Table 6.20 –Listing of GEMER Calculations for 46Kg Heterogeneous Cases

46 Kg Single Container Case with VFO

VFO-Name	VFO-KEFF	VFO-Sigma	K+2S	Bias	K+2S - B	VFO-Name	VFO-KEFF	VFO-Sigma	K+2S	Bias	K+2S - B
	0.200" Rods - Square Lattice						0.050" Rods - Square Lattice				
MSSL-058	0.48619	0.00111	0.48841	-0.01890	0.50731	MNSL-058	0.48231	0.00102	0.48435	-0.01890	0.50325
MSSL-100	0.60077	0.00126	0.60329	-0.01890	0.62219	MNSL-100	0.58753	0.00123	0.58999	-0.01890	0.60889
MSSL-200	0.75505	0.00141	0.75787	-0.01890	0.77677	MNSL-200	0.73674	0.00142	0.73958	-0.01890	0.75848
MSSL-300	0.82073	0.00136	0.82345	-0.01890	0.84235	MNSL-300	0.80462	0.00144	0.80750	-0.01890	0.82640
MSSL-400	0.84290	0.00145	0.84580	-0.01890	0.86470	MNSL-400	0.83281	0.00138	0.83557	-0.01890	0.85447
MSSL-410	0.84235	0.00134	0.84503	-0.01890	0.86393	MNSL-410	0.83423	0.00138	0.83699	-0.01890	0.85589
MSSL-420	0.84374	0.00143	0.84660	-0.01890	0.86550	MNSL-420	0.83788	0.00144	0.84076	-0.01890	0.85966
MSSL-430	0.84597	0.00139	0.84875	-0.01890	0.86765	MNSL-430	0.83672	0.00146	0.83964	-0.01890	0.85854
MSSL-437	0.84393	0.00149	0.84691	-0.01890	0.86581	MNSL-437	0.83735	0.00143	0.84021	-0.01890	0.85911
MSSL-440	0.84412	0.00142	0.84696	-0.01890	0.86586	MNSL-440	0.83673	0.00141	0.83955	-0.01890	0.85845
MSSL-450	**0.84629**	0.00145	0.84919	-0.01890	**0.86809**	MNSL-450	0.83798	0.00150	0.84098	-0.01890	0.85988
MSSL-460	0.84319	0.00148	0.84615	-0.01890	0.86505	MNSL-460	0.84235	0.00135	0.84505	-0.01890	0.86395
MSSL-470	0.84467	0.00145	0.84757	-0.01890	0.86647	MNSL-470	0.84190	0.00138	0.84466	-0.01890	0.86356
MSSL-480	0.84335	0.00136	0.84607	-0.01890	0.86497	MNSL-480	0.84210	0.00150	0.84510	-0.01890	0.86400
MSSL-486	0.84529	0.00139	0.84807	-0.01890	0.86697	MNSL-486	0.84403	0.00135	0.84673	-0.01890	0.86563
MSSL-490	0.84542	0.00139	0.84820	-0.01890	0.86710	MNSL-490	0.84444	0.00152	0.84748	-0.01890	0.86638
MSSL-500	0.84468	0.00147	0.84762	-0.01890	0.86652	MNSL-500	0.84320	0.00141	0.84602	-0.01890	0.86492
MSSL-520	0.84432	0.00146	0.84724	-0.01890	0.86614	MNSL-520	**0.84886**	0.00147	0.85180	-0.01890	**0.87070**
MSSL-540	0.84409	0.00135	0.84679	-0.01890	0.86569	MNSL-540	0.84611	0.00139	0.84889	-0.01890	0.86779
MSSL-544	0.84304	0.00133	0.84570	-0.01890	0.86460	MNSL-544	0.84510	0.00129	0.84768	-0.01890	0.86658
MSSL-560	0.84122	0.00156	0.84434	-0.01890	0.86324	MNSL-560	0.84461	0.00157	0.84775	-0.01890	0.86665
MSSL-600	0.83829	0.00132	0.84093	-0.01890	0.85983	MNSL-600	0.84725	0.00141	0.85007	-0.01890	0.86897
MSSL-616	0.83724	0.00135	0.83994	-0.01890	0.85884	MNSL-616	0.84444	0.00131	0.84706	-0.01890	0.86596
MSSL-700	0.81857	0.00138	0.82133	-0.01890	0.84023	MNSL-700	0.83314	0.00140	0.83594	-0.01890	0.85484
MSSL-705	0.81771	0.00116	0.82003	-0.01890	0.83893	MNSL-705	0.83321	0.00145	0.83611	-0.01890	0.85501
MSSL-800	0.79716	0.00127	0.79970	-0.01890	0.81860	MNSL-800	0.81838	0.00133	0.82104	-0.01890	0.83994
				Max	0.86809					Max	0.87070
	0.200" Rods - Triangular Lattice						0.050" Rods - Triangular Lattice				
MSTL-058	0.48770	0.00100	0.48970	-0.01890	0.50860	MNTL-058	0.47952	0.00115	0.48182	-0.01890	0.50072
MSTL-100	0.59841	0.00121	0.60083	-0.01890	0.61973	MNTL-100	0.58731	0.00132	0.58995	-0.01890	0.60885

MSTL-200	0.75817	0.00143	0.76103	-0.01890	0.77993
MSTL-300	0.81968	0.00152	0.82272	-0.01890	0.84162
MSTL-400	0.84382	0.00138	0.84658	-0.01890	0.86548
MSTL-410	0.84444	0.00148	0.84740	-0.01890	0.86630
MSTL-420	0.84529	0.00148	0.84825	-0.01890	0.86715
MSTL-430	0.84313	0.00148	0.84609	-0.01890	0.86499
MSTL-437	0.84447	0.00143	0.84733	-0.01890	0.86623
MSTL-440	0.84523	0.00129	0.84781	-0.01890	0.86671
MSTL-450	0.84515	0.00135	0.84785	-0.01890	0.86675
MSTL-460	0.84471	0.00150	0.84771	-0.01890	0.86661
MSTL-470	0.84416	0.00131	0.84678	-0.01890	0.86568
MSTL-480	0.84576	0.00131	0.84838	-0.01890	0.86728
MSTL-486	0.84832	0.00155	0.85142	-0.01890	0.87032
MSTL-490	0.84457	0.00138	0.84733	-0.01890	0.86623
MSTL-500	**0.84902**	0.00134	0.85170	-0.01890	**0.87060**
MSTL-520	0.84510	0.00149	0.84808	-0.01890	0.86698
MSTL-540	0.84382	0.00135	0.84652	-0.01890	0.86542
MSTL-544	0.84344	0.00143	0.84630	-0.01890	0.86520
MSTL-560	0.84415	0.00146	0.84707	-0.01890	0.86597
MSTL-600	0.84084	0.00133	0.84350	-0.01890	0.86240
MSTL-616	0.83578	0.00128	0.83834	-0.01890	0.85724
MSTL-700	0.81979	0.00136	0.82251	-0.01890	0.84141
MSTL-705	0.82340	0.00126	0.82592	-0.01890	0.84482
MSTL-800	0.80041	0.00128	0.80297	-0.01890	0.82187
	0.84902			Max	0.87060
				Max S&T"	0.87060

0.100" Rods - Square Lattice

MTSL-058	0.48437	0.00115	0.48667	-0.01890	0.50557
MTSL-100	0.59486	0.00123	0.59732	-0.01890	0.61622
MTSL-200	0.74634	0.00147	0.74928	-0.01890	0.76818
MTSL-300	0.81045	0.00143	0.81331	-0.01890	0.83221
MTSL-400	0.84111	0.00138	0.84387	-0.01890	0.86277
MTSL-410	0.84055	0.00133	0.84321	-0.01890	0.86211
MTSL-420	0.84461	0.00139	0.84739	-0.01890	0.86629
MTSL-430	0.84466	0.00127	0.84720	-0.01890	0.86610
MTSL-437	0.84537	0.00144	0.84825	-0.01890	0.86715

MNTL-200	0.73965	0.00140	0.74245	-0.01890	0.76135
MNTL-300	0.80406	0.00135	0.80676	-0.01890	0.82566
MNTL-400	0.83101	0.00150	0.83401	-0.01890	0.85291
MNTL-410	0.83656	0.00137	0.83930	-0.01890	0.85820
MNTL-420	0.83506	0.00153	0.83812	-0.01890	0.85702
MNTL-430	0.83766	0.00147	0.84060	-0.01890	0.85950
MNTL-437	0.83675	0.00136	0.83947	-0.01890	0.85837
MNTL-440	0.83803	0.00141	0.84085	-0.01890	0.85975
MNTL-450	0.84039	0.00138	0.84315	-0.01890	0.86205
MNTL-460	0.83914	0.00143	0.84200	-0.01890	0.86090
MNTL-470	0.84254	0.00150	0.84554	-0.01890	0.86444
MNTL-480	0.84460	0.00137	0.84734	-0.01890	0.86624
MNTL-486	0.84535	0.00138	0.84811	-0.01890	0.86701
MNTL-490	0.84268	0.00129	0.84526	-0.01890	0.86416
MNTL-500	0.84221	0.00133	0.84487	-0.01890	0.86377
MNTL-520	0.84386	0.00141	0.84668	-0.01890	0.86558
MNTL-540	0.84260	0.00141	0.84542	-0.01890	0.86432
MNTL-544	0.84529	0.00128	0.84785	-0.01890	0.86675
MNTL-560	0.84643	0.00140	0.84923	-0.01890	0.86813
MNTL-600	**0.84713**	0.00141	0.84995	-0.01890	**0.86885**
MNTL-616	0.84206	0.00138	0.84482	-0.01890	0.86372
MNTL-700	0.83241	0.00128	0.83497	-0.01890	0.85387
MNTL-705	0.83327	0.00140	0.83607	-0.01890	0.85497
MNTL-800	0.82066	0.00131	0.82328	-0.01890	0.84218
	0.84713			Max	0.86885
				Max S&T"	0.87070

0.025" Rods - Square Lattice

MESL-058	0.47690	0.00111	0.47912	-0.01890	0.49802
MESL-100	0.58435	0.00128	0.58691	-0.01890	0.60581
MESL-200	0.73050	0.00153	0.73356	-0.01890	0.75246
MESL-300	0.79411	0.00158	0.79727	-0.01890	0.81617
MESL-400	0.82429	0.00139	0.82707	-0.01890	0.84597
MESL-410	0.82417	0.00152	0.82721	-0.01890	0.84611
MESL-420	0.83070	0.00142	0.83354	-0.01890	0.85244
MESL-430	0.83316	0.00148	0.83612	-0.01890	0.85502
MESL-437	0.83162	0.00138	0.83438	-0.01890	0.85328

MTSL-440	0.84631	0.00130	0.84891	-0.01890	0.86781	MESL-440	0.83442	0.00141	0.83724	-0.01890	0.85614
MTSL-450	0.84523	0.00142	0.84807	-0.01890	0.86697	MESL-450	0.83420	0.00151	0.83722	-0.01890	0.85612
MTSL-460	0.84688	0.00133	0.84954	-0.01890	0.86844	MESL-460	0.83519	0.00133	0.83785	-0.01890	0.85675
MTSL-470	0.84710	0.00136	0.84982	-0.01890	0.86872	MESL-470	0.83568	0.00135	0.83838	-0.01890	0.85728
MTSL-480	0.84680	0.00147	0.84974	-0.01890	0.86864	MESL-480	0.83594	0.00143	0.83880	-0.01890	0.85770
MTSL-486	0.84858	0.00140	0.85138	-0.01890	0.87028	MESL-486	0.83832	0.00141	0.84114	-0.01890	0.86004
MTSL-490	0.84532	0.00126	0.84784	-0.01890	0.86674	MESL-490	0.83623	0.00138	0.83899	-0.01890	0.85789
MTSL-500	0.84727	0.00135	0.84997	-0.01890	0.86887	MESL-500	0.83853	0.00129	0.84111	-0.01890	0.86001
MTSL-520	0.85062	0.00140	0.85342	-0.01890	0.87232	MESL-520	0.83892	0.00139	0.84170	-0.01890	0.86060
MTSL-540	**0.85424**	0.00146	0.85716	-0.01890	**0.87606**	MESL-540	0.83576	0.00142	0.83860	-0.01890	0.85750
MTSL-544	0.85052	0.00141	0.85334	-0.01890	0.87224	MESL-544	0.83794	0.00148	0.84090	-0.01890	0.85980
MTSL-560	0.84946	0.00132	0.85210	-0.01890	0.87100	MESL-560	0.83988	0.00132	0.84252	-0.01890	0.86142
MTSL-600	0.85040	0.00139	0.85318	-0.01890	0.87208	MESL-600	**0.84060**	0.00133	0.84326	-0.01890	**0.86216**
MTSL-616	0.84872	0.00131	0.85134	-0.01890	0.87024	MESL-616	0.83660	0.00137	0.83934	-0.01890	0.85824
MTSL-700	0.83377	0.00144	0.83665	-0.01890	0.85555	MESL-700	0.82816	0.00143	0.83102	-0.01890	0.84992
MTSL-705	0.83436	0.00148	0.83732	-0.01890	0.85622	MESL-705	0.82778	0.00129	0.83036	-0.01890	0.84926
MTSL-800	0.81657	0.00138	0.81933	-0.01890	0.83823	MESL-800	0.81671	0.00133	0.81937	-0.01890	0.83827
				Max	0.87606					Max	0.86216
	0.100" Rods - Triangular Lattice						0.025" Rods - Triangular Lattice				
MTTL-058	0.48163	0.00119	0.48401	-0.01890	0.50291	METL-058	0.48044	0.00109	0.48262	-0.01890	0.50152
MTTL-100	0.59320	0.00136	0.59592	-0.01890	0.61482	METL-100	0.58314	0.00134	0.58582	-0.01890	0.60472
MTTL-200	0.74350	0.00138	0.74626	-0.01890	0.76516	METL-200	0.73344	0.00132	0.73608	-0.01890	0.75498
MTTL-300	0.81212	0.00137	0.81486	-0.01890	0.83376	METL-300	0.79617	0.00139	0.79895	-0.01890	0.81785
MTTL-400	0.84174	0.00156	0.84486	-0.01890	0.86376	METL-400	0.82619	0.00140	0.82899	-0.01890	0.84789
MTTL-410	0.83926	0.00139	0.84204	-0.01890	0.86094	METL-410	0.83031	0.00148	0.83327	-0.01890	0.85217
MTTL-420	0.84373	0.00145	0.84663	-0.01890	0.86553	METL-420	0.83033	0.00150	0.83333	-0.01890	0.85223
MTTL-430	0.84611	0.00139	0.84889	-0.01890	0.86779	METL-430	0.83249	0.00153	0.83555	-0.01890	0.85445
MTTL-437	0.84414	0.00146	0.84706	-0.01890	0.86596	METL-437	0.83021	0.00137	0.83295	-0.01890	0.85185
MTTL-440	0.84348	0.00153	0.84654	-0.01890	0.86544	METL-440	0.83166	0.00141	0.83448	-0.01890	0.85338
MTTL-450	0.84514	0.00138	0.84790	-0.01890	0.86680	METL-450	0.83260	0.00137	0.83534	-0.01890	0.85424
MTTL-460	0.84780	0.00135	0.85050	-0.01890	0.86940	METL-460	0.83529	0.00140	0.83809	-0.01890	0.85699
MTTL-470	0.85112	0.00150	0.85412	-0.01890	0.87302	METL-470	0.83717	0.00151	0.84019	-0.01890	0.85909
MTTL-480	0.84924	0.00144	0.85212	-0.01890	0.87102	METL-480	0.83559	0.00137	0.83833	-0.01890	0.85723
MTTL-486	0.84843	0.00131	0.85105	-0.01890	0.86995	METL-486	0.83568	0.00145	0.83858	-0.01890	0.85748
MTTL-490	0.84911	0.00142	0.85195	-0.01890	0.87085	METL-490	0.83489	0.00141	0.83771	-0.01890	0.85661
MTTL-500	0.84786	0.00139	0.85064	-0.01890	0.86954	METL-500	0.83764	0.00134	0.84032	-0.01890	0.85922

