https://doi.org/10.61092/iaea.wvm4-7mrk

INDC(NDS)-0751
Distr. G+IN+J

IAEA
International Atomic Energy Agency

INDC International Nuclear Data Committee

On the Benchmarking of New Evaluated Nuclear Data Libraries

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March 2018

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Printed by the IAEA in Austria

March 2018

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Contents

1. Introduction

New evaluated nuclear data libraries ENDF/B-VIII and JEFF-3.3 were released recently. The impact of these libraries on reactor criticality is of considerable interest, especially since in the new evaluations quite radical changes were made to the cross sections and other parameters of the major reactor core constituents. Although the changes are supported by differential data, they could in principle lead to a degradation of performance, since the old libraries were tuned to improve performance.

The purpose of this report is not to suggest that one library is better than the other, but mainly to show where problems exist (in the data and in the benchmark assessment) so that further improvements can be made.

2. Scope

The chosen reference "old" library was ENDF/B-VII.1. New calculations were performed with the JEFF-3.3 library (labelled "jeff33") and the ENDF/B-VIII library (labelled "e80b6").

Criticality benchmarks from the ICSBEP compilation were considered for the analysis. The analysis was limited to uranium-fuelled assemblies.

Calculations were done with the MCNP-6.1 Monte Carlo transport code. Benchmark input models were taken from the ICSBEP distribution, several were obtained from A. Kahler, B. Kos and others (private communication) and a few were developed locally, based on templates from similar cases.

3. Bulk criticality benchmark test

The LANL Mosteller suite of 119 selected benchmarks is often used as a reference for the performance of evaluated data libraries. A direct comparison of the differences between the calculated k_{eff} values and reference benchmark values is not very informative, as can be seen from Fig. 3.1.

A better representation seems to be the cumulative Chi-square per degree of freedom, shown in Fig. 3.2. However, even in this case it is obvious that the contribution to Chi^2/DoF is dominated by few groups of benchmarks with very low quoted uncertainties. For example, The Jemima-3 and -4 have a quoted uncertainty of 30 pcm (parts per 100 000), which makes ENDF/B-VII.1 library look distinctly bad, even though the differences in the calculated value from the reference are of the order of 200 pcm.

If we consider that any uncertainty in the benchmark k_{eff} below 200 pcm is unreasonable and assume this value as the minimum uncertainty of any benchmark, the plot of cumulative Chi^2/DoF is shown in Fig. 3.3. The performance of the new libraries is still better than ENDF/B-VII.1, although there are cases where this old library has some advantage.

With the extended minimum uncertainty and considering only cases that fall outside this extended uncertainty band we are left with 35 cases, shown in Fig. 3.4 (at first sight this number of outliers seems to be statistically consistent, but one should not overlook the fact that many benchmark cases are correlated). Curiously, the JEFF-3.3 library seems to perform best, according to the current criteria. For the ENDF/B-VIII library this means that the benchmarks, which are predicted well, are predicted even better, while the outliers seem to diverge further. There could be two reasons for such behaviour:

- The outliers are sensitive to secondary materials that have not been revised (or not revised carefully enough) in the ENDF/B-VIII library.
- There are hidden sources of error in some benchmark specifications.

To shed more light on bulk benchmark calculation the test was performed on a series of over 1000 benchmark cases that have been compiled for testing at the IAEA. The cumulative Chi^2/Dof for the benchmarks listed in Appendix A.2 is shown in Fig. 3.5. Numerical results are given in Appendix A.3. The biggest contributions come from the ORNL bare cylinders HEU-MET-FAST-051, some of which have ridiculously low uncertainties of 10 pcm, and the Valduc HEU-MET-THERM-011 water-moderated highly-enriched uranium benchmarks. The latter are quoted with a relatively low uncertainty and all libraries over-predict reactivity, especially for the well-thermalised systems; the JEFF-3.3 library shows marginally better agreement, but due to the low assigned benchmark uncertainty these benchmarks swing the Chi^2/DoF figure of merit in favour of JEFF-3.3. Further discussion on these benchmarks can be found in the section describing HEU-MET-THERM group of benchmarks (see section 4.8 and Fig. 4.8.1).

The lesson learned is that bulk benchmarking is useful for scoping studies to identify big outliers, but from then onwards each group of benchmarks must be reviewed very carefully. It is obvious that in some cases the uncertainties in the benchmarks are grossly underestimated, and they do not provide sufficient information on the contributions to the uncertainties that are correlated with other cases and/or other benchmark groups. For this reason, the study was extended to treat each group of benchmarks separately as classified in the ICSBEP Handbook, with subdivisions into sub-groups, when appropriate.

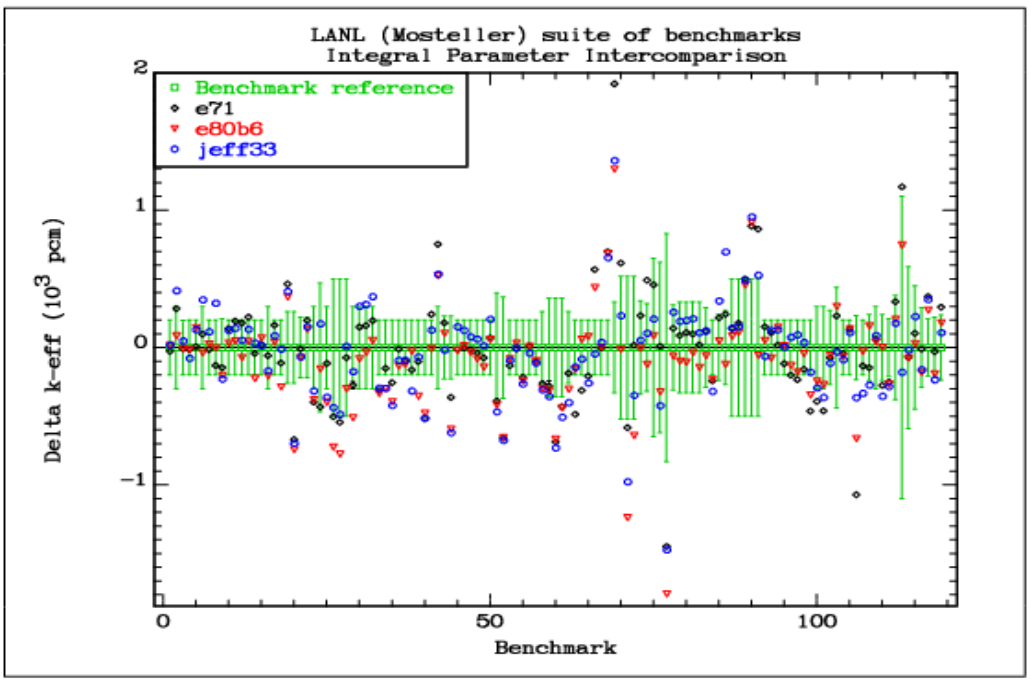

FIG. 3.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the Mosteller suite of 119 benchmark cases.

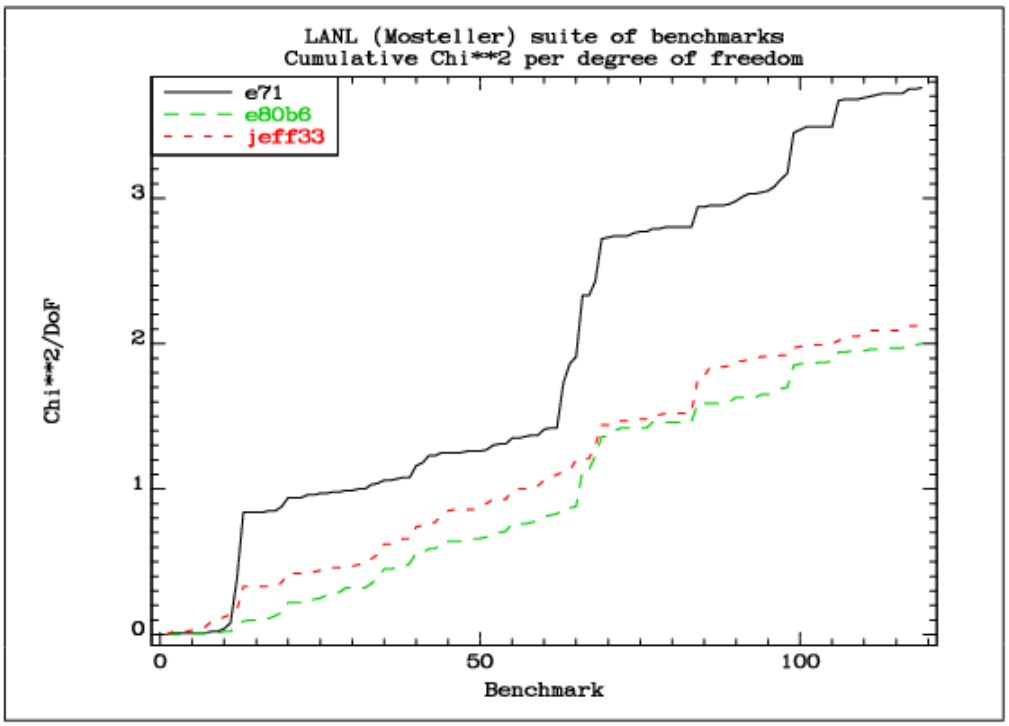

FIG. 3.2. Cumulative Chi-square per degree of freedom for the Mosteller suite of 119 benchmark cases.

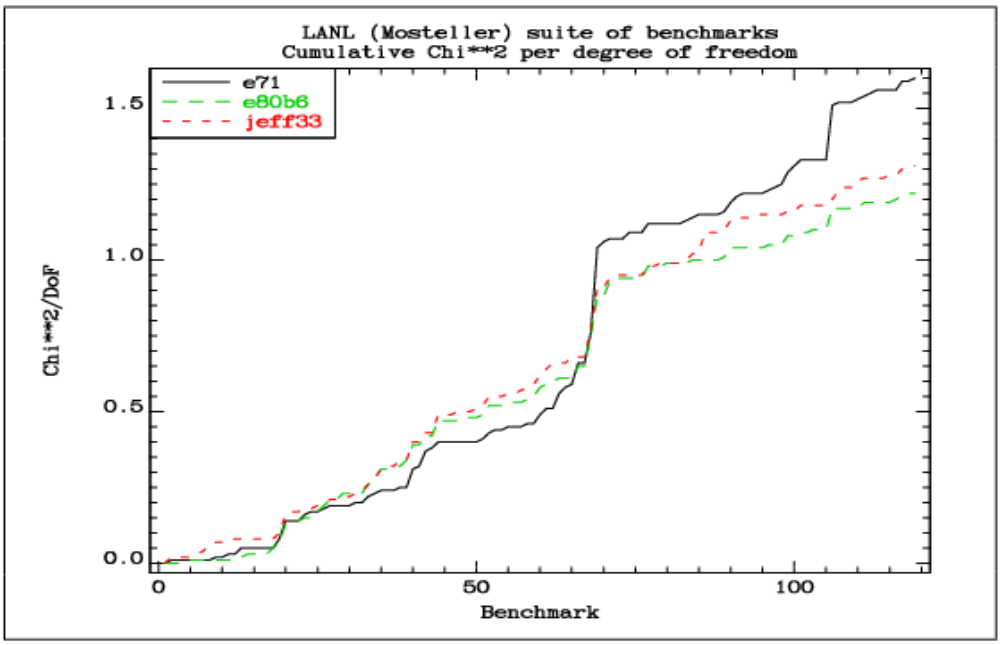

FIG. 3.3. Cumulative Chi-square per degree of freedom for the Mosteller suite of 119 benchmark cases assigning a minimum uncertainty of any benchmark to be 200 pcm.

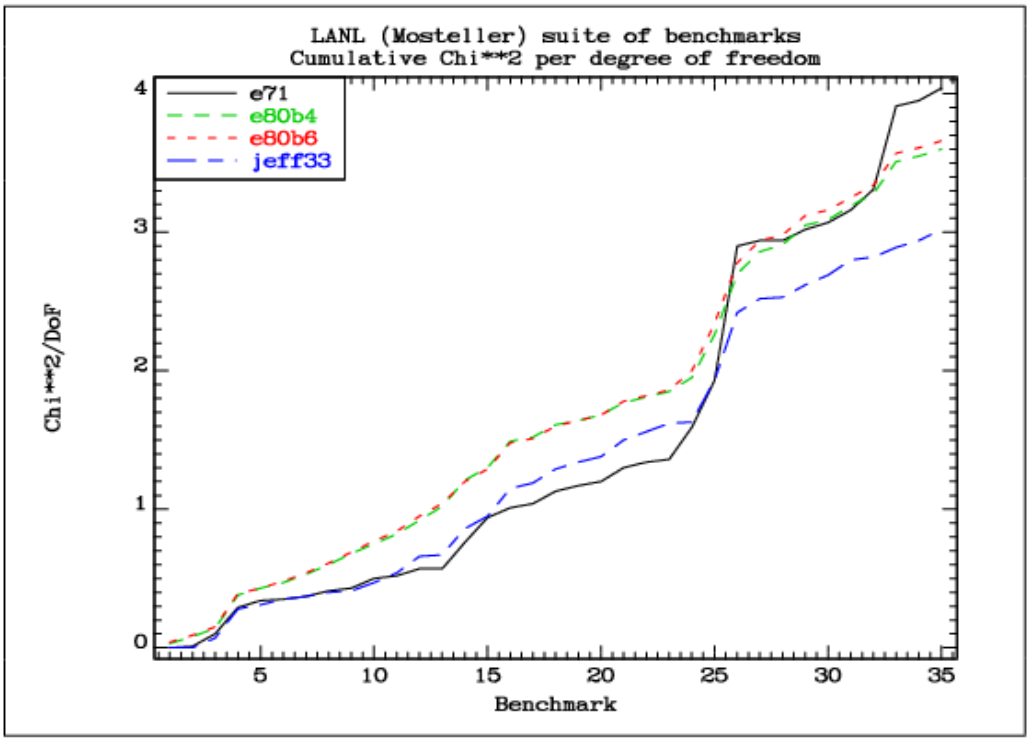

FIG. 3.4. Cumulative Chi-square per degree of freedom for the Mosteller suite of 119 benchmark but excluding cases that lie within one-sigma of the extended uncertainty interval (min. 200 pcm).

