"
sphere       2 1       0.37282
cuboid       1 1      6p0.47698
global unit 2
com="array of unit cells"
array 1 0 0 0
'Water reflector t =    24    inches
reflector    3 1    6r60.96 1
end geom
read array
ara=1 nux=23 nuy=23 nuz=23 fill f1 end fill
end array
end data
end
```

5. Inorganic Moderators – 5% Be Addition to Optimal Mixture

```
#CSAS25   PARM=SIZE=2000000
BERYLLIUM ADDED AT 5%
238GROUPNDF5
INFHOMMEDIUM
ARBMPUWP 1.05073 5 0 0 1 1001  10.55995  8016   60.01816
6012  17.83507   4309   8.80338 94239   2.78344 1 1.0 293 END
H2O    2                                          1.0 293 END
END COMPOSITION
BERYLLIUM ADDED AT 5%
READ PARAMETERS  NSK=50 GEN=250
END PARAMETERS
READ GEOMETRY
UNIT 1
SPHERE       1  1  13.84332
SPHERE       2  1  74.80332
END GEOMETRY
END DATA
END
```

6. Hydrides – ZrH_2 At H/Pu = 750

```
#CSAS25   PARM=SIZE=2000000
PU-239 MIXED WITH ZRH2
238GROUPNDF5
INFHOMMEDIUM
ARBMBKGD 5.63746 5 0 0 1 1001   2.14695  40000   97.17397
6012   0.00000 4309   0.00000 94239   0.67908 1 1.0 293 END
```

```
H2O     2                                             1.0 293 END
END COMPOSITION
PU-239 MIXED WITH ZRH2
READ PARAMETERS  NSK=50 GEN=250
END PARAMETERS
READ GEOMETRY
UNIT 1
SPHERE      1  1  12.65503
SPHERE      2  1  73.61503
END GEOMETRY
END DATA
END
```

7. Reflector Materials – 60.96 cm Thick Nickel Reflector

```
#CSAS25   PARM=SIZE=2000000
NICKEL REFLECTOR
238GROUPNDF5
INFHOMMEDIUM
ARBMBKGD 1.01451 5 0 0 1 1001  11.50907  8016   65.41253
6012  19.43807 4309   0.00000 94239   3.64033 1 1.0 293 END
NI      2                                       1.0 293 END
END COMPOSITION
NICKEL REFLECTOR
READ PARAMETERS  NSK=50 GEN=250
END PARAMETERS
READ GEOMETRY
UNIT 1
SPHERE      1  1  12.80755
SPHERE      2  1  73.76755
END GEOMETRY
END DATA
END
```

APPENDIX C
Material Densities

Table C-1: Densities of Elements Used in the Moderator and Reflector Reactivity Study*			
Element	**Density (g/cc)**	**Element**	**Density (g/cc)**
Lithium (Li)	0.534	Palladium (Pd)	12.020
Beryllium (Be)	1.850	Silver (Ag)	10.500
Boron (B)	2.370	Cadmium (Cd)	8.642
Carbon (C)	2.100	Indium (In)	7.300
Sodium (Na)	0.970	Tin (Sn)	7.310
Magnesium (Mg)	1.740	Antimony (Sb)	6.684
Aluminium (Al)	2.702	Tellurium (Te)	6.250
Silicon (Si)	2.330	Iodine (I)	4.930
Phosphorus (P)	1.820	Cesium (Cs)	1.879
Surfur (S)	2.070	Barium (Ba)	3.510
Potassium (K)	0.860	Lanthanum (La)	6.145
Calcium (Ca)	1.550	Hafnium (Hf)	13.310
Titanium (Ti)	4.500	Tantalum (Ta)	16.600
Vanadium (V)	5.960	Tungsten (W)	19.350
Chromium (Cr)	7.200	Rhenium (Re)	20.530
Manganese (Mn)	7.200	Gold (Au)	18.880
Iron (Fe)	7.860	Lead (Pb)	11.344
Cobalt (Co)	8.900	Bismuth (Bi)	9.800
Nickel (Ni)	8.900	Cerium (Ce)	6.657
Copper (Cu)	8.920	Praseodymium (Pr)	6.773
Gallium (Ga)	5.904	Neodymium (Nd)	6.800
Germanium (Ge)	5.350	Samarium (Sm)	7.520
Arsenic (As)	5.730	Europium (Eu)	5.243
Selenium (Se)	4.810	Gadolinium (Gd)	7.900
Rubidium (Rb)	1.532	Terbium (Tb)	8.229
Strontium (Sr)	2.600	Dysprosium (Dy)	8.550
Yttrium (Y)	4.469	Holmium (Ho)	8.795
Zirconium (Zr)	6.490	Erbium (Er)	9.006
Niobium (Nb)	8.570	Lutetium (Lu)	9.840
Molybdenium (Mo)	10.200	Thorium (Th)	11.700
Ruthenium (Ru)	12.300	Uranium (U)	19.050
Rhodium (Rh)	12.400	Plutonium (^{239}Pu)	19.840

* Element densities used in the analyses are taken from the *SCALE* Standard Composition Library [7]

Table C-2: Densities of Compounds Used in the Moderator and Reflector Reactivity Study	
Compound	**Density (g/cc)**
Calcium Hydride (CaH_2)	1.7000
Barium Hydride (BaH_2)	4.1600
Magnesium Hydride (MgH_2)	1.4500
Titanium Hydride (TiH_2)	3.7500
Yttrium Hydride (YH_2)	4.4300
Zirconium Hydride (ZrH_2)	5.6100
Heavy Water (D_2O)	1.1054
Beryllium Oxide (β-Beryllia: BeO)	2.6900*
Silicon Rubber ($[OSi(CH_3)_2]_n$)	1.0185
Gypsum ($CaSO_4 \cdot 2H_2O$)	2.3200
Magnesium Oxide (MgO)	3.2200
Silicon Dioxide (SiO_2)	2.3200
Salt (NaCl)	2.1650
Oak Ridge Concrete	2.2994
Inconel	8.3000
Stainless Steel 304	7.9400
Polyethylene (CH_2)	0.9230
Water (H_2O)	0.9982

* β-BeO Tetragonal [8,9]