MTTL-520	0.84861	0.00138	0.85137	-0.01890	0.87027	METL-520	0.83992	0.00143	0.84278	-0.01890	0.86168
MTTL-540	0.84927	0.00133	0.85193	-0.01890	0.87083	METL-540	0.83954	0.00139	0.84232	-0.01890	0.86122
MTTL-544	0.84917	0.00138	0.85193	-0.01890	0.87083	METL-544	0.84027	0.00142	0.84311	-0.01890	0.86201
MTTL-560	0.84723	0.00153	0.85029	-0.01890	0.86919	METL-560	**0.84035**	0.00141	0.84317	-0.01890	**0.86207**
MTTL-600	**0.85120**	0.00146	0.85412	-0.01890	**0.87302**	METL-600	0.83823	0.00146	0.84115	-0.01890	0.86005
MTTL-616	0.84365	0.00144	0.84653	-0.01890	0.86543	METL-616	0.83826	0.00131	0.84088	-0.01890	0.85978
MTTL-700	0.83327	0.00136	0.83599	-0.01890	0.85489	METL-700	0.82743	0.00145	0.83033	-0.01890	0.84923
MTTL-705	0.83370	0.00133	0.83636	-0.01890	0.85526	METL-705	0.82801	0.00147	0.83095	-0.01890	0.84985
MTTL-800	0.81712	0.00137	0.81986	-0.01890	0.83876	METL-800	0.81311	0.00138	0.81587	-0.01890	0.83477
				Max	0.87302					Max	0.86207
				Max S&T	0.87606					Max S&T	0.86216

46 Kg Undamaged Array Cases with VFO

VFO-Name	VFO-KEFF	VFO-Sigma	K+2S	Bias	K+2S - B	VFO-Name	VFO-KEFF	VFO-Sigma	K+2S	Bias	K+2S - B
	0.200" Rods - Square Lattice						0.050" Rods - Square Lattice				
AASL-058	0.54593	0.00120	0.54833	-0.01890	0.56723	ACSL-058	0.53983	0.00108	0.54199	-0.01890	0.56089
AASL-100	0.65994	0.00125	0.66244	-0.01890	0.68134	ACSL-100	0.64692	0.00125	0.64942	-0.01890	0.66832
AASL-200	0.80791	0.00133	0.81057	-0.01890	0.82947	ACSL-200	0.79021	0.00136	0.79293	-0.01890	0.81183
AASL-300	0.86836	0.00142	0.87120	-0.01890	0.89010	ACSL-300	0.85219	0.00149	0.85517	-0.01890	0.87407
AASL-400	0.88524	0.00140	0.88804	-0.01890	0.90694	ACSL-400	0.87856	0.00146	0.88148	-0.01890	0.90038
AASL-410	0.88709	0.00132	0.88973	-0.01890	0.90863	ACSL-410	0.87622	0.00124	0.87870	-0.01890	0.89760
AASL-420	0.88632	0.00140	0.88912	-0.01890	0.90802	ACSL-420	0.88162	0.00144	0.88450	-0.01890	0.90340
AASL-430	0.88711	0.00135	0.88981	-0.01890	0.90871	ACSL-430	0.88211	0.00126	0.88463	-0.01890	0.90353
AASL-437	0.88789	0.00136	0.89061	-0.01890	0.90951	ACSL-437	0.88395	0.00137	0.88669	-0.01890	0.90559
AASL-440	0.88599	0.00140	0.88879	-0.01890	0.90769	ACSL-440	0.88235	0.00129	0.88493	-0.01890	0.90383
AASL-450	0.88886	0.00134	0.89154	-0.01890	0.91044	ACSL-450	0.88119	0.00143	0.88405	-0.01890	0.90295
AASL-460	0.88685	0.00141	0.88967	-0.01890	0.90857	ACSL-460	0.88503	0.00137	0.88777	-0.01890	0.90667
AASL-470	0.88539	0.00135	0.88809	-0.01890	0.90699	ACSL-470	0.88300	0.00138	0.88576	-0.01890	0.90466
AASL-480	0.88736	0.00139	0.89014	-0.01890	0.90904	ACSL-480	0.88638	0.00145	0.88928	-0.01890	0.90818
AASL-486	**0.88897**	0.00142	0.89181	-0.01890	**0.91071**	ACSL-486	0.88367	0.00136	0.88639	-0.01890	0.90529
AASL-490	0.88791	0.00142	0.89075	-0.01890	0.90965	ACSL-490	0.88359	0.00136	0.88631	-0.01890	0.90521
AASL-500	0.88600	0.00135	0.88870	-0.01890	0.90760	ACSL-500	0.88610	0.00124	0.88858	-0.01890	0.90748
AASL-520	0.88485	0.00128	0.88741	-0.01890	0.90631	ACSL-520	0.88615	0.00124	0.88863	-0.01890	0.90753
AASL-540	0.87942	0.00131	0.88204	-0.01890	0.90094	ACSL-540	0.88595	0.00141	0.88877	-0.01890	0.90767
AASL-544	0.88304	0.00132	0.88568	-0.01890	0.90458	ACSL-544	0.88777	0.00144	0.89065	-0.01890	0.90955

AASL-560	0.88326	0.00135	0.88596	-0.01890	0.90486
AASL-600	0.87907	0.00127	0.88161	-0.01890	0.90051
AASL-616	0.87446	0.00124	0.87694	-0.01890	0.89584
AASL-700	0.85746	0.00135	0.86016	-0.01890	0.87906
AASL-705	0.85548	0.00125	0.85798	-0.01890	0.87688
AASL-800	0.83608	0.00142	0.83892	-0.01890	0.85782
				Max	0.91071

0.200" Rods - Triangular Lattice

AATL-058	0.54722	0.00108	0.54938	-0.01890	0.56828
AATL-100	0.66350	0.00118	0.66586	-0.01890	0.68476
AATL-200	0.80727	0.00139	0.81005	-0.01890	0.82895
AATL-300	0.86486	0.00137	0.86760	-0.01890	0.88650
AATL-400	0.88568	0.00137	0.88842	-0.01890	0.90732
AATL-410	0.88722	0.00130	0.88982	-0.01890	0.90872
AATL-420	0.88735	0.00150	0.89035	-0.01890	0.90925
AATL-430	0.88620	0.00138	0.88896	-0.01890	0.90786
AATL-437	**0.89076**	0.00145	0.89366	-0.01890	**0.91256**
AATL-440	0.88880	0.00139	0.89158	-0.01890	0.91048
AATL-450	0.88957	0.00130	0.89217	-0.01890	0.91107
AATL-460	0.88933	0.00133	0.89199	-0.01890	0.91089
AATL-470	0.88786	0.00135	0.89056	-0.01890	0.90946
AATL-480	0.88969	0.00142	0.89253	-0.01890	0.91143
AATL-486	0.88631	0.00136	0.88903	-0.01890	0.90793
AATL-490	0.88677	0.00146	0.88969	-0.01890	0.90859
AATL-500	0.88788	0.00139	0.89066	-0.01890	0.90956
AATL-520	0.88567	0.00133	0.88833	-0.01890	0.90723
AATL-540	0.88408	0.00148	0.88704	-0.01890	0.90594
AATL-544	0.88578	0.00133	0.88844	-0.01890	0.90734
AATL-560	0.88247	0.00137	0.88521	-0.01890	0.90411
AATL-600	0.88003	0.00151	0.88305	-0.01890	0.90195
AATL-616	0.87572	0.00138	0.87848	-0.01890	0.89738
AATL-700	0.85787	0.00122	0.86031	-0.01890	0.87921
AATL-705	0.85653	0.00135	0.85923	-0.01890	0.87813
AATL-800	0.83850	0.00117	0.84084	-0.01890	0.85974
				Max	0.91256
				Max S&T	0.91256

ACSL-560	**0.88834**	0.00138	0.89110	-0.01890	**0.91000**
ACSL-600	0.88641	0.00130	0.88901	-0.01890	0.90791
ACSL-616	0.88528	0.00141	0.88810	-0.01890	0.90700
ACSL-700	0.87351	0.00128	0.87607	-0.01890	0.89497
ACSL-705	0.87336	0.00138	0.87612	-0.01890	0.89502
ACSL-800	0.85578	0.00123	0.85824	-0.01890	0.87714
				Max	0.91000

0.050" Rods - Triangular Lattice

ACTL-058	0.53669	0.00119	0.53907	-0.01890	0.55797
ACTL-100	0.64866	0.00140	0.65146	-0.01890	0.67036
ACTL-200	0.79045	0.00134	0.79313	-0.01890	0.81203
ACTL-300	0.85219	0.00137	0.85493	-0.01890	0.87383
ACTL-400	0.87917	0.00148	0.88213	-0.01890	0.90103
ACTL-410	0.87789	0.00122	0.88033	-0.01890	0.89923
ACTL-420	0.87821	0.00142	0.88105	-0.01890	0.89995
ACTL-430	0.87912	0.00147	0.88206	-0.01890	0.90096
ACTL-437	0.88496	0.00135	0.88766	-0.01890	0.90656
ACTL-440	0.88078	0.00149	0.88376	-0.01890	0.90266
ACTL-450	0.88408	0.00133	0.88674	-0.01890	0.90564
ACTL-460	0.88684	0.00136	0.88956	-0.01890	0.90846
ACTL-470	0.88550	0.00144	0.88838	-0.01890	0.90728
ACTL-480	0.88689	0.00146	0.88981	-0.01890	0.90871
ACTL-486	0.88435	0.00126	0.88687	-0.01890	0.90577
ACTL-490	0.88347	0.00142	0.88631	-0.01890	0.90521
ACTL-500	0.88531	0.00142	0.88815	-0.01890	0.90705
ACTL-520	0.88653	0.00133	0.88919	-0.01890	0.90809
ACTL-540	0.88606	0.00127	0.88860	-0.01890	0.90750
ACTL-544	0.88548	0.00139	0.88826	-0.01890	0.90716
ACTL-560	0.88624	0.00140	0.88904	-0.01890	0.90794
ACTL-600	**0.88882**	0.00126	0.89134	-0.01890	**0.91024**
ACTL-616	0.88570	0.00131	0.88832	-0.01890	0.90722
ACTL-700	0.87278	0.00128	0.87534	-0.01890	0.89424
ACTL-705	0.87322	0.00136	0.87594	-0.01890	0.89484
ACTL-800	0.85659	0.00131	0.85921	-0.01890	0.87811
				Max	0.91024
				Max S&T	0.91024