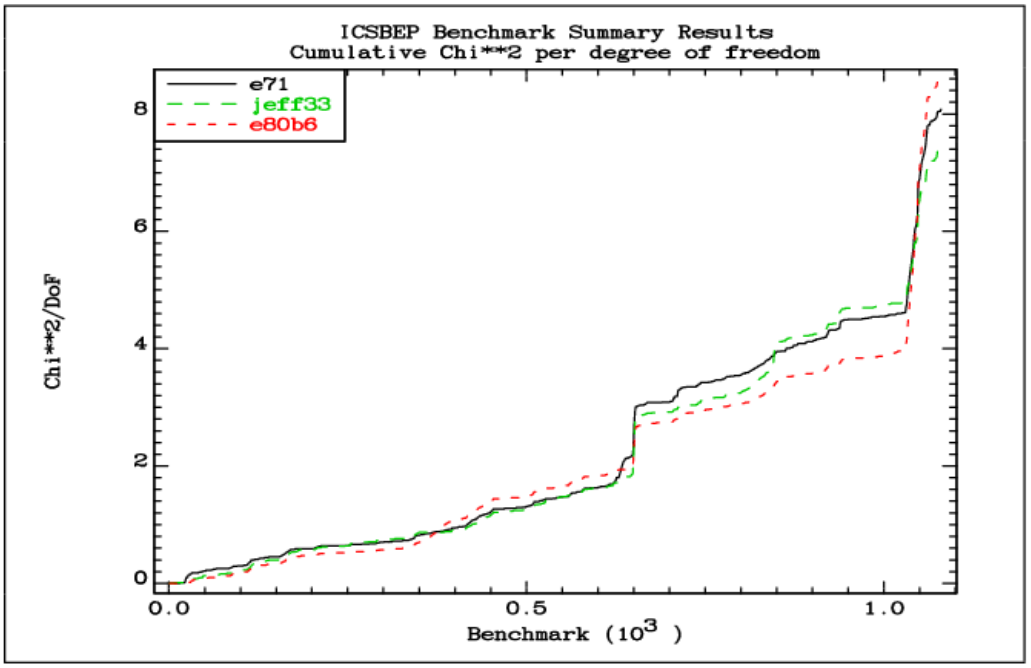

FIG. 3.5. Cumulative Chi-square per degree of freedom for the full IAEA suite of 1000 benchmark cases.

4. Highly-enriched uranium reactor benchmarks

4.1. Short list of fast reactor benchmarks

The short list of benchmarks is given below. The selection is based on a somewhat subjective judgement about the reliability of the benchmarks, considering the fact that they were frequently applied in the verification/validation of nuclear data. The results are shown in Fig. 4.1.1. The results with the ENDF/B-VIII library are flat and lie within the uncertainty intervals, greatly reducing the scattering seen in the ENDF/B-VII.1 results. In this respect the JEFF-3.3 library performs somewhat worse. An exception to this pattern is the PU-MET-FAST-029 benchmark, which seems quite insensitive to the changes in the nuclear data and the reactivity is predicted low with all libraries.

No.	ICSBEP Label	Short name	Common name
1	HEU-MET-FAST-001	hmf001	Godiva
2	HEU-MET-FAST-028	hmf028	Flattop-25
3	IEU-MET-FAST-007	imf007d	Big_Ten(detailed)
4	PU-MET-FAST-001	pmf001	Jezebel
5	PU-MET-FAST-002	pmf002	Jezebel-240
6	PU-MET-FAST-006	pmf006	Flattop-Pu
7	U233-MET-FAST-001	umf001	Jezebel-U233
8	U233-MET-FAST-006	umf006	Flattop-23
9	PU-MET-FAST-022	pmf022	Bare(98% Pu-239)
10	PU-MET-FAST-029	pmf029	Bare(88% Pu-239)
11	IEU-MET-FAST-001	imf001-001d	Jemima-1d
12	IEU-MET-FAST-001	imf001-002d	Jemima-2d
13	IEU-MET-FAST-001	imf001-003d	Jemima-3d
14	IEU-MET-FAST-001	imf001-004d	Jemima-4d

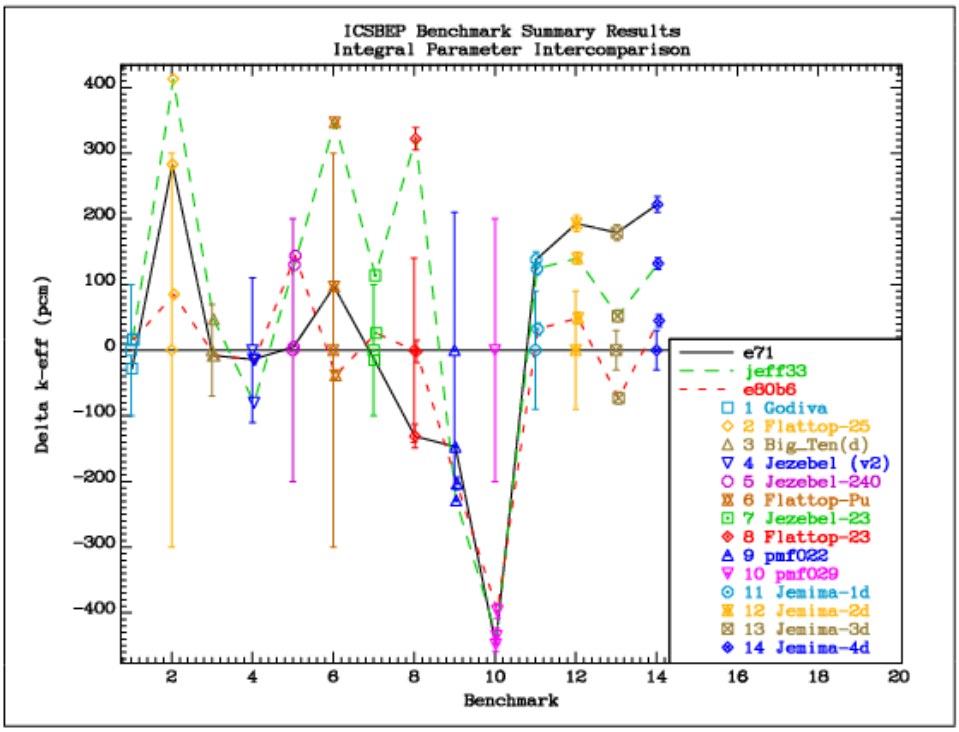

FIG. 4.1.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the selected short list of fast benchmark cases.

4.2. HEU-COMP-INTER

The benchmark suite of the IAEA includes HEU-COMP-INTER-003 (Comet facility with uranium hydride fuel and different reflectors), HEU-COMP-INTER-004 (HISS k_{inf} measurement) and HEU-COMP-INTER-005 (KBR k_{inf} measurements). It is immediately obvious that the k_{inf} measurements need to be treated separately due to the very large sensitivities.

The results for the Comet benchmarks are shown in Fig. 4.2.1. The first four benchmarks have a thick outer ^{238}U reflector and various materials for the inner reflector; they tend to over-predict reactivity slightly. The over-prediction is larger with the JEFF-3.3 library. The remaining three cases with only inner reflector of different materials lie within the experimental uncertainties. The differences are weakly related to the reflector material.

Benchmark	Reflector (outer/inner)
COMET-UH3-1	Depleted U38/Depleted U238
COMET-UH3-2	Depleted U238/Be
COMET-UH3-3	Depleted U238/Be
COMET-UH3-4	Depleted U238/Fe
COMET-UH3-5	none/Be
COMET-UH3-6	none/Depleted U238
COMET-UH3-7	none/Depleted U238

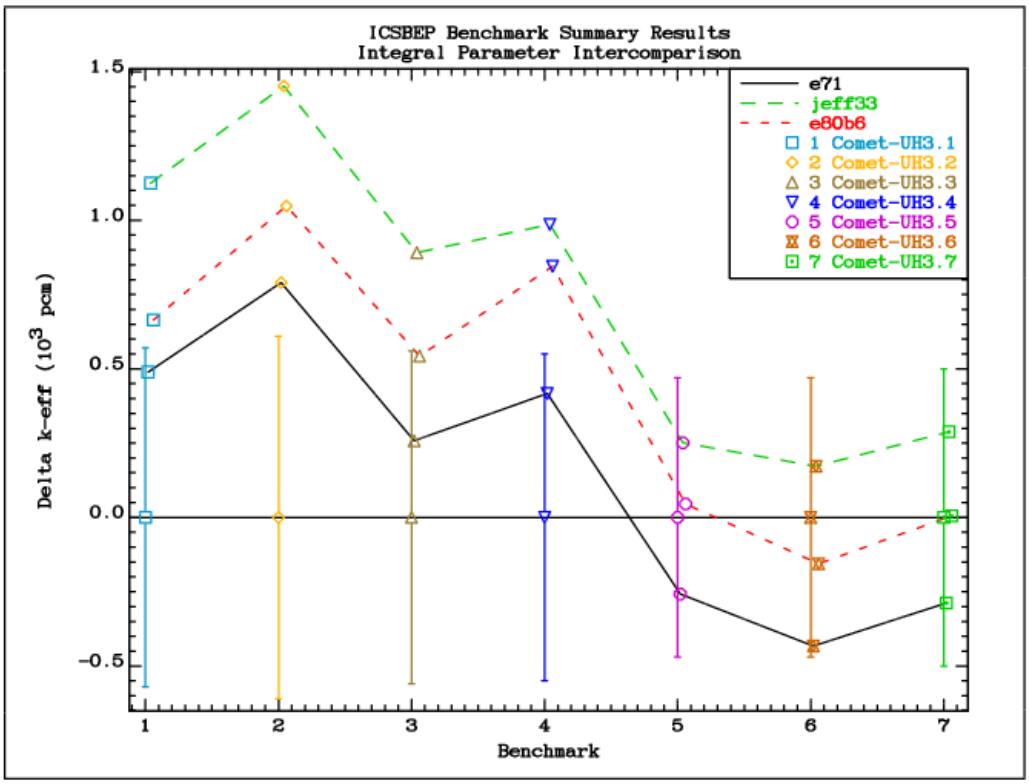

FIG. 4.2.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-COMP-INTER-003 (Comet) assemblies with different reflectors.

Measurements of k_{inf} are highly sensitive to the capture cross section. In spite of the large corrections from calculations in estimating the measured k_{inf} and the large associated uncertainties, these benchmarks are nevertheless useful for data validation. The HISS experiment (HEU-COMP-INTER-004) for ^{235}U and the KBR series of experiments (HEU-COMP-INTER-005) for the structural materials are listed in Table 4.1 below. The stainless steel KBR-09(SS) and the chromium KBR-15(Cr) benchmarks contain chromium in the measured sample, as shown in the Table 4.2 below. However, the stainless steel fuel can and tubing also contain chromium, which affects all benchmarks of the series.

The k_{inf} benchmarks show large discrepancies. There are differences in the results for the benchmarks containing nickel using the cross sections from the JEFF-3.3 and ENDF/B-VIII.0 libraries; they both deviate from the reference benchmark value but in the opposite direction. The largest discrepancies seem to arise with chromium and are similar in all libraries. The case of stainless-steel sample is most likely over-predicted for the same reason. The zirconium data in the most recent libraries seem to perform better compared to the ENDF/B-VII.1 library, but still tend to under-predict reactivity. The results are shown in Fig. 4.2.2.

The capture cross sections of ^{53}Cr differ strongly in different evaluated data library, as seen from Fig. 4.2.3. The capture cross section in BROND-3.1 was renormalized to the preliminary measurements by Guber and is significantly higher compared to other libraries. The final published capture cross section data were lower. The cross sections for ^{50}Cr in all libraries adopt the same resonance parameters, so there is no impact due to the substitution of ^{50}Cr data between different libraries. The capture cross sections of the minor Cr isotopes are shown on Fig. 4.2.4. The evaluation of the resonance parameters of the minor Cr isotopes is difficult because the resonances of ^{50}Cr and ^{53}Cr near 5 keV overlap; one should also note the strong resonance of ^{52}Cr just below 2 keV.

It is interesting to note that substituting the BROND-3.1 data for $^{50,53}Cr$ into the e80b6 library (label e80b6Crb31 in Fig. 4.2.2) greatly reduces the discrepancy between the calculated and the benchmark k_{inf} in the KBR benchmarks (the HISS benchmark contains no chromium and is not affected).

TABLE 4.1. LIST OF k_{inf} BENCHMARKS

No.	ICSBEP label	Short name	Common name
1	HEU-COMP-INTER-004	hci004	HISS
2	HEU-COMP-INTER-005	hci005-007	KBR-07(Ni)
3	HEU-COMP-INTER-005	hci005-009	KBR-09(SS)
4	HEU-COMP-INTER-005	hci005-010	KBR-10(Mo)
5	HEU-COMP-INTER-005	hci005-015	KBR-15(Cr)
6	HEU-COMP-INTER-005	hci005-016	KBR-16(Zr)

TABLE 4.2. COMPOSITION IN WEIGHT PERCENT OF THE MEASURED SAMPLES IN DIFFERENT CASES

	KBR-07(Ni)	KBR-09(SS)	KBR-10(Mo)	KBR-15(Cr)	KBR-16(Zr)
Fe	-	69.8	-	.16	-
Ni	99.9	10.2	-	-	-
Mn	-	1.2	-	-	-
Mo	-	-	100.	-	-
Cr	-	17.6	-	99.23	-
Zr	-	-	-	-	99.95

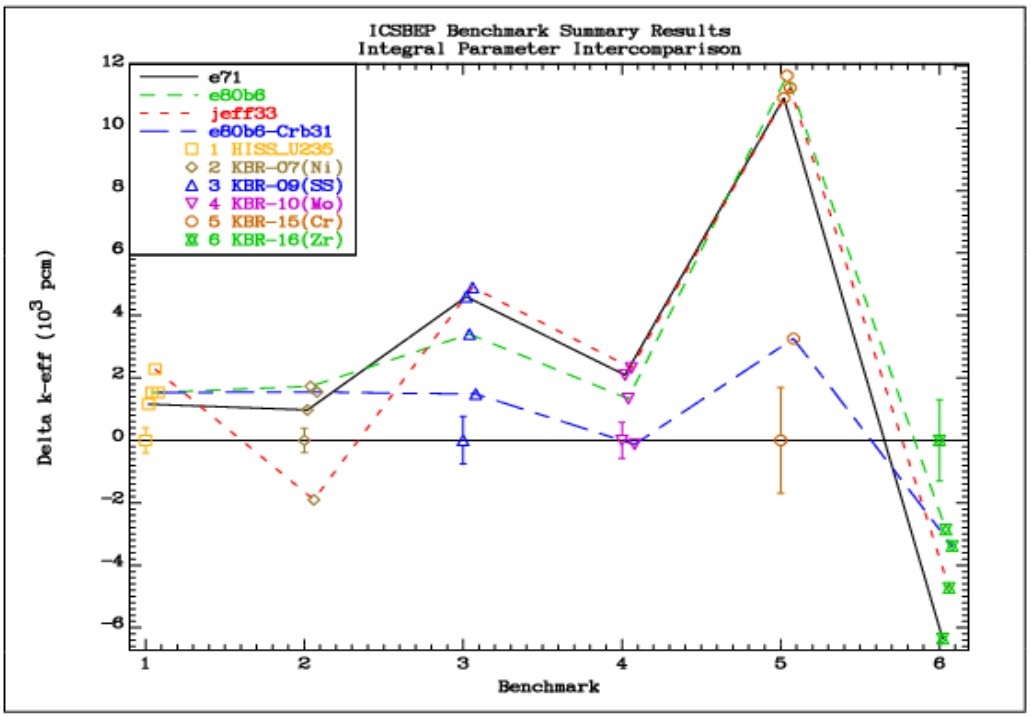

FIG. 4.2.2. Comparison of the differences between the calculated k_{inf} values and the reference benchmark values for the HISS and KBR benchmarks.