0.100" Rods - Square Lattice

ABSL-058	0.54036	0.00127	0.54290	-0.01890	0.56180
ABSL-100	0.65354	0.00116	0.65586	-0.01890	0.67476
ABSL-200	0.79634	0.00130	0.79894	-0.01890	0.81784
ABSL-300	0.85897	0.00140	0.86177	-0.01890	0.88067
ABSL-400	0.88468	0.00133	0.88734	-0.01890	0.90624
ABSL-410	0.88495	0.00150	0.88795	-0.01890	0.90685
ABSL-420	0.88756	0.00138	0.89032	-0.01890	0.90922
ABSL-430	0.88636	0.00137	0.88910	-0.01890	0.90800
ABSL-437	0.88741	0.00144	0.89029	-0.01890	0.90919
ABSL-440	0.88751	0.00129	0.89009	-0.01890	0.90899
ABSL-450	0.88759	0.00154	0.89067	-0.01890	0.90957
ABSL-460	0.89134	0.00149	0.89432	-0.01890	0.91322
ABSL-470	0.88864	0.00127	0.89118	-0.01890	0.91008
ABSL-480	0.89296	0.00142	0.89580	-0.01890	0.91470
ABSL-486	0.88909	0.00131	0.89171	-0.01890	0.91061
ABSL-490	0.88933	0.00131	0.89195	-0.01890	0.91085
ABSL-500	0.89107	0.00127	0.89361	-0.01890	0.91251
ABSL-520	**0.89600**	0.00133	0.89866	-0.01890	**0.91756**
ABSL-540	0.89228	0.00133	0.89494	-0.01890	0.91384
ABSL-544	0.89281	0.00139	0.89559	-0.01890	0.91449
ABSL-560	0.89142	0.00132	0.89406	-0.01890	0.91296
ABSL-600	0.88925	0.00141	0.89207	-0.01890	0.91097
ABSL-616	0.88897	0.00136	0.89169	-0.01890	0.91059
ABSL-700	0.87214	0.00132	0.87478	-0.01890	0.89368
ABSL-705	0.87297	0.00123	0.87543	-0.01890	0.89433
ABSL-800	0.85544	0.00129	0.85802	-0.01890	0.87692
				Max	0.91756

0.025" Rods - Square Lattice

ADSL-058	0.53699	0.00112	0.53923	-0.01890	0.55813
ADSL-100	0.64626	0.00131	0.64888	-0.01890	0.66778
ADSL-200	0.78685	0.00148	0.78981	-0.01890	0.80871
ADSL-300	0.84212	0.00140	0.84492	-0.01890	0.86382
ADSL-400	0.87205	0.00145	0.87495	-0.01890	0.89385
ADSL-410	0.87301	0.00145	0.87591	-0.01890	0.89481
ADSL-420	0.87462	0.00132	0.87726	-0.01890	0.89616
ADSL-430	0.87263	0.00137	0.87537	-0.01890	0.89427
ADSL-437	0.87525	0.00133	0.87791	-0.01890	0.89681
ADSL-440	0.87536	0.00137	0.87810	-0.01890	0.89700
ADSL-450	0.87542	0.00140	0.87822	-0.01890	0.89712
ADSL-460	0.87698	0.00144	0.87986	-0.01890	0.89876
ADSL-470	0.87973	0.00126	0.88225	-0.01890	0.90115
ADSL-480	0.87690	0.00140	0.87970	-0.01890	0.89860
ADSL-486	0.87837	0.00140	0.88117	-0.01890	0.90007
ADSL-490	0.87836	0.00137	0.88110	-0.01890	0.90000
ADSL-500	0.87640	0.00134	0.87908	-0.01890	0.89798
ADSL-520	0.88081	0.00137	0.88355	-0.01890	0.90245
ADSL-540	0.87885	0.00135	0.88155	-0.01890	0.90045
ADSL-544	0.88052	0.00145	0.88342	-0.01890	0.90232
ADSL-560	**0.88223**	0.00135	0.88493	-0.01890	**0.90383**
ADSL-600	0.87829	0.00141	0.88111	-0.01890	0.90001
ADSL-616	0.88050	0.00141	0.88332	-0.01890	0.90222
ADSL-700	0.86499	0.00134	0.86767	-0.01890	0.88657
ADSL-705	0.86636	0.00129	0.86894	-0.01890	0.88784
ADSL-800	0.85027	0.00127	0.85281	-0.01890	0.87171
				Max	0.90383

0.100" Rods - Triangular Lattice

ABTL-058	0.54080	0.00106	0.54292	-0.01890	0.56182
ABTL-100	0.65154	0.00132	0.65418	-0.01890	0.67308
ABTL-200	0.79916	0.00150	0.80216	-0.01890	0.82106
ABTL-300	0.86231	0.00145	0.86521	-0.01890	0.88411
ABTL-400	0.88693	0.00142	0.88977	-0.01890	0.90867
ABTL-410	0.88416	0.00146	0.88708	-0.01890	0.90598
ABTL-420	0.88603	0.00133	0.88869	-0.01890	0.90759

0.025" Rods - Triangular Lattice

ADTL-058	0.53490	0.00120	0.53730	-0.01890	0.55620
ADTL-100	0.64439	0.00124	0.64687	-0.01890	0.66577
ADTL-200	0.78703	0.00140	0.78983	-0.01890	0.80873
ADTL-300	0.84284	0.00137	0.84558	-0.01890	0.86448
ADTL-400	0.87114	0.00133	0.87380	-0.01890	0.89270
ADTL-410	0.87076	0.00140	0.87356	-0.01890	0.89246
ADTL-420	0.87084	0.00141	0.87366	-0.01890	0.89256

ABTL-430	0.88804	0.00144	0.89092	-0.01890	0.90982	ADTL-430	0.87458	0.00127	0.87712	-0.01890	0.89602
ABTL-437	0.89131	0.00131	0.89393	-0.01890	0.91283	ADTL-437	0.87391	0.00145	0.87681	-0.01890	0.89571
ABTL-440	0.88908	0.00135	0.89178	-0.01890	0.91068	ADTL-440	0.87581	0.00142	0.87865	-0.01890	0.89755
ABTL-450	0.88723	0.00130	0.88983	-0.01890	0.90873	ADTL-450	0.87647	0.00139	0.87925	-0.01890	0.89815
ABTL-460	0.89073	0.00144	0.89361	-0.01890	0.91251	ADTL-460	0.87906	0.00122	0.88150	-0.01890	0.90040
ABTL-470	0.89110	0.00141	0.89392	-0.01890	0.91282	ADTL-470	0.88089	0.00139	0.88367	-0.01890	0.90257
ABTL-480	0.88989	0.00143	0.89275	-0.01890	0.91165	ADTL-480	0.87745	0.00134	0.88013	-0.01890	0.89903
ABTL-486	0.88989	0.00137	0.89263	-0.01890	0.91153	ADTL-486	0.88112	0.00144	0.88400	-0.01890	0.90290
ABTL-490	**0.89307**	0.00152	0.89611	-0.01890	**0.91501**	ADTL-490	0.87697	0.00132	0.87961	-0.01890	0.89851
ABTL-500	0.88913	0.00137	0.89187	-0.01890	0.91077	ADTL-500	0.87801	0.00148	0.88097	-0.01890	0.89987
ABTL-520	0.89038	0.00137	0.89312	-0.01890	0.91202	ADTL-520	0.88147	0.00138	0.88423	-0.01890	0.90313
ABTL-540	0.89299	0.00136	0.89571	-0.01890	0.91461	ADTL-540	0.88127	0.00147	0.88421	-0.01890	0.90311
ABTL-544	0.89054	0.00136	0.89326	-0.01890	0.91216	ADTL-544	**0.88161**	0.00152	0.88465	-0.01890	**0.90355**
ABTL-560	0.88812	0.00132	0.89076	-0.01890	0.90966	ADTL-560	0.87924	0.00136	0.88196	-0.01890	0.90086
ABTL-600	0.89083	0.00126	0.89335	-0.01890	0.91225	ADTL-600	0.87964	0.00137	0.88238	-0.01890	0.90128
ABTL-616	0.88224	0.00137	0.88498	-0.01890	0.90388	ADTL-616	0.88068	0.00150	0.88368	-0.01890	0.90258
ABTL-700	0.87672	0.00137	0.87946	-0.01890	0.89836	ADTL-700	0.86849	0.00138	0.87125	-0.01890	0.89015
ABTL-705	0.87357	0.00128	0.87613	-0.01890	0.89503	ADTL-705	0.86826	0.00143	0.87112	-0.01890	0.89002
ABTL-800	0.85460	0.00132	0.85724	-0.01890	0.87614	ADTL-800	0.85202	0.00143	0.85488	-0.01890	0.87378
				Max	0.91501					Max	0.90355
				Max S&T	0.91756					Max S&T	0.90383

46 Kg Damaged Array Cases with VFO

VFO-Name	VFO-KEFF	VFO-Sigma	K+2S	Bias	K+2S - B	VFO-Name	VFO-KEFF	VFO-Sigma	K+2S	Bias	K+2S - B
	0.200" Rods - Square Lattice						0.050" Rods - Square Lattice				
AS46-058	0.50171	0.00100	0.50371	-0.01890	0.52261	CS46-058	0.49184	0.00106	0.49396	-0.01890	0.51286
AS46-100	0.62810	0.00126	0.63062	-0.01890	0.64952	CS46-100	0.61395	0.00126	0.61647	-0.01890	0.63537
AS46-200	0.80113	0.00141	0.80395	-0.01890	0.82285	CS46-200	0.78329	0.00130	0.78589	-0.01890	0.80479
AS46-300	0.87626	0.00144	0.87914	-0.01890	0.89804	CS46-300	0.85964	0.00146	0.86256	-0.01890	0.88146
AS46-400	0.90300	0.00139	0.90578	-0.01890	0.92468	CS46-400	0.89626	0.00132	0.89890	-0.01890	0.91780
AS46-410	0.90190	0.00137	0.90464	-0.01890	0.92354	CS46-410	0.89734	0.00137	0.90008	-0.01890	0.91898
AS46-420	0.90563	0.00133	0.90829	-0.01890	0.92719	CS46-420	0.90139	0.00137	0.90413	-0.01890	0.92303
AS46-430	0.90621	0.00132	0.90885	-0.01890	0.92775	CS46-430	0.90192	0.00151	0.90494	-0.01890	0.92384
AS46-437	0.90726	0.00135	0.90996	-0.01890	0.92886	CS46-437	0.90185	0.00136	0.90457	-0.01890	0.92347
AS46-440	0.90861	0.00146	0.91153	-0.01890	0.93043	CS46-440	0.90358	0.00158	0.90674	-0.01890	0.92564

AS46-450	0.90806	0.00139	0.91084	-0.01890	0.92974
AS46-460	0.91216	0.00147	0.91510	-0.01890	0.93400
AS46-470	0.91223	0.00133	0.91489	-0.01890	0.93379
AS46-480	0.91407	0.00126	0.91659	-0.01890	0.93549
AS46-486	0.91351	0.00146	0.91643	-0.01890	0.93533
AS46-490	0.91354	0.00139	0.91632	-0.01890	0.93522
AS46-500	0.91610	0.00139	0.91888	-0.01890	0.93778
AS46-520	0.91215	0.00133	0.91481	-0.01890	0.93371
AS46-540	**0.91869**	0.00129	0.92127	-0.01890	**0.94017**
AS46-544	0.91716	0.00146	0.92008	-0.01890	0.93898
AS46-560	0.91545	0.00143	0.91831	-0.01890	0.93721
AS46-600	0.91627	0.00138	0.91903	-0.01890	0.93793
AS46-616	0.91354	0.00130	0.91614	-0.01890	0.93504
AS46-700	0.89348	0.00126	0.89600	-0.01890	0.91490
AS46-705	0.89050	0.00136	0.89322	-0.01890	0.91212
AS46-800	0.86881	0.00126	0.87133	-0.01890	0.89023
				Max	0.94017
	0.200" Rods - Triangular Lattice				
AT46-058	0.50051	0.00110	0.50271	-0.01890	0.52161
AT46-100	0.62918	0.00125	0.63168	-0.01890	0.65058
AT46-200	0.79906	0.00153	0.80212	-0.01890	0.82102
AT46-300	0.87492	0.00130	0.87752	-0.01890	0.89642
AT46-400	0.90489	0.00142	0.90773	-0.01890	0.92663
AT46-410	0.90654	0.00131	0.90916	-0.01890	0.92806
AT46-420	0.90731	0.00134	0.90999	-0.01890	0.92889
AT46-430	0.90938	0.00136	0.91210	-0.01890	0.93100
AT46-437	0.91126	0.00146	0.91418	-0.01890	0.93308
AT46-440	0.91122	0.00136	0.91394	-0.01890	0.93284
AT46-450	0.90899	0.00134	0.91167	-0.01890	0.93057
AT46-460	0.91345	0.00129	0.91603	-0.01890	0.93493
AT46-470	0.91224	0.00140	0.91504	-0.01890	0.93394
AT46-480	0.91637	0.00134	0.91905	-0.01890	0.93795
AT46-486	0.91346	0.00124	0.91594	-0.01890	0.93484
AT46-490	0.91146	0.00141	0.91428	-0.01890	0.93318
AT46-500	**0.91880**	0.00130	0.92140	-0.01890	**0.94030**
AT46-520	0.91821	0.00124	0.92069	-0.01890	0.93959

CS46-450	0.90615	0.00139	0.90893	-0.01890	0.92783
CS46-460	0.91003	0.00137	0.91277	-0.01890	0.93167
CS46-470	0.91053	0.00133	0.91319	-0.01890	0.93209
CS46-480	0.91116	0.00128	0.91372	-0.01890	0.93262
CS46-486	0.91188	0.00143	0.91474	-0.01890	0.93364
CS46-490	0.91540	0.00144	0.91828	-0.01890	0.93718
CS46-500	0.91274	0.00135	0.91544	-0.01890	0.93434
CS46-520	0.91540	0.00134	0.91808	-0.01890	0.93698
CS46-540	0.91646	0.00146	0.91938	-0.01890	0.93828
CS46-544	0.92135	0.00116	0.92367	-0.01890	0.94257
CS46-560	0.91886	0.00130	0.92146	-0.01890	0.94036
CS46-600	0.92084	0.00128	0.92340	-0.01890	0.94230
CS46-616	**0.92402**	0.00128	0.92658	-0.01890	**0.94548**
CS46-700	0.90783	0.00132	0.91047	-0.01890	0.92937
CS46-705	0.91150	0.00119	0.91388	-0.01890	0.93278
CS46-800	0.89121	0.00140	0.89401	-0.01890	0.91291
				Max	0.94548
	0.050" Rods - Triangular Lattice				
CT46-058	0.49205	0.00111	0.49427	-0.01890	0.51317
CT46-100	0.61648	0.00124	0.61896	-0.01890	0.63786
CT46-200	0.78563	0.00153	0.78869	-0.01890	0.80759
CT46-300	0.85624	0.00137	0.85898	-0.01890	0.87788
CT46-400	0.89577	0.00138	0.89853	-0.01890	0.91743
CT46-410	0.89991	0.00150	0.90291	-0.01890	0.92181
CT46-420	0.90211	0.00138	0.90487	-0.01890	0.92377
CT46-430	0.90127	0.00145	0.90417	-0.01890	0.92307
CT46-437	0.90211	0.00150	0.90511	-0.01890	0.92401
CT46-440	0.90598	0.00147	0.90892	-0.01890	0.92782
CT46-450	0.90840	0.00135	0.91110	-0.01890	0.93000
CT46-460	0.90581	0.00142	0.90865	-0.01890	0.92755
CT46-470	0.91036	0.00147	0.91330	-0.01890	0.93220
CT46-480	0.91399	0.00135	0.91669	-0.01890	0.93559
CT46-486	0.91129	0.00131	0.91391	-0.01890	0.93281
CT46-490	0.91173	0.00127	0.91427	-0.01890	0.93317
CT46-500	0.91332	0.00126	0.91584	-0.01890	0.93474
CT46-520	0.91715	0.00140	0.91995	-0.01890	0.93885

AT46-540	0.91661	0.00125	0.91911	-0.01890	0.93801
AT46-544	0.91744	0.00135	0.92014	-0.01890	0.93904
AT46-560	0.91850	0.00142	0.92134	-0.01890	0.94024
AT46-600	0.91727	0.00133	0.91993	-0.01890	0.93883
AT46-616	0.91347	0.00135	0.91617	-0.01890	0.93507
AT46-700	0.89630	0.00133	0.89896	-0.01890	0.91786
AT46-705	0.89717	0.00130	0.89977	-0.01890	0.91867
AT46-800	0.87171	0.00120	0.87411	-0.01890	0.89301
				Max	0.94030
	0.100" Rods - Square Lattice			Max S&T	0.94030
BS46-058	0.49777	0.00120	0.50017	-0.01890	0.51907
BS46-100	0.61721	0.00122	0.61965	-0.01890	0.63855
BS46-200	0.79010	0.00150	0.79310	-0.01890	0.81200
BS46-300	0.86631	0.00150	0.86931	-0.01890	0.88821
BS46-400	0.90117	0.00143	0.90403	-0.01890	0.92293
BS46-410	0.90869	0.00132	0.91133	-0.01890	0.93023
BS46-420	0.90813	0.00139	0.91091	-0.01890	0.92981
BS46-430	0.90713	0.00129	0.90971	-0.01890	0.92861
BS46-437	0.91223	0.00137	0.91497	-0.01890	0.93387
BS46-440	0.91027	0.00147	0.91321	-0.01890	0.93211
BS46-450	0.91214	0.00151	0.91516	-0.01890	0.93406
BS46-460	0.91283	0.00146	0.91575	-0.01890	0.93465
BS46-470	0.91338	0.00130	0.91598	-0.01890	0.93488
BS46-480	0.91587	0.00145	0.91877	-0.01890	0.93767
BS46-486	0.91836	0.00142	0.92120	-0.01890	0.94010
BS46-490	0.91963	0.00126	0.92215	-0.01890	0.94105
BS46-500	0.91776	0.00133	0.92042	-0.01890	0.93932
BS46-520	0.92090	0.00139	0.92368	-0.01890	0.94258
BS46-540	0.92026	0.00127	0.92280	-0.01890	0.94170
BS46-544	0.92346	0.00125	0.92596	-0.01890	0.94486
BS46-560	0.92184	0.00133	0.92450	-0.01890	0.94340
BS46-600	**0.92574**	0.00128	0.92830	-0.01890	**0.94720**
BS46-616	0.92539	0.00131	0.92801	-0.01890	0.94691
BS46-700	0.90749	0.00139	0.91027	-0.01890	0.92917
BS46-705	0.90659	0.00123	0.90905	-0.01890	0.92795
BS46-800	0.89039	0.00112	0.89263	-0.01890	0.91153

CT46-540	0.91562	0.00136	0.91834	-0.01890	0.93724
CT46-544	0.91865	0.00134	0.92133	-0.01890	0.94023
CT46-560	0.92192	0.00131	0.92454	-0.01890	0.94344
CT46-600	0.92321	0.00127	0.92575	-0.01890	0.94465
CT46-616	**0.92449**	0.00131	0.92711	-0.01890	**0.94601**
CT46-700	0.90962	0.00129	0.91220	-0.01890	0.93110
CT46-705	0.91095	0.00133	0.91361	-0.01890	0.93251
CT46-800	0.89150	0.00125	0.89400	-0.01890	0.91290
				Max	0.94601
	0.025" Rods - Square Lattice			Max S&T	0.94601
DS46-058	0.49300	0.00103	0.49506	-0.01890	0.51396
DS46-100	0.61111	0.00125	0.61361	-0.01890	0.63251
DS46-200	0.77565	0.00144	0.77853	-0.01890	0.79743
DS46-300	0.85460	0.00141	0.85742	-0.01890	0.87632
DS46-400	0.89155	0.00135	0.89425	-0.01890	0.91315
DS46-410	0.89367	0.00129	0.89625	-0.01890	0.91515
DS46-420	0.89318	0.00156	0.89630	-0.01890	0.91520
DS46-430	0.89375	0.00140	0.89655	-0.01890	0.91545
DS46-437	0.89626	0.00142	0.89910	-0.01890	0.91800
DS46-440	0.89656	0.00154	0.89964	-0.01890	0.91854
DS46-450	0.89559	0.00127	0.89813	-0.01890	0.91703
DS46-460	0.90060	0.00142	0.90344	-0.01890	0.92234
DS46-470	0.90146	0.00124	0.90394	-0.01890	0.92284
DS46-480	0.90077	0.00135	0.90347	-0.01890	0.92237
DS46-486	0.90360	0.00130	0.90620	-0.01890	0.92510
DS46-490	0.90409	0.00124	0.90657	-0.01890	0.92547
DS46-500	0.90599	0.00148	0.90895	-0.01890	0.92785
DS46-520	0.90756	0.00132	0.91020	-0.01890	0.92910
DS46-540	0.90963	0.00127	0.91217	-0.01890	0.93107
DS46-544	0.91374	0.00135	0.91644	-0.01890	0.93534
DS46-560	0.91439	0.00135	0.91709	-0.01890	0.93599
DS46-600	0.91625	0.00130	0.91885	-0.01890	0.93775
DS46-616	**0.91810**	0.00124	0.92058	-0.01890	**0.93948**
DS46-700	0.90290	0.00137	0.90564	-0.01890	0.92454
DS46-705	0.90094	0.00134	0.90362	-0.01890	0.92252
DS46-800	0.88750	0.00142	0.89034	-0.01890	0.90924

				Max	0.94720
	0.100" Rods - Triangular Lattice				
BT46-058	0.49500	0.00114	0.49728	-0.01890	0.51618
BT46-100	0.62308	0.00132	0.62572	-0.01890	0.64462
BT46-200	0.79157	0.00134	0.79425	-0.01890	0.81315
BT46-300	0.86788	0.00148	0.87084	-0.01890	0.88974
BT46-400	0.90064	0.00148	0.90360	-0.01890	0.92250
BT46-410	0.90207	0.00134	0.90475	-0.01890	0.92365
BT46-420	0.90738	0.00135	0.91008	-0.01890	0.92898
BT46-430	0.90859	0.00131	0.91121	-0.01890	0.93011
BT46-437	0.91270	0.00143	0.91556	-0.01890	0.93446
BT46-440	0.91105	0.00142	0.91389	-0.01890	0.93279
BT46-450	0.91088	0.00143	0.91374	-0.01890	0.93264
BT46-460	0.91521	0.00150	0.91821	-0.01890	0.93711
BT46-470	0.92015	0.00138	0.92291	-0.01890	0.94181
BT46-480	0.92026	0.00133	0.92292	-0.01890	0.94182
BT46-486	0.91702	0.00131	0.91964	-0.01890	0.93854
BT46-490	0.91882	0.00148	0.92178	-0.01890	0.94068
BT46-500	0.91897	0.00129	0.92155	-0.01890	0.94045
BT46-520	0.92161	0.00136	0.92433	-0.01890	0.94323
BT46-540	0.92381	0.00128	0.92637	-0.01890	0.94527
BT46-544	0.92260	0.00127	0.92514	-0.01890	0.94404
BT46-560	0.92469	0.00125	0.92719	-0.01890	0.94609
BT46-600	**0.92768**	0.00050	0.92868	-0.01890	**0.94758**
BT46-616	0.92214	0.00144	0.92502	-0.01890	0.94392
BT46-700	0.91188	0.00130	0.91448	-0.01890	0.93338
BT46-705	0.91012	0.00129	0.91270	-0.01890	0.93160
BT46-800	0.89305	0.00128	0.89561	-0.01890	0.91451
				Max	0.94758
				Max S&T	0.94758

				Max	0.93948
	0.025" Rods - Triangular Lattice				
DT46-058	0.49178	0.00107	0.49392	-0.01890	0.51282
DT46-100	0.61219	0.00134	0.61487	-0.01890	0.63377
DT46-200	0.77807	0.00152	0.78111	-0.01890	0.80001
DT46-300	0.85316	0.00147	0.85610	-0.01890	0.87500
DT46-400	0.88709	0.00143	0.88995	-0.01890	0.90885
DT46-410	0.88856	0.00143	0.89142	-0.01890	0.91032
DT46-420	0.89277	0.00136	0.89549	-0.01890	0.91439
DT46-430	0.89611	0.00151	0.89913	-0.01890	0.91803
DT46-437	0.89684	0.00135	0.89954	-0.01890	0.91844
DT46-440	0.89645	0.00144	0.89933	-0.01890	0.91823
DT46-450	0.89857	0.00143	0.90143	-0.01890	0.92033
DT46-460	0.90215	0.00131	0.90477	-0.01890	0.92367
DT46-470	0.90164	0.00125	0.90414	-0.01890	0.92304
DT46-480	0.90467	0.00139	0.90745	-0.01890	0.92635
DT46-486	0.90125	0.00131	0.90387	-0.01890	0.92277
DT46-490	0.90848	0.00136	0.91120	-0.01890	0.93010
DT46-500	0.90760	0.00132	0.91024	-0.01890	0.92914
DT46-520	0.91021	0.00145	0.91311	-0.01890	0.93201
DT46-540	0.91299	0.00128	0.91555	-0.01890	0.93445
DT46-544	0.91077	0.00141	0.91359	-0.01890	0.93249
DT46-560	0.91136	0.00132	0.91400	-0.01890	0.93290
DT46-600	**0.91908**	0.00127	0.92162	-0.01890	**0.94052**
DT46-616	0.91589	0.00136	0.91861	-0.01890	0.93751
DT46-700	0.90530	0.00115	0.90760	-0.01890	0.92650
DT46-705	0.90373	0.00135	0.90643	-0.01890	0.92533
DT46-800	0.88578	0.00138	0.88854	-0.01890	0.90744
				Max	0.94052
				Max S&T	0.94052

6.11 REACTIVITY COMPARISON OF U-COMPOUNDS

A reactivity comparison between 5% enriched theoretical UO_2, U_3O_8, UNH, and $CaU_xO_y \bullet ZH_2O$ compounds with water was considered to demonstrate that a theoretical mixture of UO2 and water is conservative relative to other homogeneous uranium compounds.

For comparison purposes, an infinite system is modeled for the compound material specifications provided in Tables 6.21 and 6.22. The comparison results between UO2, U3O8, UNH, and $CaU_6O_{19} \bullet 11H_2O$ are provided in Figure 6.0 in Section 6.1, General Description. A total of five separate calcium-uranium oxide compounds were evaluated as shown in Table 6.22. Only the most reactive form is provided in Figure 6.0.

In summary, Table 6.23 provides the calculated infinite multiplication factor results for the select compound and water mixtures, through optimal moderation. This table demonstrates, for <u>infinite systems,</u> there is little difference between UO2 and other oxide forms U_3O_8, and $CaU_xO_y \bullet ZH_2O$; while the UNH is markedly lower due to nitrogen absorption. These results do demonstrate that for finite systems, provided the total material mass does not exceed the equivalent homogeneous payload for UO2, these other compound forms will be less reactive.