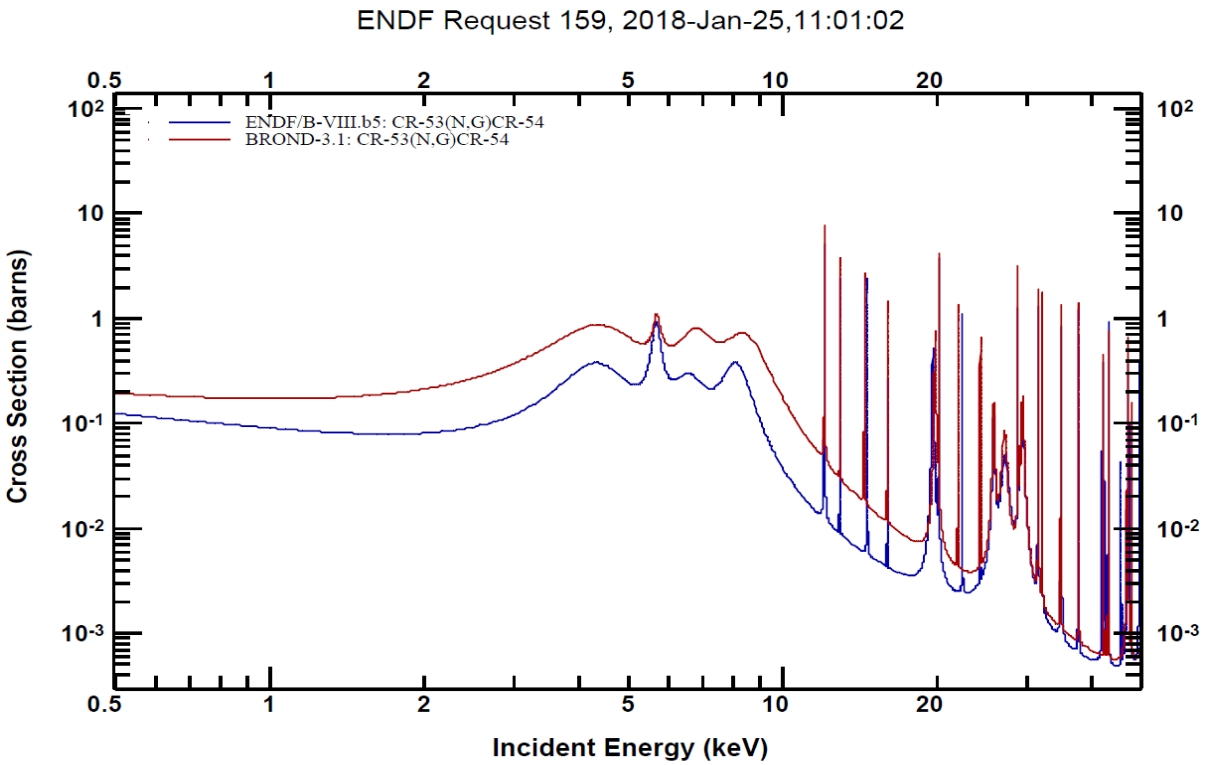

FIG. 4.2.3. Comparison of the $^{53}Cr(n,g)$ cross sections from the ENDF/B-VIII. and BROND-3.1 libraries. The Cross sections in ENDF/B-VII.1 are identical to ENDF/B-VIII.

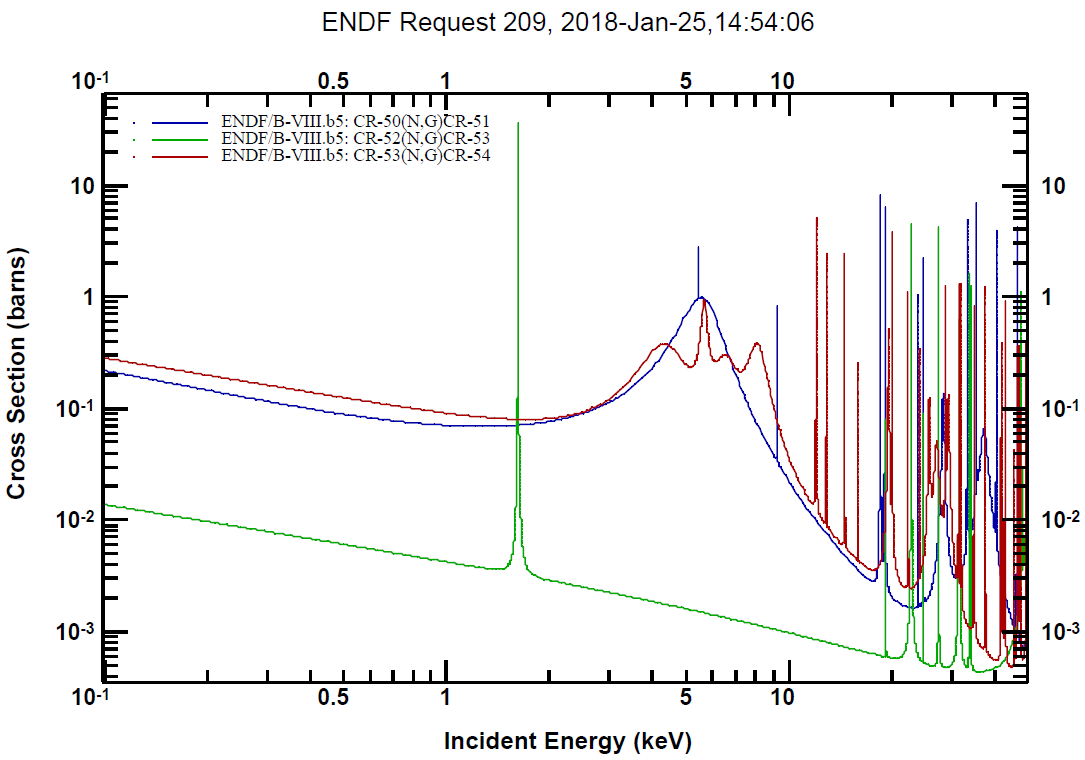

FIG. 4.2.4. Comparison of the capture cross sections of the minor Cr isotopes from the ENDF/B-VIII library.

4.3. HEU-COMP-MIXED

The benchmark suite of the IAEA includes HEU-COMP-MIXED-002 and HEU-COMP-MIXED-003. The quoted uncertainty in the latter is given for the precision of the reactivity measurement itself, which is estimated at 1 pcm and neglects all other contribution. This benchmark is useless for the validation of nuclear data. The HEU-COMP-MIXED-002 benchmarks performed at the IPPE in Obninsk include fuel immersed in mixtures of light and heavy water and are shown in Fig. 4.3.1. The quoted uncertainties are fairly large, but the calculated values with all libraries are similar and under-predict reactivity by more than the benchmark uncertainty. A moderate trend with spectrum hardness is observed, expressed as the fraction of the epithermal flux (FEPIT).

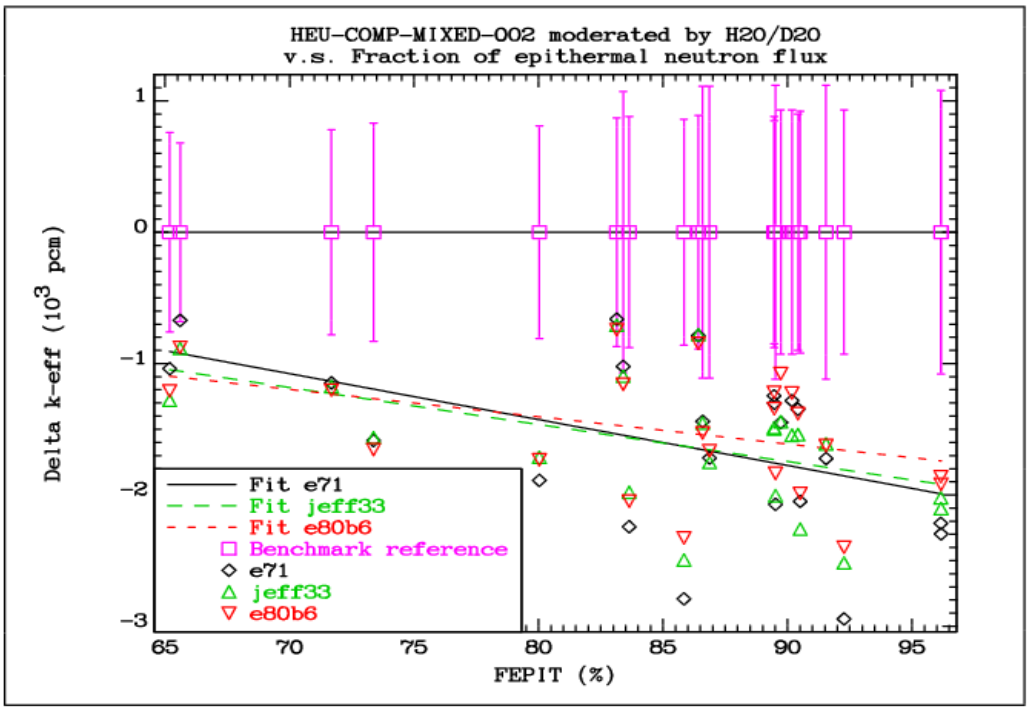

FIG. 4.3.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values as a function of the epithermal fission fraction (FEPIT) for the HEU-COMP-MIXED-002 benchmarks.

4.4. HEU-COMP-THERM

This group of benchmarks includes HEU-COMP-THERM-021, which are the Th-U (TUPE) assemblies and contain 100 cases. The data seem to be scattered and no systematic trend could be distinctly identified. In the documentation some doubts are expressed about the Lucite spacers, but a separate study in the Appendix C of the ICSBEP document suggests that the impact of the spacers on reactivity is small. The spacers were not included in the models. The results as a function of boron concentration are shown in Fig. 4.4.1. No significant differences between the results using different libraries are observed.

The list of the remaining benchmarks is given in Table 4.3 and the results are shown in Fig. 4.4.2. There seems to be a decreasing trend in reactivity with increasing epithermal fission fraction manifested in HEU-COMP-THERM-002, HEU-COMP-THERM-007, HEU-COMP-THERM-011, HEU-COMP-THERM-015 and HEU-COMP-THERM-018.

The cladding in the RRC-KI assemblies is stainless steel (cases with the epithermal fission fraction greater than 14 % in Fig. 4.4.2). A separate study was made to investigate the impact of replacing the Cr data with BROND-3.1, as in the case of the KBR benchmark analysis in Section 4.2. It was found that reactivity of these benchmarks decreases systematically and does not reduce the gradient of the trend as a function of the epithermal fission fraction.

TABLE 4.3. LIST OF HIGHLY-ENRICHED URANIUM COMPOUND BENCHMARKS

No.	ICSBEP Label	Short name	Common name
1	HEU-COMP-THERM-002	hct002-19	NRX-A_19
2	HEU-COMP-THERM-002	hct002-18	NRX-A_18
3	HEU-COMP-THERM-002	hct002-11	NRX-A_11
4	HEU-COMP-THERM-002	hct002-23	NRX-A_23
5	HEU-COMP-THERM-002	hct002-03	NRX-A_03
6	HEU-COMP-THERM-015	hct015-11	SB-1
7	HEU-COMP-THERM-015	hct015-15	SB-5
8	HEU-COMP-THERM-011	hct011-001	RRC-KI-22x22-001
9	HEU-COMP-THERM-011	hct011-002	RRC-KI-22x22-002
10	HEU-COMP-THERM-011	hct011-003	RRC-KI-22x22-003
11	HEU-COMP-THERM-012	hct012-001	RRC-KI-18x18-001
12	HEU-COMP-THERM-012	hct012-002	RRC-KI-18x18-002
13	HEU-COMP-THERM-013	hct013-001	RRC-KI-14x14-001
14	HEU-COMP-THERM-013	hct013-002	RRC-KI-14x14-002
15	HEU-COMP-THERM-014	hct014-001	RRC-KI-10x10-001
16	HEU-COMP-THERM-014	hct014-002	RRC-KI-10x10-002
17	HEU-COMP-THERM-018	hct018-001	ETA-I
18	HEU-COMP-THERM-007	hct007-2	RRCt-2

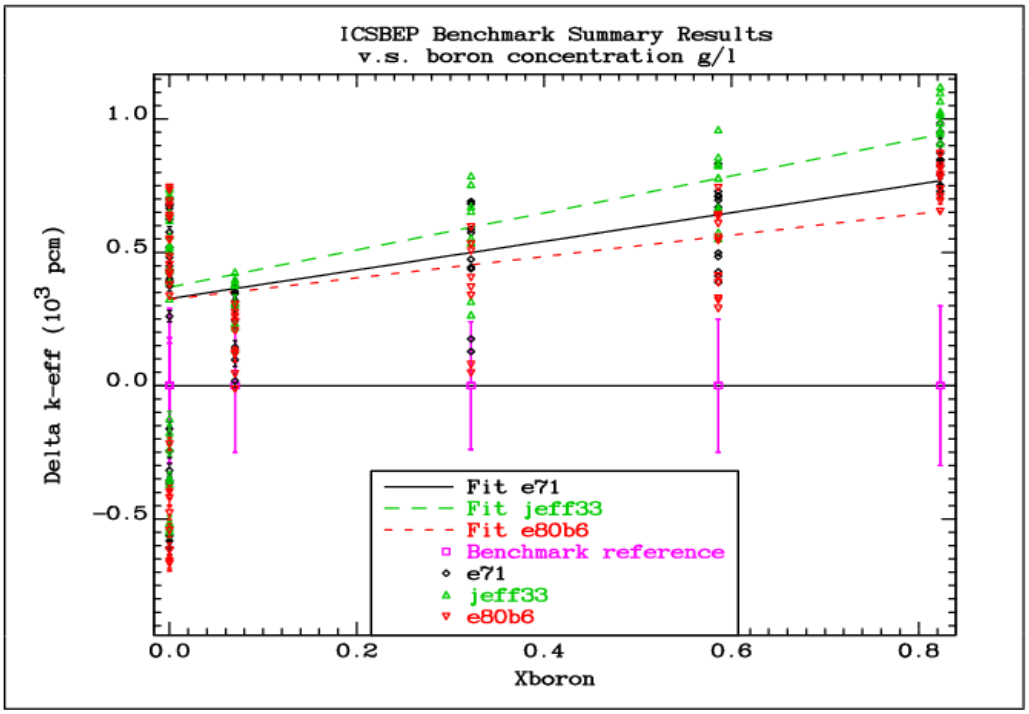

FIG. 4.4.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the "HEU-COMP-THERM-021" benchmarks as a function of boron concentration [g/l].