Table 6.21 Material Specifications – Infinite System Reactivity Comparisons for UO2, U3O8, and UNH Compounds, 5% Enriched

COM	WF-W	FR.ENR	DFACT	RHOMIX gm/cc	RHOC gm/cc	RHOU gm/cc	UFACT	H/5	H/U x10
uo2, rho_c = 10.96 g/cc; ufact = 0.88144									
UO2	.000	.05000	1.0000	10.9600	10.9600	9.6606	.88144	0	0
UO2	.025	.05000	1.0000	8.7750	8.5556	7.5413	.88144	15	8
UO2	.050	.05000	1.0000	7.3164	6.9506	6.1265	.88144	31	16
UO2	.075	.05000	1.0000	6.2736	5.8031	5.1151	.88144	48	24
UO2	.100	.05000	1.0000	5.4910	4.9419	4.3560	.88144	66	33
UO2	.125	.05000	1.0000	4.8820	4.2717	3.7653	.88144	85	43
UO2	.150	.05000	1.0000	4.3945	3.7354	3.2925	.88144	104	53
UO2	.200	.05000	1.0000	3.6631	2.9305	2.5830	.88144	148	75
UO2	.250	.05000	1.0000	3.1404	2.3553	2.0761	.88144	197	100
UO2	.300	.05000	1.0000	2.7482	1.9238	1.6957	.88144	254	128
UO2	.350	.05000	1.0000	2.4432	1.5881	1.3998	.88144	319	161
UO2	.400	.05000	1.0000	2.1990	1.3194	1.1630	.88144	395	200
UO2	.450	.05000	1.0000	1.9993	1.0996	0.9692	.88144	484	245
UO2	.500	.05000	1.0000	1.8328	0.9164	0.8077	.88144	592	300
uox = u3o8; rho_c = 8.39 g/cc; ufact = 0.84793									
UOX	.000	.05000	1.0000	8.3900	8.3900	7.1141	.84793	0	0
UOX	.050	.05000	1.0000	6.1263	5.8200	4.9350	.84793	32	16
UOX	.100	.05000	1.0000	4.8246	4.3422	3.6818	.84793	68	35
UOX	.150	.05000	1.0000	3.9791	3.3823	2.8679	.84793	109	55
UOX	.200	.05000	1.0000	3.3858	2.7086	2.2967	.84793	154	78
UOX	.250	.05000	1.0000	2.9464	2.2098	1.8738	.84793	205	104
UOX	.300	.05000	1.0000	2.6080	1.8256	1.5480	.84793	264	133
UOX	.350	.05000	1.0000	2.3393	1.5206	1.2893	.84793	331	168
UOX	.400	.05000	1.0000	2.1208	1.2725	1.0790	.84793	410	208
UOX	.450	.05000	1.0000	1.9397	1.0668	0.9046	.84793	504	255
UOX	.500	.05000	1.0000	1.7870	0.8935	0.7576	.84793	615	311
unh = $UO_2(NO_3)_2 \bullet 6H_2O$; rho_c = 2.807 g/cc; ufact = 0.4739									
UNH	.000	.05000	1.0000	2.8070	2.8070	1.3302	.47390	237	120
UNH	.050	.05000	1.0000	2.5744	2.4457	1.1590	.47390	295	149
UNH	.100	.05000	1.0000	2.3774	2.1397	1.0140	.47390	359	182

UNH	.150	.05000	1.0000	2.2084	1.8771	0.8896	.47390	431	218
UNH	.200	.05000	1.0000	2.0618	1.6495	0.7817	.47390	512	259
UNH	.250	.05000	1.0000	1.9335	1.4501	0.6872	.47390	604	306
UNH	.300	.05000	1.0000	1.8202	1.2742	0.6038	.47390	709	359
UNH	.350	.05000	1.0000	1.7195	1.1177	0.5297	.47390	830	420
UNH	.400	.05000	1.0000	1.6293	0.9776	0.4633	.47390	971	492
UNH	.450	.05000	1.0000	1.5481	0.8515	0.4035	.47390	1138	576
UNH	.500	.05000	1.0000	1.4747	0.7373	0.3494	.47390	1338	677

Table 6.22 Material Specifications – Infinite System Reactivity Comparisons for Calcium – Uranium Oxide Compounds[2], 5% Enriched

compound id	rho c (g/cc)	ufact	mol. wt.
ca1: cauo3	6.97	0.729807	325.9748
ca2: cauo4	7.45	0.695663	341.9742
ca6: cau3o10*4h2o	5.337	0.723955	985.8290
ca7: cau6o19*11h2o	5.25	0.724702	1969.626
ca8: cau6o19*10h2o	5.10	0.731392	1951.611

Table 6.23 K-Infinite System Reactivity Results

CALCULATIONAL RESULTS

FILENAME	K-INF	SIGMA	K+2S	BIAS	K+2S-B	# HIST	LOST	DATE
k-infinite reactivity comparisons for select u-compounds								
guo2-00	0.8336	0.0005	0.8345	-.0090	0.8435	380000	3	08/09/02
guo2-025	1.0918	0.0008	1.0933	-.0090	1.1023	380000	3	08/09/02
guo2-05	1.2126	0.0008	1.2142	-.0090	1.2232	380000	2	08/09/02
guo2-075	1.2893	0.0008	1.2908	-.0090	1.2998	380000	3	08/09/02
guo2-10	1.3428	0.0009	1.3446	-.0090	1.3536	380000	2	08/09/02
guo2-125	1.3819	0.0008	1.3834	-.0090	1.3924	380000	1	08/09/02
guo2-15	1.4070	0.0007	1.4083	-.0090	1.4173	380000	0	08/09/02
guo2-20	1.4398	0.0007	1.4412	-.0090	1.4502	380000	2	08/09/02
guo2-25	1.4516	0.0007	1.4529	-.0090	**1.4619**	380000	0	08/09/02
guo2-30	1.4507	0.0006	1.4519	-.0090	1.4609	380000	1	08/09/02
guo2-35	1.4377	0.0005	1.4388	-.0090	1.4478	380000	0	08/09/02
guo2-40	1.4188	0.0005	1.4199	-.0090	1.4289	380000	0	08/09/02
guo2-45	1.3898	0.0005	1.3909	-.0090	1.3999	380000	1	08/09/02
guo2-50	1.3518	0.0004	1.3527	-.0090	1.3617	380000	0	08/09/02
guox-00	0.8257	0.0005	0.8267	-.0090	0.8357	380000	4	08/14/02
guox-05	1.2124	0.0009	1.2141	-.0090	1.2231	380000	2	08/09/02
guox-10	1.3454	0.0008	1.3469	-.0090	1.3559	380000	3	08/09/02
guox-15	1.4096	0.0007	1.4111	-.0090	1.4201	380000	3	08/09/02
guox-20	1.4395	0.0006	1.4407	-.0090	1.4497	380000	0	08/09/02
guox-25	1.4512	0.0007	1.4526	-.0090	**1.4615**	380000	0	08/09/02
guox-30	1.4489	0.0006	1.4500	-.0090	1.4590	380000	0	08/09/02
guox-35	1.4358	0.0006	1.4370	-.0090	1.4460	380000	4	08/09/02
guox-40	1.4144	0.0006	1.4155	-.0090	1.4245	380000	2	08/09/02
guox-45	1.3836	0.0005	1.3846	-.0090	1.3936	380000	4	08/09/02
guox-50	1.3428	0.0005	1.3437	-.0090	1.3527	380000	2	08/09/02
gunh-00	1.3054	0.0006	1.3066	-.0125	**1.3191**	380000	1	08/09/02
gunh-05	1.3036	0.0005	1.3047	-.0125	1.3172	380000	2	08/09/02
gunh-10	1.2964	0.0006	1.2975	-.0125	1.3100	380000	0	08/09/02
gunh-15	1.2821	0.0005	1.2831	-.0125	1.2956	380000	0	08/09/02
gunh-20	1.2619	0.0005	1.2628	-.0125	1.2753	380000	0	08/09/02
gunh-25	1.2368	0.0004	1.2377	-.0125	1.2502	380000	2	08/09/02
gunh-30	1.2069	0.0004	1.2077	-.0125	1.2202	380000	2	08/09/02
gunh-35	1.1712	0.0004	1.1720	-.0125	1.1845	380000	2	08/09/02
gunh-40	1.1311	0.0003	1.1318	-.0125	1.1443	380000	0	08/09/02
gunh-45	1.0857	0.0003	1.0863	-.0125	1.0988	380000	2	08/09/02

[2] Source: Crystal Data Detemination Tables, U.S. Department of Commerce National Bureau of Standards, Third Edition, Vol. 5 & 6.

gunh-50	1.0345	0.0003	1.0351	-.0125	1.0476	380000	1	08/09/02
gca1-00	0.7658	0.0003	0.7665	-.0090	0.7755	380000	5	08/15/02
gca1-05	1.1883	0.0008	1.1898	-.0090	1.1988	380000	0	08/15/02
gca1-10	1.3276	0.0007	1.3289	-.0090	1.3379	380000	2	08/15/02
gca1-15	1.3891	0.0007	1.3906	-.0090	1.3996	380000	4	08/15/02
gca1-20	1.4161	0.0007	1.4175	-.0090	1.4265	380000	1	08/15/02
gca1-25	1.4250	0.0006	1.4263	-.0090	**1.4353**	380000	0	08/15/02
gca1-30	1.4169	0.0005	1.4180	-.0090	1.4270	380000	1	08/15/02
gca1-35	1.4006	0.0005	1.4017	-.0090	1.4107	380000	0	08/15/02
gca1-40	1.3717	0.0005	1.3727	-.0090	1.3817	380000	2	08/15/02
gca2-00	0.7635	0.0003	0.7642	-.0090	0.7732	380000	4	08/15/02
gca2-05	1.1925	0.0007	1.1940	-.0090	1.2030	380000	2	08/15/02
gca2-10	1.3309	0.0009	1.3326	-.0090	1.3416	380000	0	08/15/02
gca2-15	1.3912	0.0006	1.3925	-.0090	1.4015	380000	1	08/15/02
gca2-20	1.4166	0.0007	1.4180	-.0090	1.4270	380000	1	08/15/02
gca2-25	1.4239	0.0006	1.4251	-.0090	**1.4341**	380000	1	08/15/02
gca2-30	1.4139	0.0006	1.4151	-.0090	1.4241	380000	0	08/15/02
gca2-35	1.3932	0.0005	1.3943	-.0090	1.4033	380000	0	08/15/02
gca2-40	1.3633	0.0005	1.3642	-.0090	1.3732	380000	3	08/15/02
gca6-00	1.2802	0.0008	1.2819	-.0090	1.2909	380000	2	08/15/02
gca6-05	1.3706	0.0008	1.3723	-.0090	1.3813	380000	1	08/15/02
gca6-10	1.4158	0.0007	1.4172	-.0090	1.4262	380000	2	08/15/02
gca6-15	1.4345	0.0007	1.4359	-.0090	**1.4449**	380000	1	08/15/02
gca6-20	1.4411	0.0007	1.4425	-.0090	1.4515	380000	0	08/15/02
gca6-25	1.4344	0.0007	1.4357	-.0090	1.4447	380000	1	08/15/02
gca6-30	1.4205	0.0006	1.4216	-.0090	1.4306	380000	5	08/15/02
gca6-35	1.3973	0.0005	1.3983	-.0090	1.4073	380000	0	08/15/02
gca6-40	1.3657	0.0005	1.3668	-.0090	1.3758	380000	1	08/15/02
gca7-00	1.3445	0.0008	1.3460	-.0090	1.3550	380000	0	08/15/02
gca7-05	1.4015	0.0008	1.4030	-.0090	1.4120	380000	0	08/15/02
gca7-15	1.4450	0.0007	1.4464	-.0090	**1.4554**	380000	0	08/15/02
gca7-20	1.4440	0.0006	1.4451	-.0090	1.4541	380000	0	08/15/02
gca7-25	1.4358	0.0006	1.4370	-.0090	1.4460	380000	1	08/15/02
gca7-30	1.4184	0.0006	1.4196	-.0090	1.4286	380000	0	08/15/02
gca7-35	1.3946	0.0005	1.3957	-.0090	1.4047	380000	1	08/15/02
gca7-40	1.3623	0.0005	1.3633	-.0090	1.3723	380000	2	08/15/02
gca8-00	1.3270	0.0008	1.3286	-.0090	1.3376	380000	5	08/15/02
gca8-05	1.3945	0.0007	1.3959	-.0090	1.4049	380000	0	08/15/02
gca8-10	1.4295	0.0007	1.4309	-.0090	1.4399	380000	1	08/15/02
gca8-15	1.4443	0.0007	1.4456	-.0090	**1.4546**	380000	1	08/15/02
gca8-20	1.4175	0.0006	1.4187	-.0090	1.4277	380000	1	08/15/02
gca8-25	1.4380	0.0006	1.4392	-.0090	1.4482	380000	1	08/15/02
gca8-30	1.4213	0.0005	1.4224	-.0090	1.4314	380000	2	08/15/02
gca8-35	1.3973	0.0005	1.3984	-.0090	1.4074	380000	1	08/15/02
gca8-40	1.3661	0.0005	1.3670	-.0090	1.3760	380000	0	08/15/02

6.12 ANALYSIS AND VERIFICATION SIGNOFF

(See Next Page)

Global Nuclear Fuel

A Joint Venture of GE, Toshiba, & Hitachi

eDRF No. 0000-0006-6390
Criticality Safety Analysis
New Powder Container (NPC)
(Revision 02)

Analysis By: ____________________ Date: _________
William C. Peters

Verified By: ____________________ Date: _________
Lon E. Paulson

7.0 OPERATING PROCEDURES

7.1 Procedure for Loading the NPC Packaging

This section delineates the procedures for loading a payload into the NPC packaging. Reference to specific NPC packaging components may be found in Appendix 1.3.1, *Packaging General Arrangement Drawings.*

7.1.1 Preparation of the NPC for Loading

1. Outer Confinement Assembly (OCA) Body – Visually inspect the silos for the ICCAs and verify they are clean and dry. A silicon rubber pad must be located in the bottom of each silo.
2. OCA Body – Visually inspect the 16 threaded lugs for damage and verify a threaded insert is present in each lug, fully seated and undamaged.
3. OCA Body – Visually verify that each of the 24 holes for attaching the four OCA closure strips contain a thread insert which is fully seated and undamaged.
4. OCA Body – Visually inspect all external surfaces for damage. The maximum acceptable dent or bulge is a 1/2-inch deflection.
5. OCA Body – Visually verify that the plastic vent plug on each container side (4 total) is in place and tightly secured.
6. OCA Body – Visually verify that the exposed polyurethane foam is in good condition and the outlines for the ICCA lock ring locations are clearly stenciled on the foam.
7. OCA Body – Visually verify the stainless steel channel receptacle for the ceramic fiber braided rope in the lid is in place and undamaged.
8. OCA Lid – Visually inspect the external surfaces of the lid for handling damage. Maximum acceptable dent or bulge is a 1/2-inch deflection.
9. OCA Lid – Visually verify the presence of the ceramic fiber braided rope around the inside periphery of the lid and inspect that it has no tears, deterioration or other damage and is tightly adhering.
10. OCA Lid – Visually verify the exposed polyurethane foam is in good condition.
11. Inner Containment Canister Assembly (ICCA) – Visually verify no dents in ICCA exterior greater than 1/4-inch deep.
12. ICCA – Visually verify the silicon rubber gasket in the lid is clean, in good condition with no tears or cuts, and is tightly adhering. Visually verify the rolled edge mating gasket surface at the top of the ICCA body is clean, smooth and undamaged.
13. ICCA – Visually verify the ICCA interior is clean and dry.
14. ICCA – Visually verify the lock ring is undamaged and the 5/16-inch bolt threads are not stripped or deformed. Replace the lock ring bolt nut with a new one after each use.
15. When deviations to items 1, 5 and 13 are found, the item is corrected before release to loading.