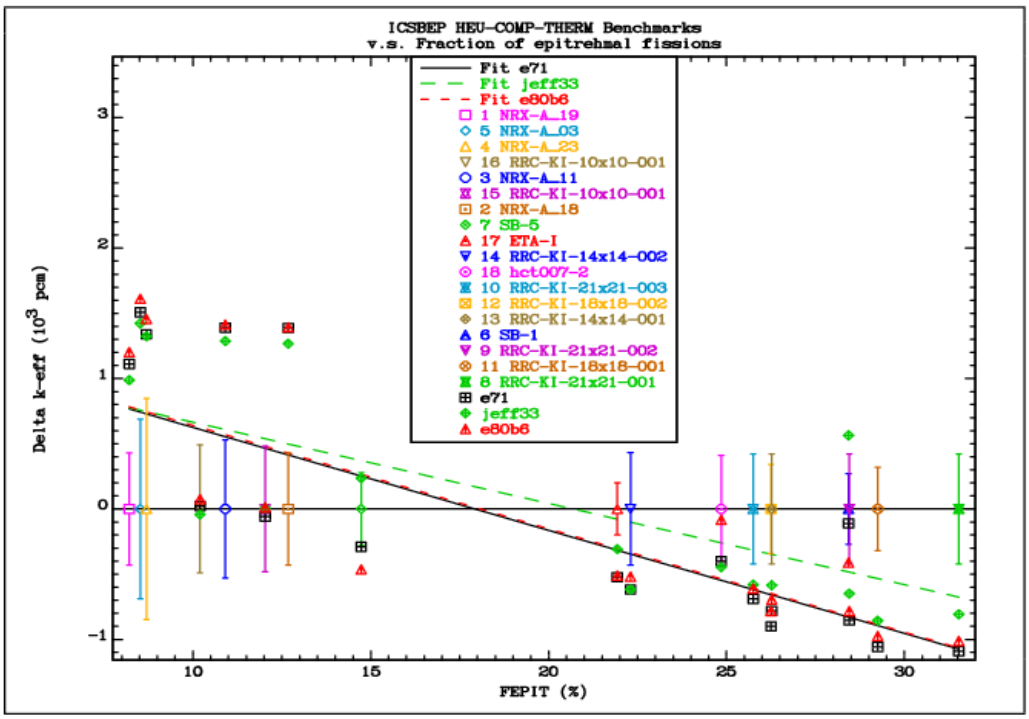

FIG. 4.4.2. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the "HEU-COMP-THERM" benchmarks (excluding the group HEU-COMP-THERM-021) as a function of the epithermal fission fraction.

4.5. HEU-MET-FAST

Numerous benchmarks are available for this group, as shown in Fig. 4.5.1. They include bare assemblies, as well as assemblies with different reflectors and various configurations with different materials. Fig. 4.5.2 clearly shows that only a few groups of benchmarks are responsible for large contributions to the cumulative Chi^2/DoF. Such cases are identified by splitting the list into sub-groups and analysed separately.

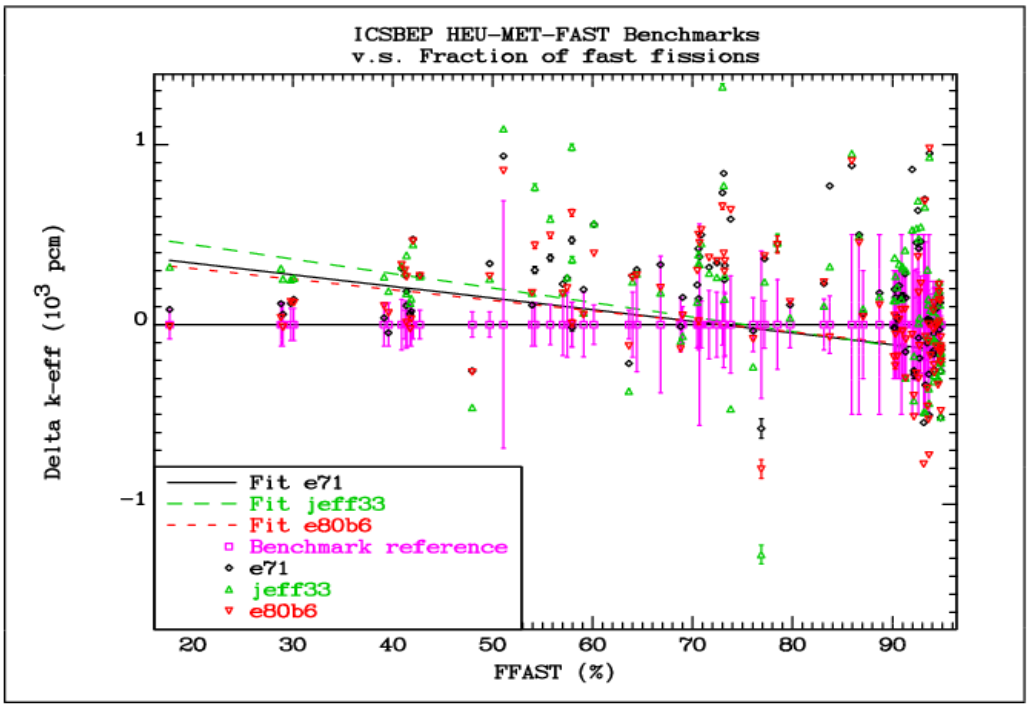

FIG. 4.5.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-MET-FAST group of benchmarks from the full IAEA suite of 1000 benchmark cases as a function of the fast fission fraction.

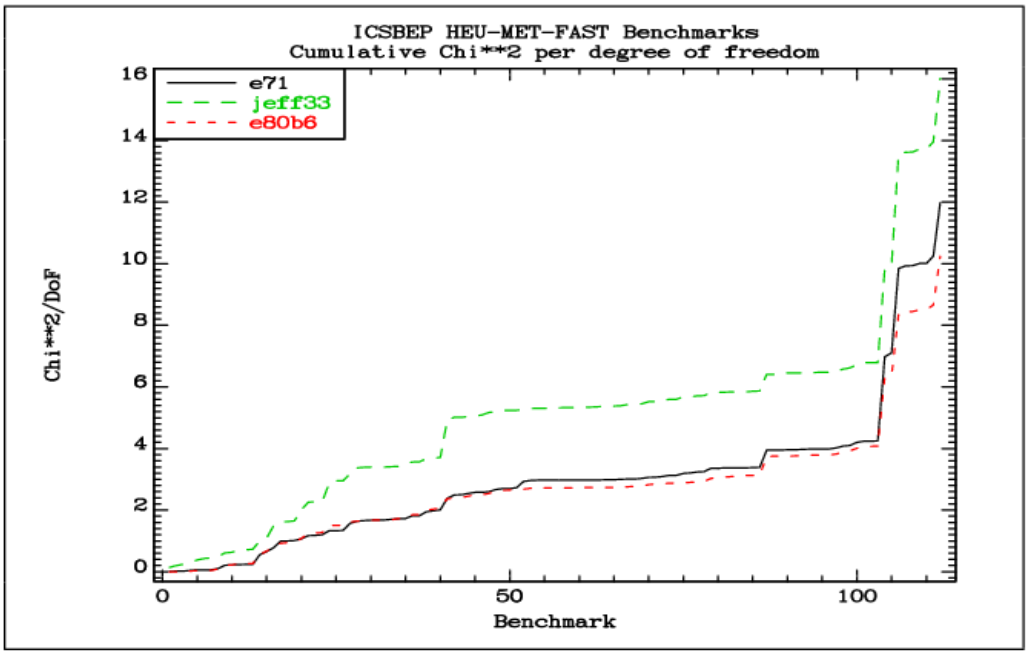

FIG. 4.5.2. Cumulative Chi-square per degree of freedom for the HEU-MET FAST group of benchmarks from the full IAEA suite of 1000 benchmark cases.

4.5.1. Bare assemblies

Highly-enriched uranium assemblies should be a clean case, since they primarily depend on the cross sections of ^{235}U. The benchmarks are listed below. Only six cases out of 18 from the ORNL assemblies are chosen, since they all show similar trends; the benchmarks are listed in Table 4.4.

TABLE 4.4. SHORT LIST OF FAST REACTOR BENCHMARKS

No#	ICSBEP label	Short name	Common name
1	HEU-MET-FAST-001	hmf001	Godiva
2	HEU-MET-FAST-008	hmf008	VNIIEF-CTF-bare
3	HEU-MET-FAST-015	hmf015	VNIIEF-CTF-UnrCy1
4	HEU-MET-FAST-065	hmf065	VNIIEF-CTF-UnrCy2
5	HEU-MET-FAST-018	hmf018	VNIIEF_Sphere
6	HEU-MET-FAST-051	hmf051-01	ORCEF-01
7	HEU-MET-FAST-051	hmf051-02	ORCEF-02
8	HEU-MET-FAST-051	hmf051-03	ORCEF-03
9	HEU-MET-FAST-051	hmf051-15	ORCEF-15
10	HEU-MET-FAST-051	hmf051-16	ORCEF-16
11	HEU-MET-FAST-051	hmf051-17	ORCEF-17
12	HEU-MET-FAST-100	hmf100-1	ORSphere-1
13	HEU-MET-FAST-100	hmf100-2	ORSphere-2
14	HEU-MET-FAST-080	hmf080	Caliban

The results are shown in Fig. 4.5.3. The Dice system from the NEA Data Bank shows that the sensitivity profiles for all of them are practically the same, which means that a change in any of the cross sections affects the calculated results in the same way. Hence, no improvement in the calculated results can be expected from the improvements in nuclear data. This problem has been reported already at the ND2016 Conference and at the CSEWG Meetings in 2016 and 2017. It has also been reported to the ICSBEP coordinator, but no recommendations or updates to the relevant benchmarks were received so far. In particular:

- The Russian bare cylinders and spheres HEU-MET-FAST-008, HEU-MET-FAST-015, HEU-MET-FAST-065, and HEU-MET-FAST-018 show a spread of more than 500 pcm with a bias to a lower reactivity using exactly the same nuclear data as the benchmarks mentioned above that showed good agreement. Therefore, HEU-MET-FAST-008, HEU-MET-FAST-015, HEU-MET-FAST-065 benchmark specifications or computational models require attention if we assume that HEU-MET-FAST-001 and HEU-MET-FAST-018 are acceptable.
- The Oak Ridge cylinders HEU-MET-FAST-051 have a relatively small spread, but the predicted reactivity is lower compared to Godiva (HEU-MET-FAST-001) by about 250 pcm. The HEU-MET-FAST-051 suite actually includes 18 cases and they all show a similar trend. Cases 15, 16 and 17 have uncertainties of 10 pcm, which are not credible. On the other hand, the two Oak Ridge spheres HEU-MET-FAST-100 cases are high compared to Godiva by about 200 pcm. Overall, the Oak Ridge benchmarks also have a spread of nearly 500 pcm. Therefore, ORNL benchmark specifications or computational models may need some attention.
- The predicted reactivity of the French Caliban cylindrical assembly HEU-MET-FAST-080 is by far the highest, differing by nearly 1000 pcm from the average. A quick review of the input model and the benchmark specifications (O. Cabellos, private communication, December

2016) reveals that the fissile material mass calculated from the volumes and the densities is 0.5 % higher than specified in the benchmark description. This would account for about 400 pcm, which would still leave a discrepancy of about 500 pcm. Therefore, in our opinion this benchmark needs a complete review.

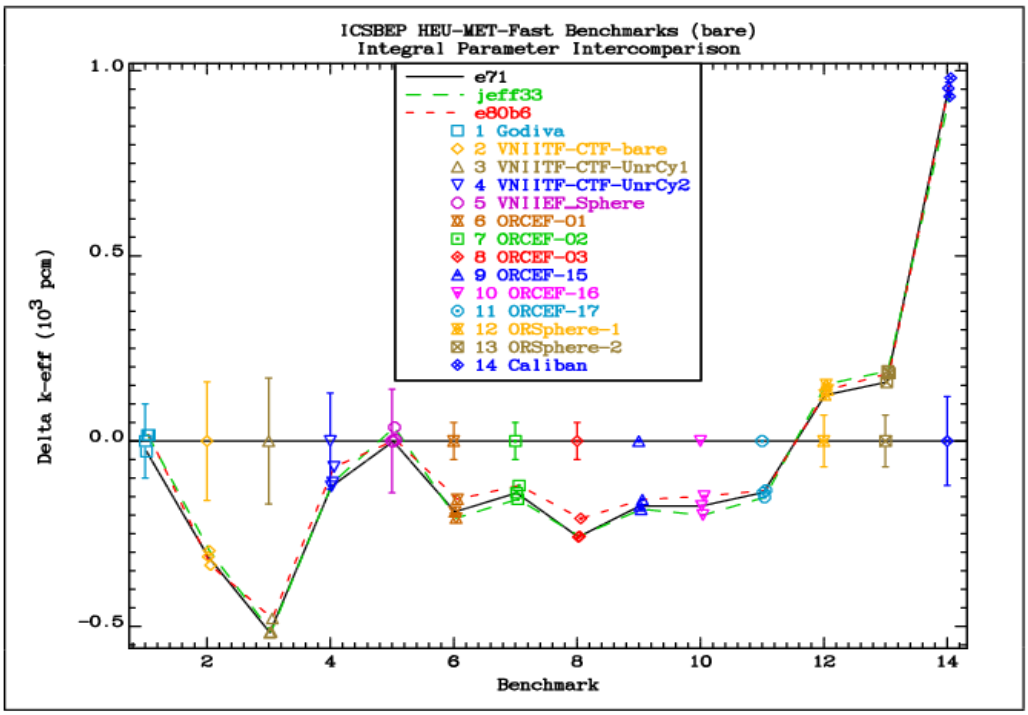

FIG. 4.5.3. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the bare assemblies of the HEU-MET-FAST group of benchmarks.