16. When deviations to items 2, 3, 4, 6, 7, 8, 9, 10, 11, 12 and 14 are identified, the package or packaging component is immediately removed from service, identified as non-conforming material, and dispositioned in accord with written procedures including the10 CFR 71, Subpart approved QA Plan.

7.1.2 Loading the Payload into the NPC

1. The uranium oxides and compounds payload are secured in plastic receptacles (e.g. bags, bottles, etc.). Verify that all the conditions of the certificate are conformed to paying particular attention to assuring the authorize contents limitations are complied with and that the contents as loaded will not exceed a Type A quantity of material.
2. After loading the payload inside the ICCA body, the ICCA lid shall be positioned on top of the ICCA body. Visually verify the silicon rubber gasket is clean, without tears or cuts and is tightly adhering. Install the lock ring around the lid and tighten up the lock ring bolt while tapping the outer circumference of the lock ring with a small rubber hammer to assure the lock ring is fully and tightly secured. Torque the lock ring bolt to 35 – 50 lb-in.
3. Unless the ICCAs are already positioned in the OCA, pick up the loaded ICCA with a special lifting harness attached to the periphery of the lock ring and insert it carefully into the OCA silo. Insert the balance of the ICCAs in a like manner.
4. Assure that the lock ring bolt for each ICCA is oriented within the outline stenciled around the top of the silo.
5. Using a special lifting sling, attach a lifting eye to each of the four threaded holes located near the corners of the OCA lid. Lift the lid and position it over the OCA body so that the alignment marks on the side of the OCA lid and body line up correctly.
6. Lower the OCA lid in place and secure with sixteen (16) 1/2-inch socket head cap screws. Visually verify prior to assembly that the bolt threads are not stripped or deformed. Tighten the bolts around the periphery of the OCA lid and then final torque to 50 ± 5 lb-ft.
7. Install the four OCA closure strips and secure with twenty- four (24) 7/16-inch hex bolts. Visually verify prior to assembly that the bolt threads are not stripped or deformed. Final torque the bolts to 40 ± 5 lb-ft.
8. Install 5/16-18 screws into the four stainless steel locating "buttons" on the OCA lid to prevent them from being used as lifting devices for the NPC package during transport.
9. Install plastic or rubber weather plugs in sixteen (16) bolt hole locations in top of OCA lid.

7.1.3 Final Package Preparations for Transport

1. Install the two tamper-indicating seals near the OCA closure strips located on opposite sides of the container.
2. Monitor external radiation for each package per 49CFR §173.441[1].
3. Determine the surface contamination levels for each NPC package per 49CFR §173.443.
4. Determine the transport index for the loaded NPC package per 49 CFR §173.403.
5. Complete all necessary shipping papers in accordance with Subpart C of 49 CFR 172[2].

[1] Title 49, Code of Federal regulations Part 173 (49CFR 173), *Shippers – General Requirements for Shipments and Packagings*, 1-1-97 Edition

6. Utilizing only the forklift pockets, raise and move the NPC package into the transport vehicle (i.e., sea-land container, enclosed truck, etc.). The NPC package may be stacked up to a height of two packages.

7. Install and secure the stainless steel covers over each forklift pocket using the 1/4-20UNC machine screws and washers.

8. Install a minimum of one horizontal restraint having a minimum width of 2.18 inches on each side and top of the NPC package. When using a single side restraint configuration, the restraint shall be installed at least 23 inches above the base of the NPC package. A single top restraint shall be installed proximate to the centerline of the package.

7.2 Procedures for Unloading the Package

This section delineates procedures for unloading the NPC.

7.2.1 Unloading the Transport Vehicle

1. Open the transport vehicle and carefully remove the restraints from around the NPC package to facilitate unloading.

2. Remove the stainless steel covers from two adjacent forklift pockets to provide access for handling equipment. The remaining stainless steel covers over the other forklift pockets may be removed as necessary to handle the NPC package.

3. Utilizing only the forklift pockets, remove the package from the transport vehicle using appropriate handling equipment and the forklift pockets on the bottom of the NPC package.

7.2.2 Removal of the Payload from the NPC Package

1. Remove the two tamper safe seals and the twenty-four (24) hex bolts securing the four OCA closure strips.
2. Remove the OCA closure strips
3. Remove the sixteen (16) socket head cap screws securing the OCA lid to the OCA body.
4. Using a special lifting sling, attach a lifting eye to each of the four threaded holes located near the corners of the OCA lid. Carefully lift and remove the OCA lid from the OCA body. It may be necessary to tap the sides of the lid with a rubber hammer to facilitate the lid removal.
5. Attach a special lifting sling to the periphery of an ICCA and pull it up and out of the OCA silo. Repeat for the remainder of the ICCAs.
6. Use a wrench to loosen and remove the nut securing the lock ring bolt on the ICCA. Remove the lock ring and ICCA lid.

[2]Title 49, Code of Federal Regulations, Part 172 (49 CFR 172), *Hazardous Materials Tables and Hazardous Communications Regulations*, 1-1-97 Edition.

7. Remove the uranium contents by carefully lifting the receptacle and packing material out of the ICCA or by upending the ICCA with a special fixture and allowing the receptacles to be pulled/slide out.

7.2.3 Final Package Preparations for Transport of Unloaded NPC

1. Complete all required shipping papers in accordance with Subpart C of 49 CFR 172.
2. NPC package marking shall be in accordance with 10 CFR §71.85(c) and Subpart D of 49 CFR 172. Package labeling shall be in accordance with Subpart E of 49 CFR 172. Packaging placarding shall be in accordance with Subpart F of 49 CFR 172.

7.3 Preparation of an Empty Packaging for Transport

Previously used and empty NPC packagings shall be prepared and transported per the requirements of 49 CFR §173.428, Subpart I.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

8.1 Acceptance Tests

Per the requirements of 10 CFR §71.85(c)[1], this section discusses the inspections and tests to be performed prior to first use of the NPC package.

8.1.1 Visual Inspections

All NPC packaging materials of construction and welds shall be examined in accordance with the requirements delineated on the drawings in Appendix 1.3.1, *Packaging General Arrangement Drawings*, per the requirements of 10 CFR §71.85(a).

8.1.2 Structural and Pressure Tests

8.1.2.1 Lifting/Tie-Down Device Load Testing

The NPC packaging does not contain any lifting/tiedown devices that require load testing.

8.1.2.2 Containment Vessel Pressure Testing

Per the requirements of 10 CFR §71.85(b), the Inner Containment Canister Assemblies (ICCAs), prior to wrapping with cadmium and polyethylene, shall be pressure tested to 150% of the Maximum Normal Operation Pressure (MNOP) to verify structural integrity. The MNOP of the ICCAs is equal to the 6.1 psig. Thus, each ICCA is required to be pressure tested to $6.1 \times 1.5 =$ 9.1 psig minimum. However, since the ICCA design pressure is greater than this pressure, each ICCA shall be tested to the 24.0-psig design pressure.

Following containment vessel pressure testing, the base material and the welds directly related to the pressure testing of the containment vessels shall be visually inspected for plastic deformation or cracking in accordance with AWS D1.6[2], as delineated on the drawings in Appendix 1.3.1, *Packaging General Arrangement Drawings*. Indications of cracking or distortion shall be recorded on a nonconformance report and dispositioned prior to final acceptance with the cognizant quality assurance program.

8.1.3 Fabrication Verification Leak Tests

The NPC packaging does not contain any seals or containment boundaries that require leak testing.

[1] Title 10, Code of Federal Regulations, Part 71 (10 CFR 71), *Packaging and Transportation of Radioactive Material*, 1-1-98 Edition.

[2] ANSI/AWS D1.6, *Structural Welding Code – Stainless Steel*, American Welding Society (AWS).

8.1.4 Component Tests

8.1.4.1 Polyurethane Foam

This section establishes the requirements and acceptance criteria for installation, inspection, and testing of rigid, closed-cell, polyurethane foam utilized within the NPC packaging.

8.1.4.1.1 Introduction and General Requirements

The polyurethane foam utilized within the NPC packaging is comprised of a specific "formulation" of foam constituents (i.e., mix of chemical constituents) that defines the foam's characteristics such as density, compressive stress and specific heat. Based on the foam's physical requirements, chemical constituents are combined into batches containing multiple parts (e.g., parts A and B) for easier handling. Therefore, a foam "batch" is defined as mixing into vats a specific foam formulation for each part. Based on the foam's physical requirements, portions from each batch part are combined to produce the liquid foam material for pouring into the component to be foamed. Thus, a foam "pour" is defined as apportioning the pouring batch parts into a desired quantity of liquid foam material for subsequent installation (pouring).

8.1.4.1.1.1 Polyurethane Foam Chemical Composition

The foam supplier shall certify that the chemical composition of the polyurethane foam is as delineated below, with the chemical component weight percents falling within the specified ranges. In addition, the foam supplier shall certify that the finished (cured) polyurethane foam does not contain halogen-type flame retardants or trichloromonofluoromethane (Freon 11).

Carbon………………50% - 70%	Phosphorus……………..0% - 2%
Oxygen………………14% - 34%	Silicon……………………...< 1%
Nitrogen……………. 4% - 12%	Chlorides………………...< 0.18%
Hydrogen……………6.4% - 10%	Other……………………..…< 1%

8.1.4.1.1.2 Polyurethane Foam Constituent Storage

The foam suppliers shall certify that the polyurethane foam constituents have been properly stored prior to use, and that the polyurethane foam constituents have been used within their shelf life.

8.1.4.1.1.3 Foamed Component Preparation

Prior to the in-situ foam installation, the foam supplier shall visually verify that adequate bracing/shoring of the component shells is provided to maintain the dimensional configuration throughout the foam pouring/curing process. This bracing/shoring is required to resist the internal pressures generated during the foam pouring/curing process.

8.1.4.1.1.4 In-Situ Polyurethane Foam Installation

The direction of foam rise for in-situ foam installation and prefabricated foam slabs shall be parallel with the vertical axis of the package. The surrounding walls of each part, OCA body and OCA lid, where the liquid foam material is to be installed shall be between 55 ºF and 95 ºF prior to foam installation. Measure and record the component wall temperature to an accuracy of ±2 ºF prior to foam installation.

In the case of multiple pours into a single foamed component, no pour-to-pour interface shall occur within eight inches of the closure interface on the OCA body. In addition, the cured level of each pour shall be measured and recorded to an accuracy of ±1-inch.

Measure and record the weight of liquid foam material installed during each pour to an accuracy of ±10 pounds.

For in-situ foam, all test samples shall be poured into disposable containers at the same time as the actual pour it represents, clearly marking the test sample container with the pour date and a unique pour identification number. For foam slabs, all test samples shall be taken from the actual foam slabs that will be utilized in the NPC packaging. All test samples shall be cut from a larger block to obtain freshly cut faces. Prior to physical testing, each test sample shall be cleaned of superfluous foam dust.

8.1.4.1.1.5 Polyurethane Foam Pour and Test Data Records

A production pour and testing record shall be compiled by the foam supplier during the foam pouring operation and subsequent physical testing. Upon completion of production and testing, the foam supplier shall issue a certification referencing the production record data and test data pertaining to each foamed component. At a minimum, relevant pour and test data shall include:

- Formulation, batch, and pour numbers, with foam material traceability, and pour date.
- Foamed component description, part number, and serial number.
- Instrumentation description, serial number, and calibration due date.
- Pour and test data (e.g., date, temperature, dimensional and/or weight measurements.
- Technician and Quality Assurance/Quality Control (QA/QC) sign-off.

8.1.4.1.2 Physical Characteristics

The following subsections delineate the required physical characteristics of the polyurethane foam material utilized for the NPC packaging design. All pertinent data, as identified in the following subsections, shall be recorded.

Testing for the various polyurethane foam physical characteristics is based on a "formulation", "batch", or "pour", as defined in Section 8.1.4.1.1, *Introduction and General Requirements*.

8.1.4.1.2.1 Physical Characteristics Determined for a Foam Formulation

Foam material physical characteristics for the following parameters shall be determined once for a particular foam formulation. If multiple components are to be foamed utilizing a specific foam formulation, then additional physical testing, as defined below, need not be performed.

8.1.4.1.2.1.1 Thermal Expansion Coefficient

1. Three (3) test samples shall be taken from the sample pour. Each test sample shall be a rectangular prism with a minimum cross-section of 1.0-inch square and a minimum length of 6.0-inches.
2. Place the test samples in a room (ambient) temperature environment (i.e., 65 ºF to 85 ºF) for sufficient time to thermally stabilize the test samples. Measure and record the room temperature (T_{RT}) to an accuracy of ±2 ºF.

3. Measure and record the room temperature length (L_{RT}) of each test sample to an accuracy of ±0.001 inches.
4. Place the test samples in a -40 ºF to -60 ºF cold environment for a minimum of three hours. Measure and record the cold environment temperature (T_C) to an accuracy of ±2 ºF.
5. Measure and record the cold environment length (L_C) of each test sample to an accuracy of ±0.001 inches.
6. Determine and record the thermal expansion coefficient for each cold environment test sample as follows:

$$\alpha_C = \frac{\left(L_{RT} - L_C\right)}{\left(L_{RT}\right)\left(T_{RT} - T_C\right)}, \text{ in / in/}^\circ\text{F}$$

7. Place the test samples in a 180 ºF to 200 ºF hot environment for a minimum of three hours. Measure and record the hot environment temperature (T_H) to an accuracy of ±2 ºF.
8. Measure and record the hot environment length (L_H) of each test sample to an accuracy of ±0.001 inches.
9. Determine and record the thermal expansion coefficient for each hot environment test sample as follows:

$$\alpha_H = \frac{\left(L_H - L_{RT}\right)}{\left(L_{RT}\right)\left(T_H - T_{RT}\right)}, \text{ in / in/}^\circ\text{F}$$

10. Determine and record the average thermal expansion coefficient of each cold and hot environment test sample as follows:

$$\alpha = \frac{\alpha_C + \alpha_H}{2}, \text{ in/in/}^\circ\text{F}$$

11. Determine and record the thermal expansion coefficient of each test sample. The thermal expansion coefficient of each test sample shall nominally be 3.5×10^{-5} in/in/ºF ±25% (i.e., within the range of 2.6×10^{-5} to 4.4×10^{-5} in/in/ºF).
12. Determine and record the average thermal expansion coefficient of the three test samples. The numerically averaged thermal expansion coefficient of the three test samples shall nominally be 3.5×10^{-5} in/in/ºF ±20% (i.e., within the range of 2.8×10^{-5} to 4.2×10^{-5} in/in/ºF).

8.1.4.1.2.1.2 Thermal Conductivity

1. The thermal conductivity test shall be performed using a Heat Flow Meter (HFM) apparatus. The HFM establishes steady state unidirectional heat flux through a test specimen between two parallel plates at constant but different temperatures. By measurement of the plate temperatures and plate separation, Fourier's law of heat conduction is used by the HFM to automatically calculate thermal conductivity. Description of a typical HFM is provided in ASTM C518[3]. The HFM shall be calibrated against a traceable reference specimen per the HFM manufacturer's operating instructions.

[3] ASTM C518, *Standard Test Method for Steady-State Heat Flux Measurement and Thermal Transmission Properties by Means of the Heat Flux Meter Apparatus*, American Society of Testing and Materials (ASTM).

2. Three (3) test samples shall be taken from the sample pour. Each test sample shall be of sufficient size to enable testing per the HFM manufacturer's operating instructions.
3. Place the test samples in a room (ambient) temperature environment (i.e., 65 ºF to 85 ºF) for sufficient time to thermally stabilize the test samples.
4. Measure and record the necessary test sample parameters as input data to the HFM per the HFM manufacturer's operating instructions.
5. Perform thermal conductivity testing and record the measured thermal conductivity for each test sample following the HFM manufacturer's operating instructions.
6. Determine and record the thermal conductivity of each test sample. The thermal conductivity of each test sample shall lie within ±25% of the nominal value as shown in Table 8-1.1.
7. Determine and record the average thermal conductivity of the three test samples. The numerically averaged thermal conductivity of the three test samples shall lie within ±20% of the nominal value as shown in Table 8-1.1.

8.1.4.1.2.1.3 Specific Heat

1. The specific heat test shall be performed using a Differential Scanning Calorimeter (DSC) apparatus. The DSC establishes a constant heating rate and measures the differential heat flow into both a test specimen and a reference specimen. Description of a typical DSC is provided in ASTM E1269[4]. The DSC shall be calibrated against a traceable reference specimen per the DSC manufacturer's operating instructions.
2. Three (3) test samples shall be taken from the sample pour. Each test sample shall be of sufficient size to enable testing per the DSC manufacturer's operating instructions.
3. Place the test samples in a room (ambient) temperature environment (i.e., 65 ºF to 85 ºF) for sufficient time to thermally stabilize the test samples.
4. Measure and record the necessary test sample parameters as input data to the DSC per the DSC manufacturer's operating instructions.
5. Perform specific heat testing and record the measured specific heat for each test sample following the DSC manufacturer's operating instructions.
6. Determine and record the specific heat of each test specimen. The specific heat of each test sample shall nominally be 0.47 Btu/lb_m-ºF ±25% (i.e., within the range of 0.35 to 0.59 Btu/lb_m-ºF).
7. Determine and record the average specific heat of the three test specimens. The numerically averaged specific heat of the three test samples shall nominally be 0.47 Btu/lb_m-ºF ±20% (i.e., within the range of 0.38 to 0.56 Btu/lb_m-ºF).

8.1.4.1.2.1.4 Leachable Chlorides

1. The leachable chlorides test shall be performed using an Ion Chromatograph (IC) apparatus. The IC measures inorganic anions of interest (i.e., chlorides) in water. Description of a

[4] ASTM E1269, *Standard Test Method for Determining Specific Heat Capacity by Differential Scanning Calorimetry*, American Society of Testing and Materials (ASTM).

typical IC is provided in EPA Method 300.0[5]. The IC shall be calibrated against a traceable reference specimen per the IC manufacturer's operating instructions.

2. One (1) test sample shall be taken from a pour from each foam batch. The test sample shall be a cube with dimensions of 2.00 ±0.03 inches.
3. Place the test sample in a room (ambient) temperature environment (i.e., 65 ºF to 85 ºF) for sufficient time to thermally stabilize the test sample. Measure and record the room temperature to an accuracy of ±2 ºF.
4. Obtain a minimum of 550 ml of distilled or deionized water for testing. The test water shall be from a single source to ensure consistent anionic properties for testing control.
5. Obtain a 400 ml, or larger, contaminant free container that is capable of being sealed. Fill the container with 262 ±3 ml of test water. Fully immerse the test sample inside the container for a duration of 72 ±3 hours. If necessary, use an inert standoff to ensure the test sample is completely immersed for the full test duration. Seal the container.
6. Obtain a second, identical container to use as a "control". Fill the control container with 262 ±3 ml of the same test water. Seal the control container.
7. At the end of the test period, measure and record the leachable chlorides in the test water per the IC manufacturer's operating instructions. The leachable chlorides in the test water shall not exceed one part per million (1 ppm).
8. Should leachable chlorides in the test water exceed 1 ppm, measure and record the leachable chlorides in the test water from the "control" container. The difference in leachable chlorides from the test water and "control" water sample shall not exceed 1 ppm.

8.1.4.1.2.2 Physical Characteristics Determined for a Foam Pour

Foam material physical characteristics for the following parameters shall be determined for each foam pour based on the formulation defined in Section 8.1.4.1.2.1, *Physical Characteristics Determined for a Foam Formulation*.

8.1.4.1.2.2.1 Density

1. Three (3) test samples shall be taken from the foam pour. Each test sample shall be a rectangular prism with nominal dimensions of 1.0-inch thick (T) × 2.0-inches wide (W) × 2.0-inches long (L).
2. Place the test samples in a room (ambient) temperature environment (i.e., 65 to 85 ºF) for sufficient time to thermally stabilize the test samples. Measure and record the room temperature to an accuracy of ±2 ºF.
3. Measure and record the weight of each test sample to an accuracy of ±0.01 grams.
4. Measure and record the thickness, width, and length of each test sample to an accuracy of ±0.001 inches.

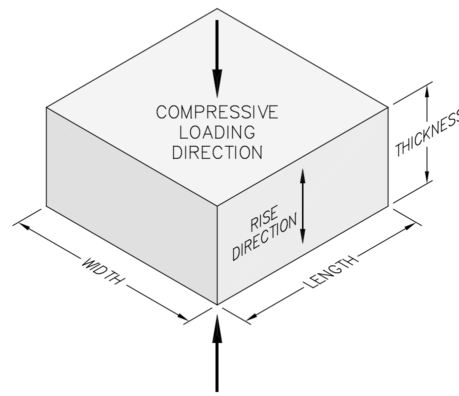
[5] EPA Method 300.0, *Determination of Inorganic Anions in Water by Ion Chromatography*, U.S. Environmental Protection Agency.

5. Determine and record the room temperature density of each test sample utilizing the following formula:

$$\rho_{\text{foam}} = \frac{\text{Weight, g}}{453.6\ \text{g/lb}} \times \frac{1{,}728\ \text{in}^3/\text{ft}^3}{\text{T} \times \text{W} \times \text{L in}^3},\ \text{lb/ft}^3$$

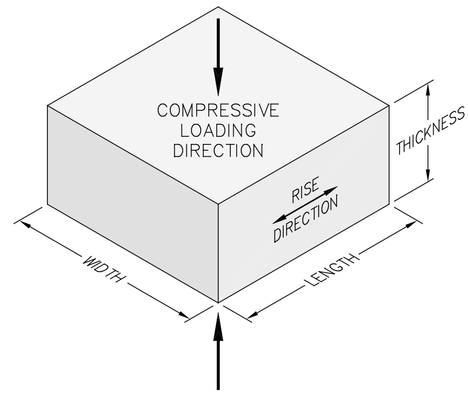
6. Determine and record the density of each test sample. The density of each test sample shall be +20%/-15% of specified nominal density.
7. Determine and record the average density of the three test samples. The numerically averaged density of the three test samples shall be +15%/-10% of specified nominal density.

8.1.4.1.2.2.2 Parallel-to Rise Compressive Stress



1. Three (3) test samples shall be taken from the foam pour. Each test sample shall be a rectangular prism with nominal dimensions of 1.0-inch thick (T) × 2.0-inches wide (W) × 2.0-inches long (L). The thickness dimension shall be the parallel-to-rise direction.
2. Place the test samples in a room (ambient) temperature environment (i.e., 65 ºF to 85 ºF) for sufficient time to thermally stabilize the test samples. Measure and record the room temperature to an accuracy of ±2 ºF.
3. Measure and record the thickness, width, and length of each test sample to an accuracy of ±0.001 inches.
4. Compute and record the surface area of each test sample by multiplying the width by the length (i.e., W × L).
5. Place a test sample in a Universal Testing Machine. Lower the machine's crosshead until it touches the test sample. Set the machine's parameters for the thickness of the test sample.
6. Apply a compressive load to each test sample at a rate of 0.10 ±0.05 inches/minute until a strain of 70%, or greater, is achieved. For each test sample, plot the compressive stress versus strain and record the compressive stress at strains of 10%, 40%, and 70%.
7. Determine and record the parallel-to-rise compressive stress of each test sample from each batch pour for each foam density. As delineated in Tables 8-1.2 through 8-1.4, the parallel-to-rise compressive stress for each batch pour shall be the nominal compressive stress ±25% at strains of 10%, 40%, and 70%.
8. Determine and record the average parallel-to-rise compressive stress of the three test samples from each batch pour for each foam density. As delineated in Tables 8-1.2 through 8-1.4, the average parallel-to-rise compressive stress for each batch pour shall be the nominal compressive stress ±20% at strains of 10%, 40%, and 70%.
9. Determine and record the average parallel-to-rise compressive stress of all test samples from each foamed component. As delineated in Tables 8-1.2 through 8-1.4, the average parallel-to-rise compressive stress for a foamed component shall be the nominal compressive stress ±15% at strains of 10%, 40%, and 70%. Note that the strength for the 40 lb/ft^3 foam need not be tested.

8.1.4.1.2.2.3 Perpendicular-to-Rise Compressive Stress



1. Three (3) test samples shall be taken from the foam pour. Each test sample shall be a rectangular prism with nominal dimensions of 1.0-inch thick (T) × 2.0-inches wide (W) × 2.0-inches long (L). The thickness dimension shall be the perpendicular-to-rise direction.
2. Place the test samples in a room (ambient) temperature environment (i.e., 65 ºF to 85 ºF) for sufficient time to thermally stabilize the test samples. Measure and record the room temperature to an accuracy of ±2 ºF.
3. Measure and record the thickness, width, and length of each test sample to an accuracy of ±0.001 inches.
4. Compute and record the surface area of each test sample by multiplying the width by the length (i.e., W × L).
5. Place a test sample in a Universal Testing Machine. Lower the machine's crosshead until it touches the test sample. Set the machine's parameters for the thickness of the test sample.
6. Apply a compressive load to each test sample at a rate of 0.10 ±0.05 inches/minute until a strain of 70%, or greater, is achieved. For each test sample, plot the compressive stress versus strain and record the compressive stress at strains of 10%, 40%, and 70%.
7. Determine and record the perpendicular-to-rise compressive stress of each test sample from each batch pour for each foam density. As delineated in Tables 8-1.2 through 8-1.4, the perpendicular-to-rise compressive stress for each batch pour sample shall be the nominal compressive stress ±25% at strains of 10%, 40%, and 70%.
8. Determine and record the average perpendicular-to-rise compressive stress of the three test samples from each batch pour for each foam density. As delineated in Tables 8-1.2 through 8-1.4, the average perpendicular-to-rise compressive stress for each batch pour shall be the nominal compressive stress ±20% at strains of 10%, 40%, and 70%.
9. Determine and record the average perpendicular-to-rise compressive stress of all test samples from each foamed component. As delineated in Tables 8-1.2 through 8-1.4, the average perpendicular-to-rise compressive stress for a foamed component shall be the nominal compressive stress ±15% at strains of 10%, 40%, and 70%. Note that the strength for the 40 lb/ft^3 foam need not be tested.

8.1.4.2 Ceramic Fiber Board and Braided Rope

This section establishes the requirements and acceptance criteria for inspection and testing of Ceramic Fiber Board (CFB) and Ceramic Fiber Braided Rope (CFBR) utilized within the NPC packaging.