4.5.2. Uranium-reflected systems

In addition to the Flattop (HEU-MET-FAST-028, PU-MET-FAST-006, U233-MET-FAST-006) and some Russian assemblies (HEU-MET-FAST-014 and HEU-MET-FAST-052), several groups of Topsy assemblies are available in the ICSBEP Handbook. The overall results are shown in Fig. 4.5.4, but the results are difficult to interpret, hence a finer split is made. The list is given in Table 4.5 below. The Flattop ^{239}Pu and ^{233}U uranium-reflected benchmarks are added for completeness.

TABLE 4.5. SHORT LIST OF URANIUM-REFLECTED FAST ASSEMBLIES

No.	ICSBEP label	Short name	Common name
1	HEU-MET-FAST-028	hmf028	Flattop-25
2	PU-MET-FAST-006	pmf006	Flattop-Pu
3	U233-MET-FAST-006	umf006	Flattop-23
4	HEU-MET-FAST-002	hmf002-001	Topsy-1
5	HEU-MET-FAST-002	hmf002-002	Topsy-2
6	HEU-MET-FAST-002	hmf002-003	Topsy-3
7	HEU-MET-FAST-002	hmf002-004	Topsy-4
8	HEU-MET-FAST-002	hmf002-005	Topsy-5
9	HEU-MET-FAST-002	hmf002-006	Topsy-6
10	HEU-MET-FAST-003	hmf003-001	Topsy-U_2.0in
11	HEU-MET-FAST-003	hmf003-002	Topsy-U_3.0in
12	HEU-MET-FAST-003	hmf003-003	Topsy-U_4.0in
13	HEU-MET-FAST-003	hmf003-004	Topsy-U_5.0in
14	HEU-MET-FAST-003	hmf003-005	Topsy-U_6.0in
15	HEU-MET-FAST-003	hmf003-006	Topsy-U_8.0in

```
 16  HEU-MET-FAST-003     hmf003-007  Topsy-U_11.in
 17  HEU-MET-FAST-014     hmf014      VNIIEF-CTF-DU
 18  HEU-MET-FAST-032     hmf032-001  COMET-TU1_3.93in
 19  HEU-MET-FAST-032     hmf032-002  COMET-TU2_3.52in
 20  HEU-MET-FAST-032     hmf032-003  COMET-TU3_1.742in
 21  HEU-MET-FAST-032     hmf032-004  COMET-TU4_0.683in
 22  HEU-MET-FAST-052     hmf052      KFBN2-f2
-------------------------------------------------------
```

Benchmark groups HEU-MET-FAST-002, HEU-MET-FAST-003 and HEU-MET-FAST-032 are reflected by uranium of different thicknesses. The first group has a constant reflector thickness of 8" but different configuration of the core. The calculated results seem to be in agreement with the measurements. In the remaining two groups there is a distinct trend of increasing reactivity with reflector thickness. The trend is particularly distinct in the HEU-MET-THERM-003 group due to the wide range of reflector thicknesses. The results are shown in Figs 4.5.5 and 4.5.6. The origin of this trend requires further investigation.

The trend is supported also by the HEU-COMP-INTER-003 benchmark cases with a thick outer reflector (see Section 4.2).

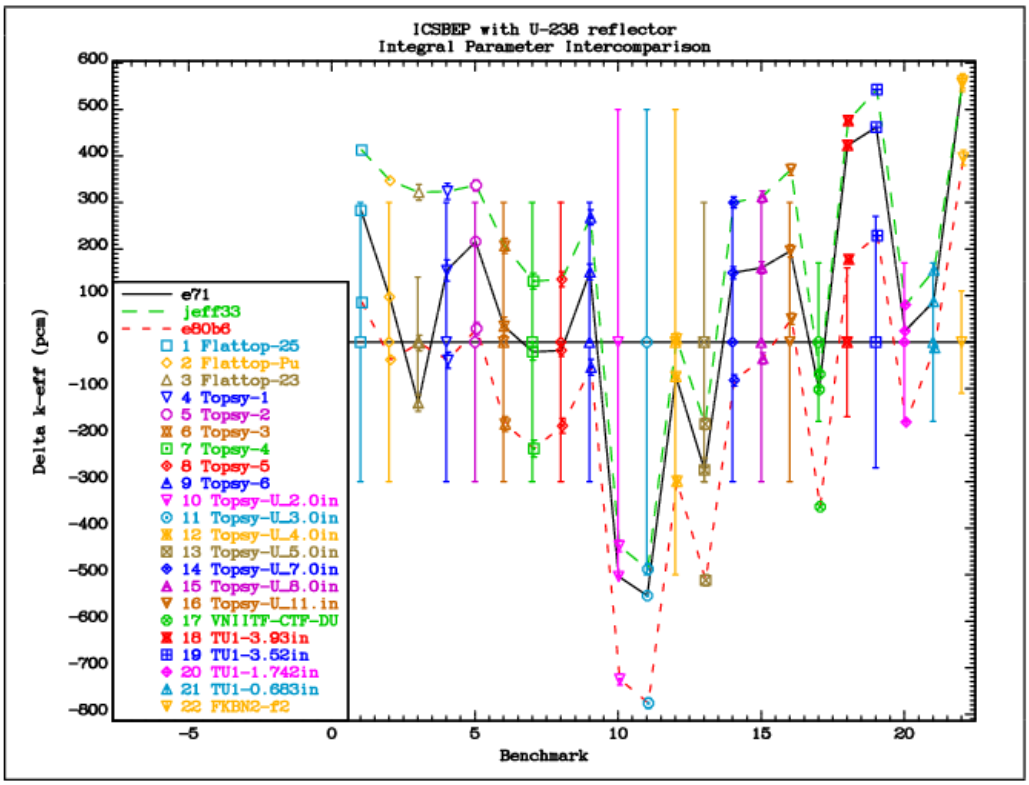

FIG. 4.5.4. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the uranium-reflected assemblies of the HEU-MET-FAST group of benchmarks with a uranium reflector.

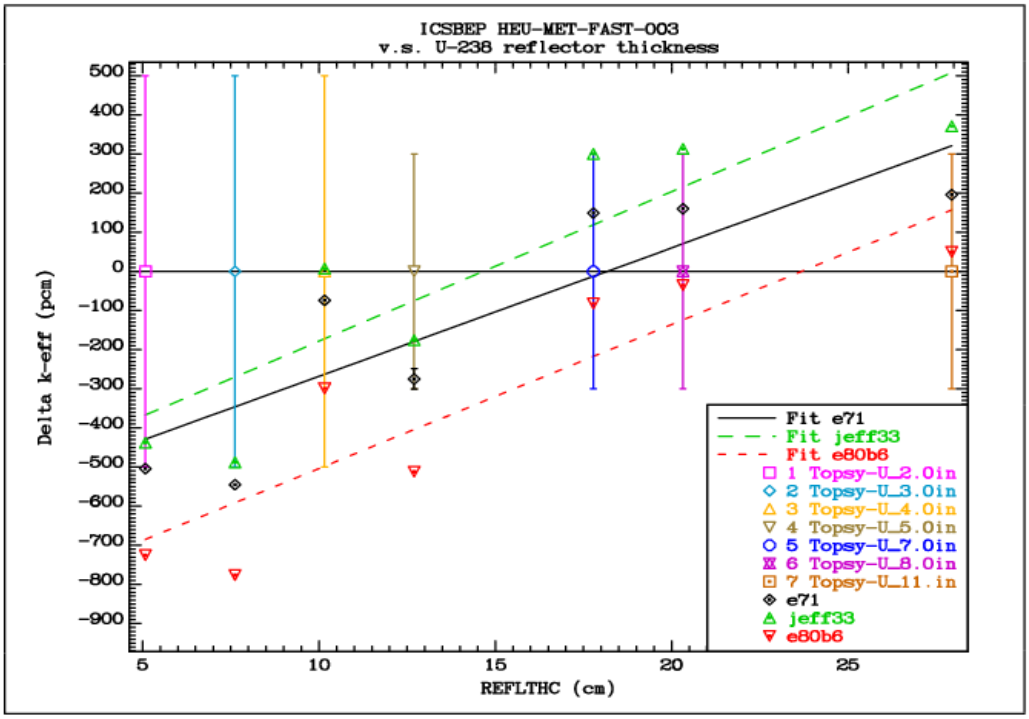

FIG. 4.5.5. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the uranium-reflected assemblies of the HEU-MET-FAST-003 group of benchmarks as a function of reflector thickness.

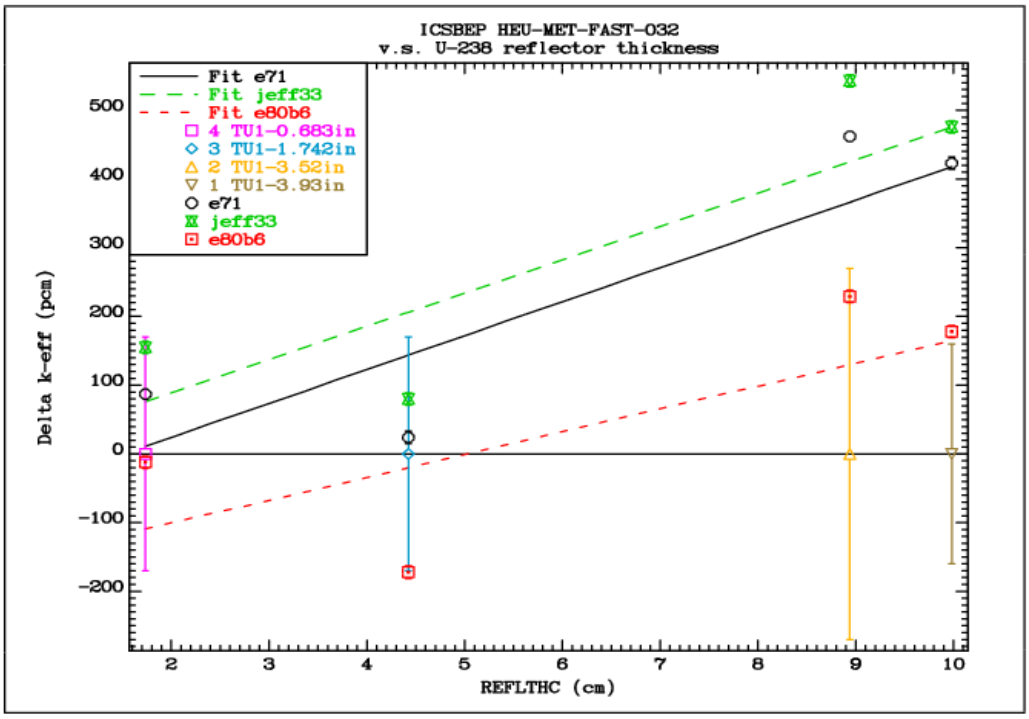

FIG. 4.5.6. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the uranium-reflected assemblies of the HEU-MET-FAST-032 group of benchmarks as a function of reflector thickness.

4.6. HEU-MET-INTER

The list of benchmarks is given in Table 4.6 below. The first four are the Zeus assemblies containing graphite and copper; note the small assigned uncertainties. The KBR-23 assembly contains thorium, uranium and polyethylene. The last two cases refer to the ZPR-9/34 assembly using simplified and detailed model, respectively, which is highly sensitive to the iron data in the 10-25 keV region. The JEFF-3.3 library shows a significant deviation from the benchmark reactivity, as seen in Fig. 4.6.1.

TABLE 4.6. LIST OF HIGHLY-ENRICHED URANIUM METAL INTERMEDIATE SPECTRUM ASSEMBLIES

No.	ICSBEP label	Short name	Common name
1	HEU-MET-INTER-006	hmi006-001	Zeus-1/Gr
2	HEU-MET-INTER-006	hmi006-002	Zeus-2/Gr
3	HEU-MET-INTER-006	hmi006-003	Zeus-3/Gr
4	HEU-MET-INTER-006	hmi006-004	Zeus-4/Gr
5	HEU-MET-INTER-008	hmi008	KBR-23 (U/Th/PE)
6	HEU-MET-INTER-001	hmi001	ZPR-9/34
7	HEU-MET-INTER-001	hmi001d	ZPR-9/34(detailed)

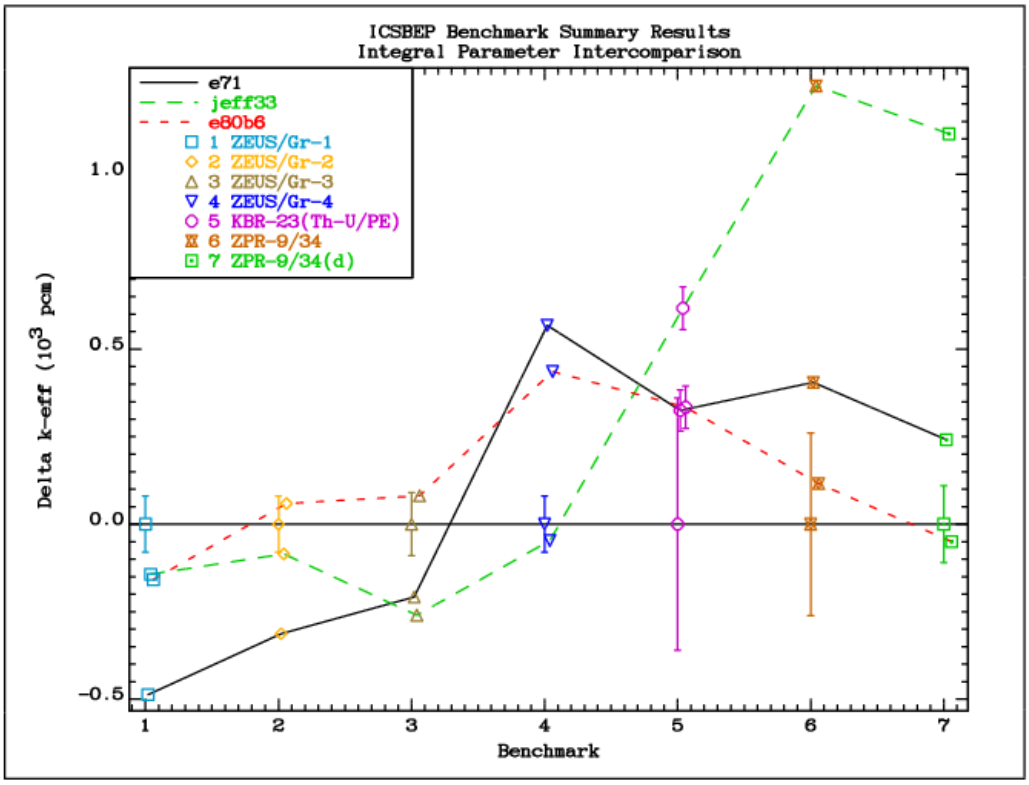

FIG. 4.6.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-MET-INTER group of benchmarks.