8.1.4.2.1 Ceramic Fiber Board and Braided Rope Composition

The ceramic fiber supplier shall certify that the composition of the Ceramic Fiber Board (CFB) and Ceramic Fiber Braided Rope (CFBR) has a fiber content of 100% amorphous alumina-silca fibers.

8.1.4.2.2 Ceramic Fiber Board Density

1. Three (3) test samples shall be taken from each lot of ceramic fiber board. Each test sample shall be one-square foot with nominal dimensions of 12.0-inches wide (W) × 12.0-inches long (L).
2. Place the test samples in a room (ambient) temperature environment (i.e., 65 to 85 ºF) for sufficient time to thermally stabilize the test samples. Measure and record the room temperature to an accuracy of ±2 ºF.
3. Measure and record the weight of each test sample to an accuracy of ±0.01 grams.
4. Measure and record the width and length of each test sample to an accuracy of ±0.10 inches.
5. Measure and record the thickness (T) by utilizing a 4 lb_m/ft^2 plate and a digital indicator equipped with a blunt or pointed foot mounted on the contact stem.
6. Determine and record the room temperature density of each test sample utilizing the following formula:

$$\rho_{\text{cfb}} = \frac{\text{Weight, g}}{\text{453.6 g/lb}} \times \frac{\text{1,728 in}^3\text{/ft}^3}{\text{T} \times \text{W} \times \text{L in}^3},\ \text{lb/ft}^3$$

7. Determine and record the density of each test sample. The density of each test sample shall be nominally be 17.5 lb/ft^3 ±25% (i.e., within the range of 13.1 to 21.9 lb/ft^3).
8. Determine and record the average density of the three test samples. The numerically averaged density of the three test samples shall be nominally be 17.5 lb/ft^3 ±20% (i.e., within the range of 14.0 to 21.0 lb/ft^3).

8.1.4.2.3 Ceramic Fiber Braided Rope Density

1. Three (3) test samples shall be taken from each lot of 1-inch × 1-inch ceramic fiber braided rope. Each test sample shall be 12.0 inches long (L).
2. Place the test samples in a room (ambient) temperature environment (i.e., 65 to 85 ºF) for sufficient time to thermally stabilize the test samples. Measure and record the room temperature to an accuracy of ±2 ºF.
3. Measure and record the weight of each test sample to an accuracy of ±0.1 grams.
4. Measure and record the length of each test sample to an accuracy of ±0.1 inches.
5. Determine and record the room temperature density of each test sample utilizing the following formula:

$$\rho_{\text{cfb}} = \frac{\text{Weight, g}}{\text{453.6 g/lb}} \times \frac{\text{1,728 in}^3\text{/ft}^3}{\text{1.0 x 1.0 x L in}^3},\ \text{lb/ft}^3$$

6. Determine and record the density of each test sample. The numerically density of each test sample shall be nominally be 36 lb/ft^3 ±25% (i.e., within the range of 25.0 to 45.0 lb/ft^3).
7. Determine and record the average density of the three test samples. The numerically averaged density of the three test samples shall be nominally be 36 lb/ft^3 ±20% (i.e., within the range of 28.8 to 43.2 lb/ft^3).

8.1.4.2.4 Thermal Conductivity

1. The thermal conductivity test shall be performed using a Guarded-Hot-Plate (GHP) apparatus. The GHP is an absolute (or primary) method of measurement that establishes steady state unidirectional heat flux through a test specimen between two parallel plates at constant but different temperatures. By measurement of the plate temperatures and plate separation, Fourier's law of heat conduction is used by the GHP to calculate thermal conductivity. Description of a typical GHP test method is provided in ASTM C177. The GHP shall be calibrated against a traceable reference specimen per the GHP manufacturer's operating instructions.
2. Three (3) test samples shall be taken from a ceramic fiber board lot and a braided rope lot. Each test sample shall be of sufficient size to enable testing per the GHP manufacturer's operating instructions.
3. Place the test samples in a room (ambient) temperature environment (i.e., 65 ºF to 85 ºF) for sufficient time to thermally stabilize the test samples.
4. Measure and record the necessary test sample parameters as input data to the GHP per the GHP manufacturer's operating instructions.
5. Perform thermal conductivity testing and record the measured thermal conductivity for each test sample following the GHP manufacturer's operating instructions.
6. Determine and record the thermal conductivity of each test sample. The thermal conductivity of each test sample shall be within ±25% of the nominal value.
7. Determine and record the average thermal conductivity of the three test samples. The numerically averaged thermal conductivity of the three test samples shall be within ±20% of the nominal value.

8.1.4.3 Cadmium Sheeting

This section establishes the requirements and acceptance criteria for inspection and testing of cadmium sheeting utilized within the NPC packaging.

8.1.4.3.1 Cadmium Purity

The cadmium sheets used to wrap the exterior of the ICCA shall be purchased to ASTM B440-98[6]. except the cadmium supplier shall certify that the cadmium purity is 99.9% minimum. A sample of cadmium from each lot shall be independently analyzed to verify the 99.9% minimum cadmium purity has been met.

8.1.4.3.2 Cadmium Thickness

Prior to installation, each cadmium sheet used to wrap the ICCA shall be inspected for thickness at a minimum of two locations to verify the .020 inch minimum requirement. In addition, the cadmium sheets used to wrap a single ICCA shall be weighed to ±3 grams. Based upon the total cadmium weight, the initial ICCA average OD, the length of the cadmium wrap, and the density of cadmium (8.65 grams/cc), a calculation shall be made to determine the average cadmium thickness which shall be .021 inch minimum.

[6] ASTM B440-98, Standard Specification for Cadmium, American Society of Testing and Materials (ASTM)

8.1.4.4 Polyethylene Sheeting

This section establishes the requirements and acceptance criteria for inspection and testing of High Density Polyethylene (HDPE) sheeting utilized within the NPC packaging.

8.1.4.4.1 Polyethylene Composition

The supplier shall certify that the polyethylene is High Density Polyethylene (HDPE).

8.1.4.4.2 Density

Each lot of HDPE shall be verified to have a density value between 0.941 and 0.985 grams/cc.

8.1.4.4.3 Hydrogen Content

A sample of each lot of HDPE shall be analyzed for hydrogen content. The result of this analysis shall be 14.0 weight percent minimum.

8.1.4.4.4 Wrapped ICCA Polyethylene Weight Density

Each ICCA shall be weighed before and after polyethylene wrapping to ±3 grams. Based upon the pre-wrap average outer diameter of the ICCA, the wrapped polyethylene length, and the net polyethylene weight, a calculation shall be made to ensure that an equivalent polyethylene density minimum of 0.92 grams/cc for a minimum 0.57 inch thickness is satisfied.

8.1.4.4.5 Wrapped ICCA Hydrogen Areal Density

1. Measure and record the outer diameter of the ICCA shell with the cadmium sheet installed to an accuracy of ±0.03 inches. This diameter is the inner diameter (ID) of the polyethylene wrapping.
2. After installation of the polyethylene sheet, measure and record the height (H) of the polyethylene wrapping to an accuracy of ±0.1 inches.
3. Utilizing the polyethylene weight (W) determined in §8.1.4.4.4, *Wrapped ICCA Polyethylene Weight Density*, determine and record the hydrogen areal density of each ICCA utilizing the following formula:

$$\rho_{\text{H-areal}} = \frac{0.14\,(\text{W})}{\pi\,(\text{ID})\,(\text{H})\,(6.452\,\text{cm}^2/\text{in}^2)},\ \text{grams/cm}^2$$

4. The hydrogen areal density of each ICCA shall be a minimum of 0.199 grams/cm^2. This areal density value is based on minimum polyethylene thickness of 0.57 inches, a minimum polyethylene height of 30.3 inches, a minimum polyethylene density of 0.92 grams/cc, and a minimum polyethylene hydrogen content of 14.0%.

8.1.5 Test for Shielding Integrity

The NPC package does not contain any biological shielding.

8.1.6 Thermal Acceptance Tests

The material properties utilized in Chapter 3.0, *Thermal*, are consistently conservative for the Normal Conditions of Transport (NCT) thermal analysis performed. The Hypothetical Accident Condition (HAC) fire certification testing of the NPC package (see Section 2.10.1, *Certification Tests*) served to verify material performance in the HAC thermal environment. As such, with the exception of the tests required for specific packaging components, as discussed in Section 8.1.4, *Component Tests*, specific acceptance tests for material thermal properties are not required or performed.

8.1.7 ICCA Neutronic Confirmation

Prior to first use, each ICCA shall be evaluated utilizing neutron reflectometry techniques to confirm that the neutronic configuration is correct.

8.1.8 Neutron Moderating Stability of Polyurethane Foam

The polyurethane foam is highly durable and the stability of the hydrogen content (neutron moderating component) has been demonstrated for both NCT and HAC. Since the hydrogen is molecular in nature, there is no reason to suspect that its content or functionality will change. Notwithstanding these facts, archive samples of the 7-lb/ft^3 slab foam will be collected at the rate of one slab at random for each group of 50 packages fabricated. These archive samples will be sealed and retained so that in case of any suspected degradation of the packages during their life, the material will be quickly available for evaluation.

Table 8-1.1 - Foam Thermal Conductivity at 65 ºF to 85 ºF

Thermal Conductivity (BTU-in)/(hr-ft^2 - ^{0}F)					
Density (lb/ft^3)	**Nominal -25%**	**Nominal –20%**	**Nominal**	**Nominal +20%**	**Nominal +25%**
7	0.188	0.200	0.250	0.300	0.313
11	0.217	0.231	0.289	0.347	0.361
15	0.245	0.262	0.327	0.392	0.409
40	0.420	0.448	0.560	0.672	0.700

Table 8-1.2 - Acceptable Compressive Strength Ranges for 7 lb/ft^3 Foam (psi)

Sample Range	Parallel-to-Rise at Strain, $\varepsilon_{//}$			Perpendicular-to-Rise at Strain, $\varepsilon_{\perp}$		
	ε = 10%	ε = 40%	ε = 70%	ε = 10%	ε = 40%	ε = 70%
Nominal –25%	145	156	369	120	140	363
Nominal –20%	154	166	394	128	150	387
Nominal –15%	164	177	418	136	159	411
Nominal	193	208	492	160	187	484
Nominal +15%	222	239	566	184	215	557
Nominal +20%	232	250	590	192	224	581
Nominal +25%	241	260	615	200	234	605

Table 8-1.3 – Acceptable Compressive Strength for 11 lb/ft^3 Foam (psi)

Sample Range	Parallel-to-Rise at Strain, $\varepsilon_{//}$			Perpendicular-to-Rise at Strain, $\varepsilon_{\perp}$		
	ε = 10%	ε = 40%	ε = 70%	ε = 10%	ε = 40%	ε = 70%
Nominal –25%	304	344	963	299	337	983
Nominal –20%	324	366	1027	318	359	1049
Nominal –15%	344	389	1091	338	382	1114
Nominal	405	458	1284	398	449	1311
Nominal +15%	466	527	1477	458	516	1508
Nominal +20%	486	550	1541	478	539	1573
Nominal +25%	506	573	1605	498	561	1639

Table 8-1.4 – Acceptable Compressive Strength for 15 lb/ft^3 Foam (psi)

Sample Range	Parallel-to-Rise at Strain, $\varepsilon_{//}$			Perpendicular-to-Rise at Strain, $\varepsilon_{\perp}$		
	ε = 10%	ε = 40%	ε = 70%	ε = 10%	ε = 40%	ε = 70%
Nominal –25%	522	613	1940	541	631	1964
Nominal –20%	556	654	2070	577	673	2095
Nominal –15%	591	694	2199	613	715	2226
Nominal	695	817	2587	721	841	2619
Nominal +15%	800	940	2975	829	967	3012
Nominal +20%	834	980	3104	865	1009	3143
Nominal +25%	869	1021	3234	901	1051	3274

8.2 Maintenance Program

This section describes the maintenance program used to ensure continued performance of the NPC package.

8.2.1 Structural and Pressure Tests

8.2.1.1 Lifting/Tie-Down Device Load Testing

The NPC package does not contain any lifting/tie-down devices that require load testing.

8.2.1.2 Containment Boundary Pressure Testing

No pressure tests are necessary to ensure continued performance of the NPC packaging.

8.2.2 Leak Tests

No leak tests are necessary to ensure continued performance of the NPC packaging.

8.2.3 Subsystem Maintenance

8.2.3.1 Fasteners

All threaded components shall be inspected prior to each use for deformed or stripped threads. Damaged components shall be repaired or replaced prior to further use. The threaded components to be visually inspected are the OCA closure lid bolts, the OCA closure strip socket head cap screws, and the T-bolts on the band clamp assembly for the ICCA closure lids. The nylon locking nut utilized on the T-bolt for the band clamp assemblies shall be replaced after each use.

8.2.3.2 Ceramic Fiber Braided Rope

Prior to each use, inspect the ceramic fiber braided rope for tears, damage, or deterioration.

8.2.4 Valves, Rupture Disks, and Gaskets on Containment Vessel

8.2.4.1 Valves

The NPC packaging does not contain any valves.

8.2.4.2 Rupture Disks

The NPC packaging does not contain any rupture disks.

8.2.4.3 Gaskets

The gaskets on the ICCAs shall be replaced when damaged, per the size and material requirements delineated on the drawings in Appendix 1.3.1, *Packaging General Arrangement Drawings*.

8.2.5 Shielding

The NPC packaging does not contain any biological shielding.

8.2.6 Thermal

No thermal tests are necessary to ensure continued performance of the NPC packaging.

8.2.7 ICCA Neutronic Confirmation

Five (5) years after the initial service date and every 5 years thereafter, a 1% random sample of the ICCAs will be re-evaluated using neutron reflectometry (or equivalent) techniques to confirm that the neutronic configuration remains correct. If any ICCA is rejected, the entire population representative of the suspect production batch shall be 100% re-evaluated and all nonconforming items eliminated from use.