4.7. HEU-MET-MIXED

A single benchmark case HEU-MET-MIXED-017 (FKBN2-f3) was analysed. It contains tungsten and polyethylene reflector. All libraries overestimate reactivity compared to the benchmark value by a few 100 pcm. The results are shown in the sub-section 7.3 on “Systems containing tungsten”.

4.8. HEU-MET-THERM

Most of the cases in this group of benchmarks include a polyethylene reflector. The list is given in Table 4.7 below. The Valduc series of 43 cases is a special one for investigating the reactivity of a uranium – aluminium alloy in water.

The differences from the reference benchmark values for the Valduc benchmarks are shown in Fig. 4.8.1. At low values of the epithermal fission fraction the reactivity is significantly overpredicted with all libraries and shows a distinct decreasing trend as the epithermal fission fraction increases. The results for the remaining HEU-MET-THERM benchmarks are shown in Fig. 4.8.2; they also indicate over-prediction of reactivity at low epithermal fission fraction values, but without a trend. The Valduc benchmarks claim very small uncertainties, but from Fig. 3.5 it is seen that they are the main contributors to the Chi^2/DoF. Similar problems are not observed in other HEU benchmarks. Therefore, it is wise not to jump to conclusions about nuclear data deficiencies before independent evidence is provided in support of such observations.

TABLE 4.7. LIST OF HIGHLY-ENRICHED URANIUM METAL THERMAL BENCHMARKS

No.	ICSBEP Label	Short name	Common name	Comment
1	HEU-MET-THERM-010	hmt010-001s	Planet_Gd_7.5mil	
2	HEU-MET-THERM-010	hmt010-002s	Planet_Gd_15.mil	
3	HEU-MET-THERM-012	hmt012-001s	hmt012-001s	PE
4	HEU-MET-THERM-013	hmt013-001	hmt013-001	Fe 0.065" plates, PE
5	HEU-MET-THERM-013	hmt013-002	hmt013-002	Fe 0.015" plates, PE
6	HEU-MET-THERM-014	hmt014-001s	Planet_SiO2_Poly	; NNL169; SiO2 ; PE
7	HEU-MET-THERM-015	hmt015	hmt015	
8	HEU-MET-THERM-031	hmt031-001s	Planet_Poly	; PE
9	HEU-MET-THERM-011	hmt011-nnn	Valduc	; 43 cases

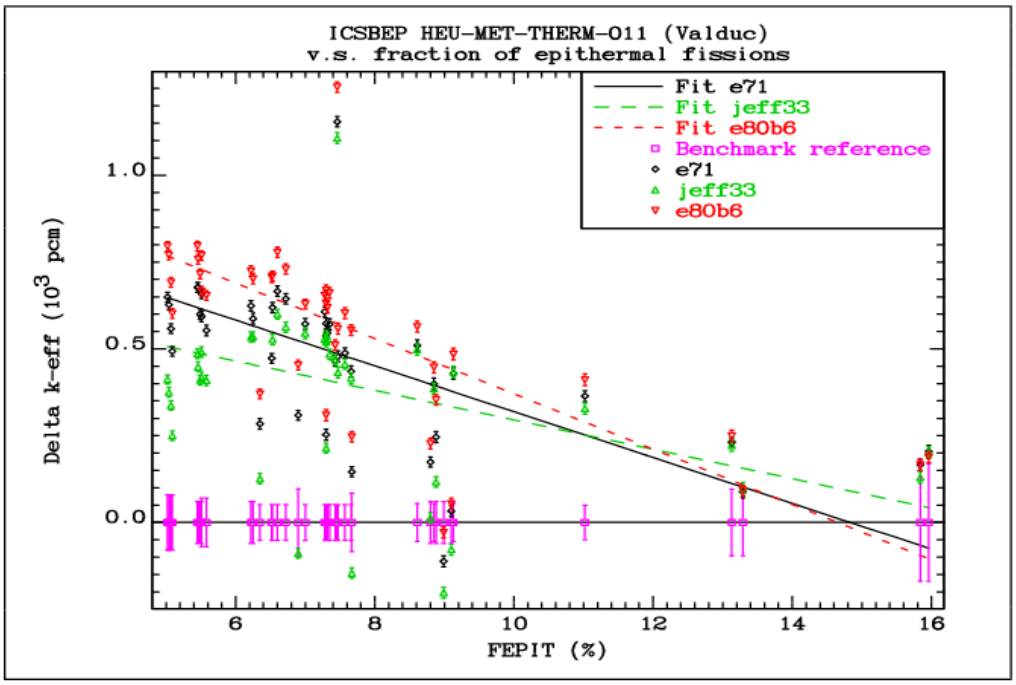

FIG. 4.8.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for HEU-MET-THERM-011 (Valduc) benchmarks as a function of the epithermal fission fraction.

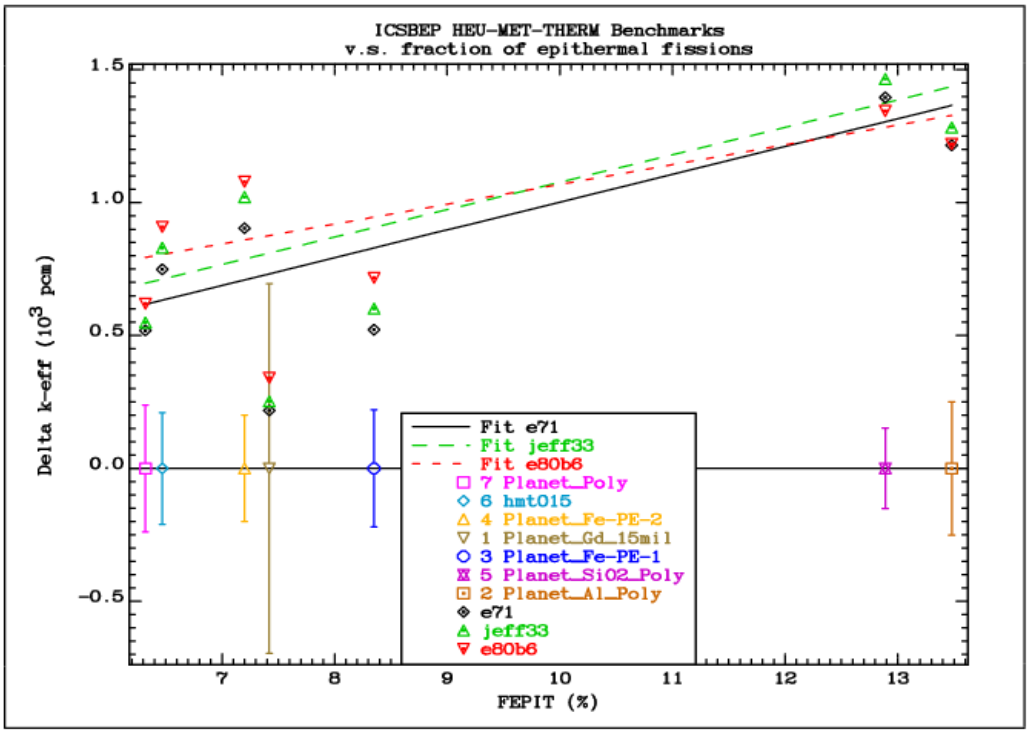

FIG. 4.8.2. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for HEU-MET-THERM benchmarks (excluding Valduc) as a function of the epithermal fission fraction. These are mainly cases containing polyethylene.

4.9. HEU-SOL-THERM

Several benchmarks are available in the ICSBEP collection, out of which 149 were included in the analysis. An established way of comparing these benchmarks is by the above-thermal leakage fraction (ATLF). The results for 45 cases are shown in Fig. 4.9.1, excluding HEU-SOL-THERM-048 and HEU-SOL-THERM-049 because of some doubts about their reliability (see below), and HEU-SOL-THERM-004 and HEU-SOL-THERM-020 because they are heavy-water solutions. The benchmarks are listed in Table 4.8 below. The cumulative Chi^2/DoF on Fig. 4.9.2 shows a fairly uniform trend, with the final value slightly below one for all libraries.

TABLE 4.8. LIST OF HIGHLY-ENRICHED URANIUM SOLUTION BENCHMARKS

No.	ICSBEP label	Short name	Common name
1	HEU-SOL-THERM-009	hst009-001	ORNL_S1
2	HEU-SOL-THERM-009	hst009-002	ORNL_S2
3	HEU-SOL-THERM-009	hst009-003	ORNL_S3
4	HEU-SOL-THERM-009	hst009-004	ORNL_S4
5	HEU-SOL-THERM-013	hst013-001	ORNL_T1
6	HEU-SOL-THERM-013	hst013-002	ORNL_T2
7	HEU-SOL-THERM-013	hst013-003	ORNL_T3
8	HEU-SOL-THERM-013	hst013-004	ORNL_T4
9	HEU-SOL-THERM-032	hst032	ORNL_T5
10	HEU-SOL-THERM-001	hst001-001	R01
11	HEU-SOL-THERM-001	hst001-002	R02
12	HEU-SOL-THERM-001	hst001-003	R03
13	HEU-SOL-THERM-001	hst001-004	R04
14	HEU-SOL-THERM-001	hst001-005	R05
15	HEU-SOL-THERM-001	hst001-006	R06

16	HEU-SOL-THERM-001	hst001-007	R07
17	HEU-SOL-THERM-001	hst001-008	R08
18	HEU-SOL-THERM-001	hst001-009	R09
19	HEU-SOL-THERM-001	hst001-010	R10
20	HEU-SOL-THERM-042	hst042-001	ORNL_C1
21	HEU-SOL-THERM-042	hst042-002	ORNL_C2
22	HEU-SOL-THERM-042	hst042-003	ORNL_C3
23	HEU-SOL-THERM-042	hst042-004	ORNL_C4
24	HEU-SOL-THERM-042	hst042-005	ORNL_C5
25	HEU-SOL-THERM-042	hst042-006	ORNL_C6
26	HEU-SOL-THERM-042	hst042-007	ORNL_C7
27	HEU-SOL-THERM-042	hst042-008	ORNL_C8
28	HEU-SOL-THERM-043	hst043-001	ORNL_LS1
29	HEU-SOL-THERM-043	hst043-002	ORNL_LS2
30	HEU-SOL-THERM-043	hst043-003	ORNL_LS3
31	HEU-SOL-THERM-010	hst010-001	ORNL_S10T0
32	HEU-SOL-THERM-011	hst011-001	ORNL_S17.1
33	HEU-SOL-THERM-011	hst011-002	ORNL_S17.2
34	HEU-SOL-THERM-012	hst012	ORNL_S91
35	HEU-SOL-THERM-050	hst050-001	ORNL_UO2F2-01
36	HEU-SOL-THERM-050	hst050-002	ORNL_UO2F2-03
37	HEU-SOL-THERM-050	hst050-003	ORNL_UO2F2-03
38	HEU-SOL-THERM-050	hst050-004	ORNL_UO2F2-04
39	HEU-SOL-THERM-050	hst050-005	ORNL_UO2F2-05
40	HEU-SOL-THERM-050	hst050-006	ORNL_UO2F2-06
41	HEU-SOL-THERM-050	hst050-007	ORNL_UO2F2-07
42	HEU-SOL-THERM-050	hst050-008	ORNL_UO2F2-08
43	HEU-SOL-THERM-050	hst050-009	ORNL_UO2F2-09
44	HEU-SOL-THERM-050	hst050-010	ORNL_UO2F2-10
45	HEU-SOL-THERM-050	hst050-011	ORNL_UO2F2-11

It is sometimes useful to define a short list of representative benchmarks for quick scoping studies. The short list of such benchmarks is given in Table 4.9 below and the results are shown on Fig. 4.9.3.

TABLE 4.9. SHORT LIST OF HIGHLY-ENRICHED URANIUM SOLUTION BENCHMARKS

No.	ICSBEP label	Short name	Common name	ATLF
1	HEU-SOL-THERM-009	hst009-001	ORNL_S1	0.56252
2	HEU-SOL-THERM-009	hst009-004	ORNL_S4	0.54880
3	HEU-SOL-THERM-013	hst013-001	ORNL_T1	0.14375
4	HEU-SOL-THERM-032	hst032	ORNL_T5	0.053
5	HEU-SOL-THERM-001	hst001-004	R04	0.4431
6	HEU-SOL-THERM-001	hst001-005	R05	0.338
7	HEU-SOL-THERM-001	hst001-007	R07	0.338
8	HEU-SOL-THERM-042	hst042-1	ORNL_C1	0.099
9	HEU-SOL-THERM-042	hst042-004	ORNL_C4	0.038
10	HEU-SOL-THERM-042	hst042-008	ORNL_C8	0.0098
11	HEU-SOL-THERM-043	hst043-003	ORNL_LS3	0.1429
12	HEU-SOL-THERM-010	hst010-001	ORNL_S10T0	0.49647
13	HEU-SOL-THERM-012	hst012	ORNL_S91	0.20665

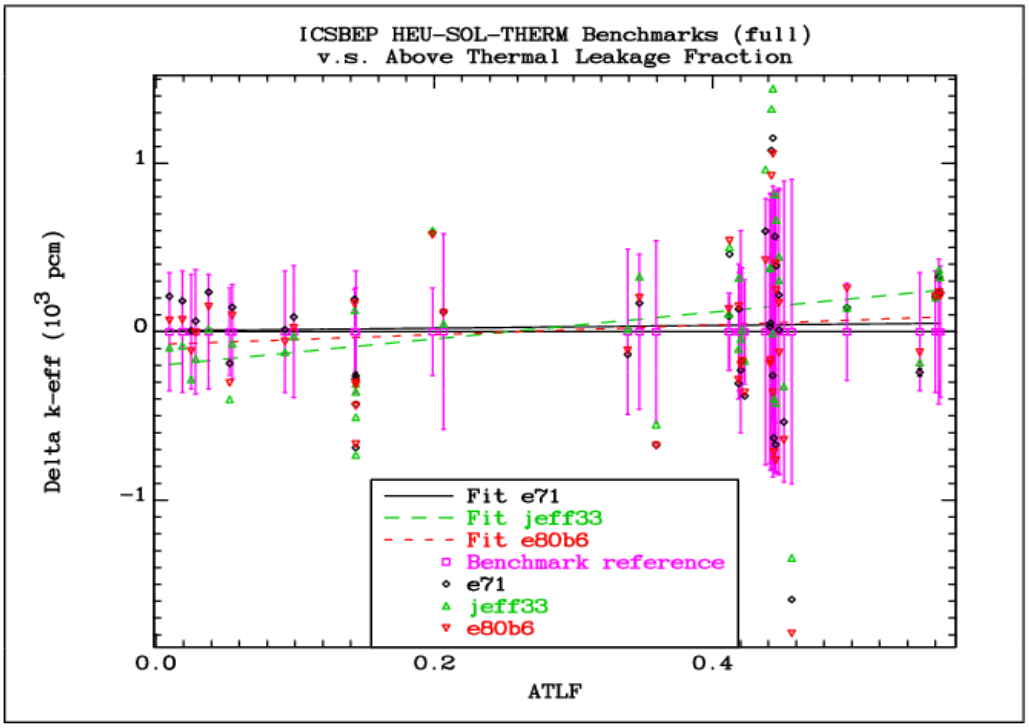

FIG. 4.9.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-SOL-THERM benchmark cases.

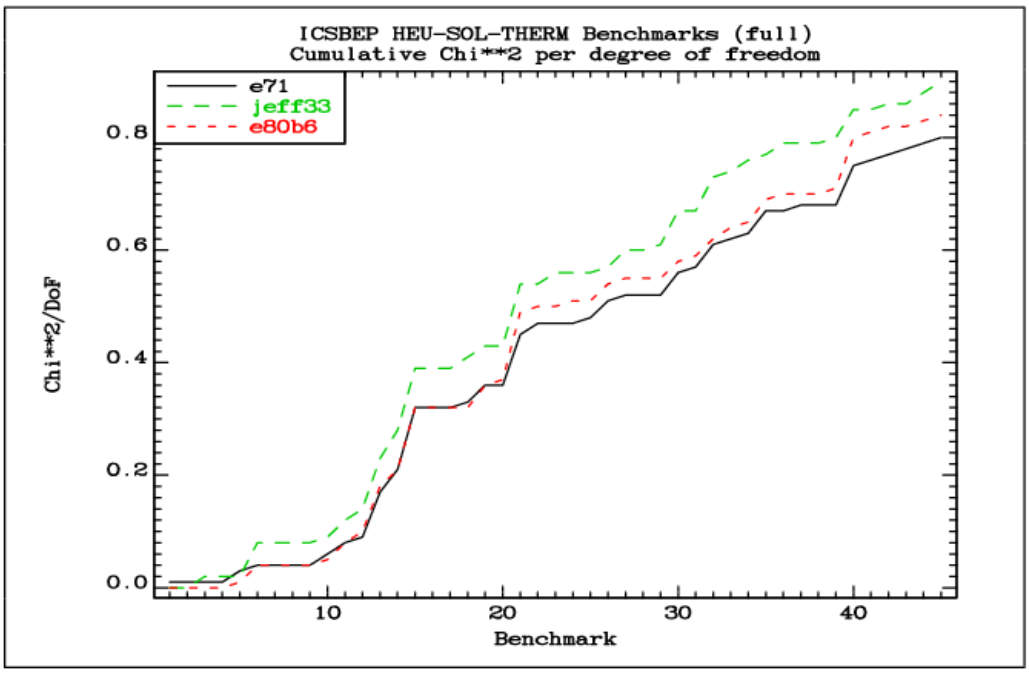

FIG. 4.9.2. Cumulative Chi-square per degree of freedom for the HEU-SOL-THERM benchmark cases.

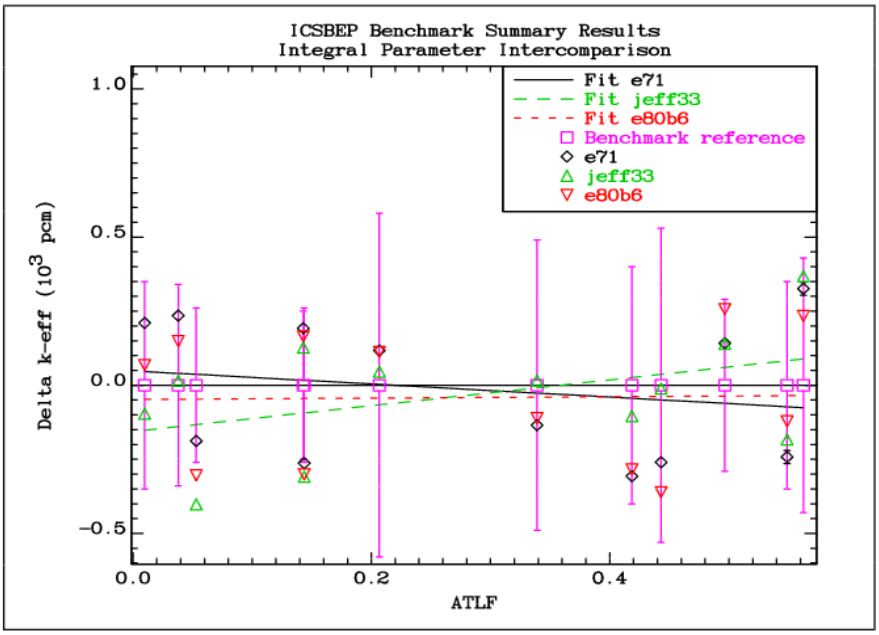

FIG. 4.9.3. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the short list of representative HEU-SOL-THERM benchmark cases.

4.9.1. HEU-SOL-THERM-004 (heavy water)

The Los Alamos reflected heavy water solutions includes six cases, which show reasonable agreement with the reference benchmark values, as seen from Fig. 4.9.4. A slight trend to under-predict reactivity is observed for all libraries, the smallest being for JEFF-3.3.

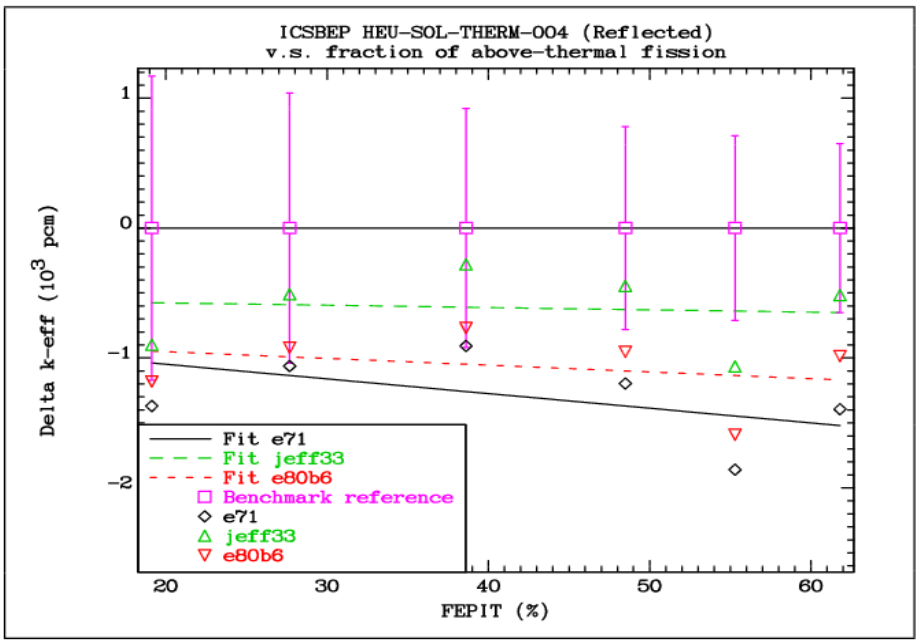

FIG. 4.9.4. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-SOL-THERM-004 benchmark cases as a function of the epithermal fission fraction.

4.9.2. HEU-SOL-THERM-020 (heavy water)

The Los Alamos un-reflected solutions includes four cases. They tend to over-predict reactivity in well-thermalised systems. The trend decreases with increasing spectrum hardness. The results are shown on Fig. 4.9.5.

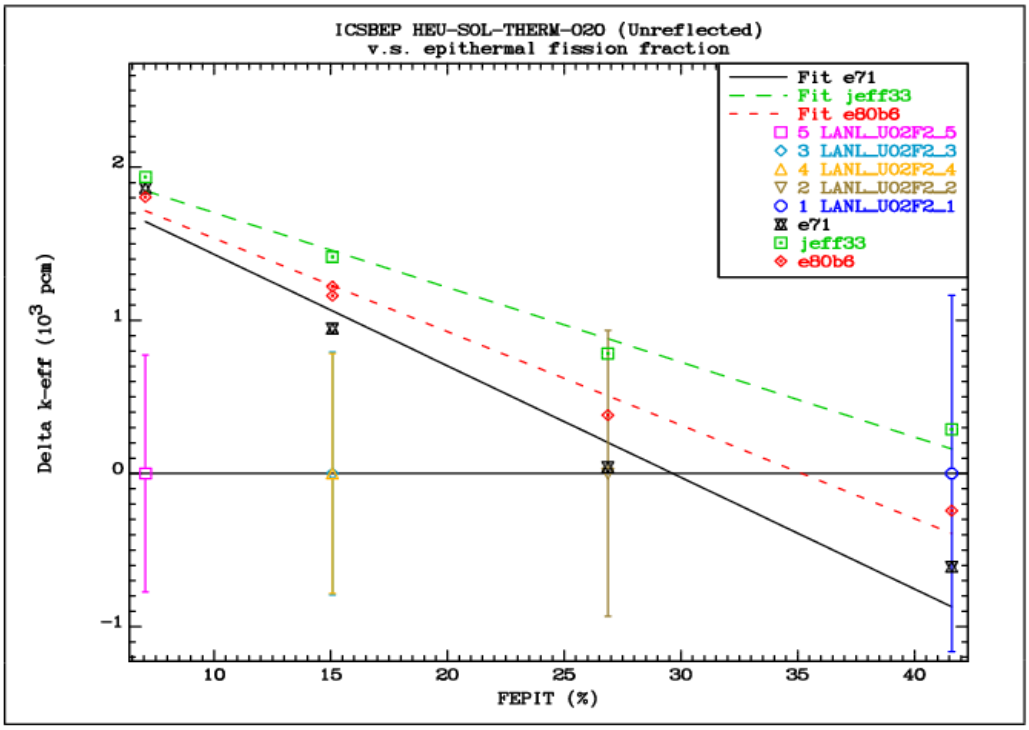

FIG.4.9.5. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-SOL-THERM-020 benchmark cases as a function of the epithermal fission fraction.

4.9.3. HEU-SOL-THERM-048

There seems to be a problem with the HST048 group of benchmarks, which includes 20 cases. The actual benchmarks were all critical (k_{eff}=1), so the benchmark values correspond exactly to the biases assigned by the evaluator due to the simplifications of the geometry and/or the material composition. The differences between the calculated and the benchmark k_{eff} values as a function of the benchmark k_{eff} are plotted in Fig. 4.9.6. The Figure clearly indicates that there is a strong correlation between the assigned bias and the deviation of the calculated k_{eff} from the benchmark value (see for example cases 15*, 16*, 17*, 18*), which suggests that there is something wrong with the assumptions about the benchmark model. In the discussion with the benchmark evaluator (Lengar, Jan.2017, private communication) he acknowledged that there is some uncertainty regarding the dimensions and the content of the Tygon tubing and proposed a correction to the ICSBEP benchmark description, suggesting an increase in the uncertainties and declaring some of the benchmark cases unacceptable. Hopefully the updates will appear in the next release of the Handbook. These benchmarks were excluded from further analysis.

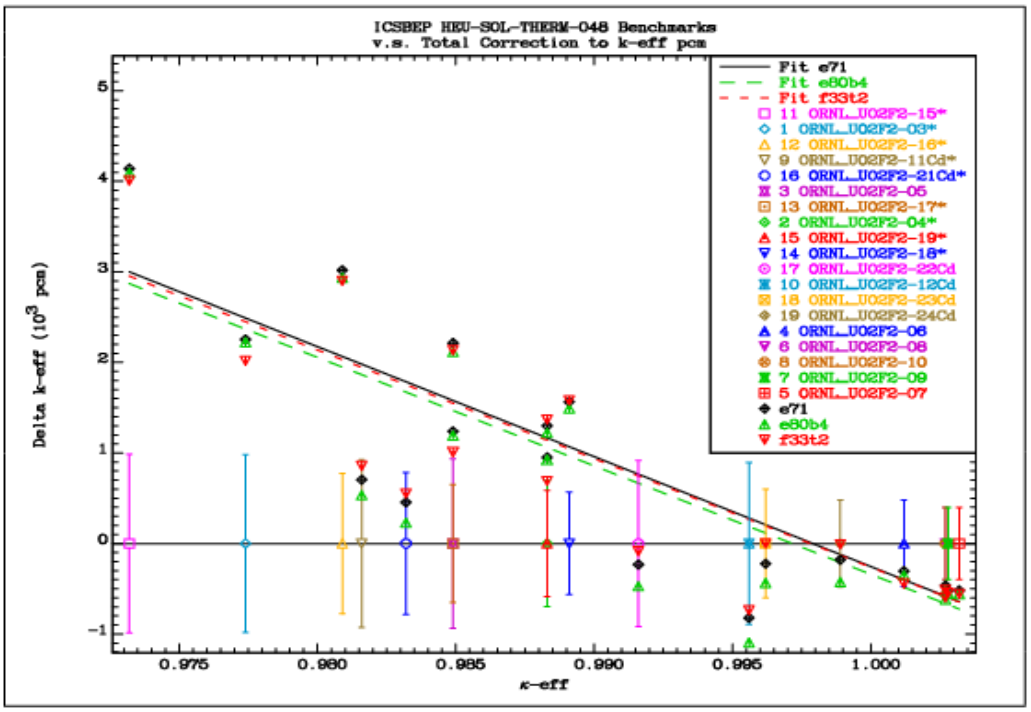

FIG. 4.9.6. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-SOL-THERM-048 benchmark cases.

4.9.4. HEU-SOL-THERM-049

Benchmark group HEU-SOL-THERM-049 includes 20 cases, some with, and others without, cadmium in the reflector solution, but there is always cadmium in the central fissile solution. The differences between the calculated and the benchmark k_{eff} values for the cases without cadmium in the reflector are in reasonable agreement with the benchmark values and are shown in Fig. 4.9.7. There does not seem to be a strong dependence on the cadmium concentration present in the fuel solution. On the other hand, the cases with cadmium in the surrounding reflector are strongly underpredicted for low cadmium concentrations in the fuel region, with an increasing trend as the cadmium concentration increases, as seen in Fig. 4.9.8. The root cause of the discrepancy requires further investigation, so these benchmarks were excluded from the present analysis.

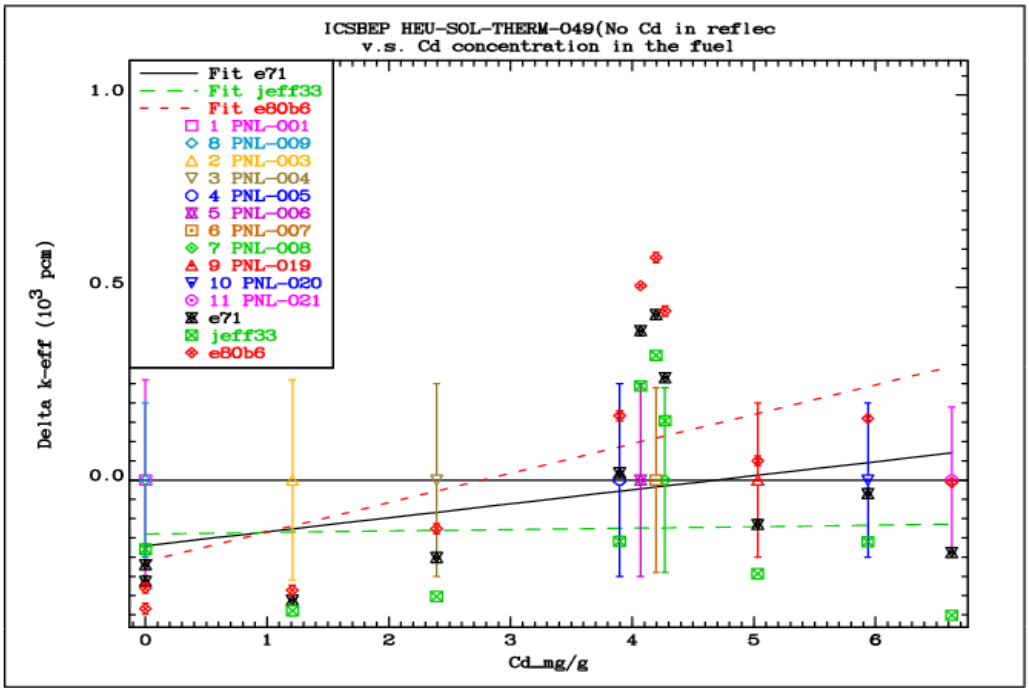

FIG. 4.9.7. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-SOL-THERM-049 benchmark cases without cadmium in the reflector solution.

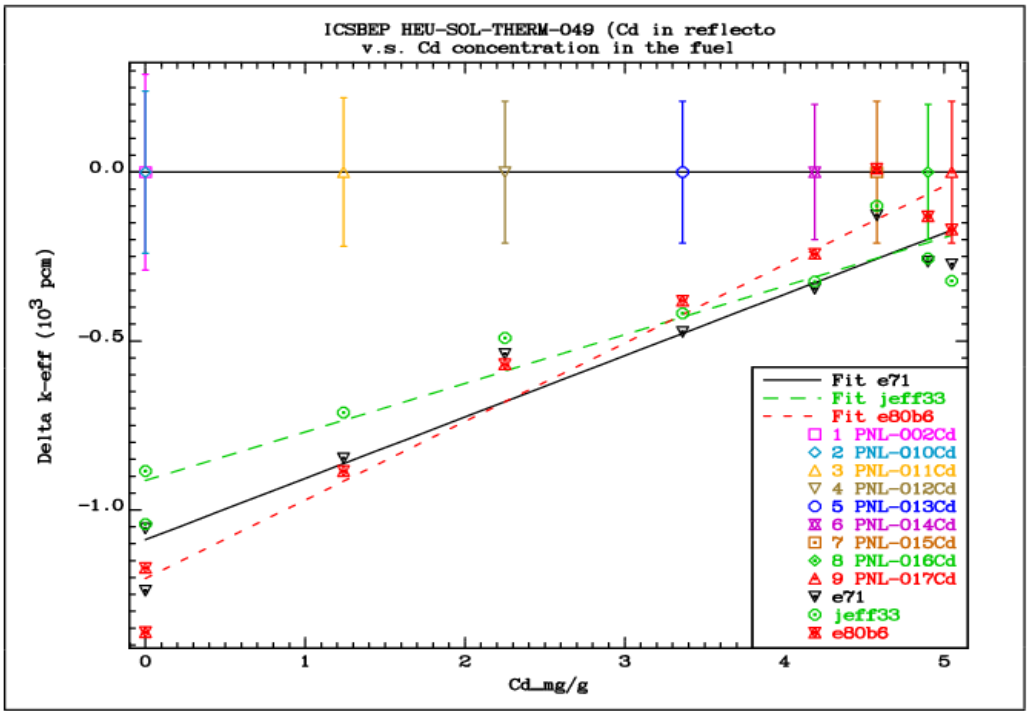

FIG. 4.9.8. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-SOL-THERM-049 benchmark cases with cadmium in the reflector solution.

4.9.5. HEU-SOL-THERM benchmarks containing gadolinium

The list of benchmarks is given in Table 4.10, including 52 cases with different concentrations of uranium and gadolinium in the solution. They were all done at the IPPE. The uranium concentration is evident from the column “Common name” and the gadolinium concentration in the “Comment”.

TABLE 4.10. LIST OF IPPE HIGHLY-ENRICHED SOLUTION BENCHMARKS CONTAINING GADOLINIUM.

No.	ICSBEP Label	Short name	Common name	Comment
1	HEU-SOL-THERM-014	hst014-001	IPPE-070g/l-Gd-1	hst-Gd 0.000 g/l
2	HEU-SOL-THERM-014	hst014-002	IPPE-070g/l-Gd-2	hst-Gd 0.100 g/l
3	HEU-SOL-THERM-014	hst014-003	IPPE-070g/l-Gd-3	hst-Gd 0.193 g/l
4	HEU-SOL-THERM-015	hst015-001	IPPE-100g/l-Gd-1	hst-Gd 0.000 g/l
5	HEU-SOL-THERM-015	hst015-002	IPPE-100g/l-Gd-2	hst-Gd 0.000 g/l
6	HEU-SOL-THERM-015	hst015-003	IPPE-100g/l-Gd-3	hst-Gd 0.197 g/l
7	HEU-SOL-THERM-015	hst015-004	IPPE-100g/l-Gd-4	hst-Gd 0.197 g/l
8	HEU-SOL-THERM-015	hst015-005	IPPE-100g/l-Gd-5	hst-Gd 0.400 g/l
9	HEU-SOL-THERM-016	hst016-001	IPPE-150g/l-Gd-1	hst-Gd 0.000 g/l
10	HEU-SOL-THERM-016	hst016-002	IPPE-150g/l-Gd-2	hst-Gd 0.300 g/l
11	HEU-SOL-THERM-016	hst016-003	IPPE-150g/l-Gd-3	hst-Gd 0.525 g/l
12	HEU-SOL-THERM-017	hst017-001	IPPE-200g/l-Gd-1	hst-Gd 0.000 g/l
13	HEU-SOL-THERM-017	hst017-002	IPPE-200g/l-Gd-2	hst-Gd 0.000 g/l
14	HEU-SOL-THERM-017	hst017-003	IPPE-200g/l-Gd-3	hst-Gd 0.000 g/l
15	HEU-SOL-THERM-017	hst017-004	IPPE-200g/l-Gd-4	hst-Gd 0.298 g/l
16	HEU-SOL-THERM-017	hst017-005	IPPE-200g/l-Gd-5	hst-Gd 0.497 g/l
17	HEU-SOL-THERM-017	hst017-006	IPPE-200g/l-Gd-6	hst-Gd 0.497 g/l
18	HEU-SOL-THERM-017	hst017-007	IPPE-200g/l-Gd-7	hst-Gd 0.497 g/l
19	HEU-SOL-THERM-017	hst017-008	IPPE-200g/l-Gd-8	hst-Gd 0.790 g/l
20	HEU-SOL-THERM-018	hst018-001	IPPE-300g/l-Gd-1	hst-Gd 0.000 g/l
21	HEU-SOL-THERM-018	hst018-002	IPPE-300g/l-Gd-2	hst-Gd 0.000 g/l
22	HEU-SOL-THERM-018	hst018-003	IPPE-300g/l-Gd-3	hst-Gd 0.000 g/l
23	HEU-SOL-THERM-018	hst018-004	IPPE-300g/l-Gd-4	hst-Gd 0.497 g/l
24	HEU-SOL-THERM-018	hst018-005	IPPE-300g/l-Gd-5	hst-Gd 0.497 g/l
25	HEU-SOL-THERM-018	hst018-006	IPPE-300g/l-Gd-6	hst-Gd 0.497 g/l
26	HEU-SOL-THERM-018	hst018-007	IPPE-300g/l-Gd-7	hst-Gd 0.977 g/l
27	HEU-SOL-THERM-018	hst018-008	IPPE-300g/l-Gd-8	hst-Gd 0.977 g/l
28	HEU-SOL-THERM-018	hst018-009	IPPE-300g/l-Gd-9	hst-Gd 0.977 g/l
29	HEU-SOL-THERM-018	hst018-010	IPPE-300g/l-Gd-10	hst-Gd 1.400 g/l
30	HEU-SOL-THERM-018	hst018-011	IPPE-300g/l-Gd-12	hst-Gd 1.400 g/l
31	HEU-SOL-THERM-018	hst018-012	IPPE-300g/l-Gd-12	hst-Gd 1.943 g/l
32	HEU-SOL-THERM-019	hst019-001	IPPE-400g/l-Gd-1	hst-Gd 0.000 g/l
33	HEU-SOL-THERM-019	hst019-002	IPPE-400g/l-Gd-2	hst-Gd 0.647 g/l
34	HEU-SOL-THERM-019	hst019-003	IPPE-400g/l-Gd-3	hst-Gd 1.160 g/l
35	HEU-SOL-THERM-025	hst025-001	IPPE-051g/l-Gd-01	hst-Gd 0.000 g/l
36	HEU-SOL-THERM-025	hst025-002	IPPE-051g/l-Gd-02	hst-Gd 0.000 g/l
37	HEU-SOL-THERM-025	hst025-003	IPPE-051g/l-Gd-03	hst-Gd 0.107 g/l
38	HEU-SOL-THERM-025	hst025-004	IPPE-053g/l-Gd-04	hst-Gd 0.000 g/l
39	HEU-SOL-THERM-025	hst025-005	IPPE-077g/l-Gd-05	hst-Gd 0.000 g/l
40	HEU-SOL-THERM-025	hst025-006	IPPE-049g/l-Gd-06	hst-Gd 0.190 g/l
41	HEU-SOL-THERM-025	hst025-007	IPPE-068g/l-Gd-07	hst-Gd 0.292 g/l
42	HEU-SOL-THERM-025	hst025-008	IPPE-070g/l-Gd-08	hst-Gd 0.378 g/l
43	HEU-SOL-THERM-025	hst025-009	IPPE-095g/l-Gd-09	hst-Gd 0.410 g/l
44	HEU-SOL-THERM-025	hst025-010	IPPE-142g/l-Gd-10	hst-Gd 0.723 g/l
45	HEU-SOL-THERM-025	hst025-011	IPPE-142g/l-Gd-11	hst-Gd 0.918 g/l
46	HEU-SOL-THERM-025	hst025-012	IPPE-185g/l-Gd-12	hst-Gd 1.375 g/l
47	HEU-SOL-THERM-025	hst025-013	IPPE-189g/l-Gd-13	hst-Gd 1.703 g/l
48	HEU-SOL-THERM-025	hst025-014	IPPE-273g/l-Gd-14	hst-Gd 3.860 g/l
49	HEU-SOL-THERM-025	hst025-015	IPPE-268g/l-Gd-15	hst-Gd 4.830 g/l
50	HEU-SOL-THERM-025	hst025-016	IPPE-400g/l-Gd-16	hst-Gd 5.793 g/l
51	HEU-SOL-THERM-025	hst025-017	IPPE-393g/l-Gd-17	hst-Gd 8.138 g/l
52	HEU-SOL-THERM-025	hst025-018	IPPE-395g/l-Gd-18	hst-Gd 10.37 g/l

As shown in Fig. 4.9.9, the results for groups of benchmarks HEU-SOL-THERM-014 to HEU-SOL-THERM-019 show a strong positive gradient in reactivity with increasing gadolinium concentration. The last HEU-SOL-THERM-019 is an exception. There is large scatter in the data of more than 2 % in k_{eff} (>2000 pcm) even in cases with the same Gd concentration. The group of benchmarks HEU-SOL-THERM-025 are in a slightly better shape: the calculations agree with the measurement for cases without gadolinium and for those with a high gadolinium content, but are scattered far outside the uncertainty intervals in the cases with relatively low gadolinium concentrations. Similarly, there does not seem to be any correlation of the discrepancies with the uranium concentration. The results are shown in Fig. 4.9.10 and 4.9.11.

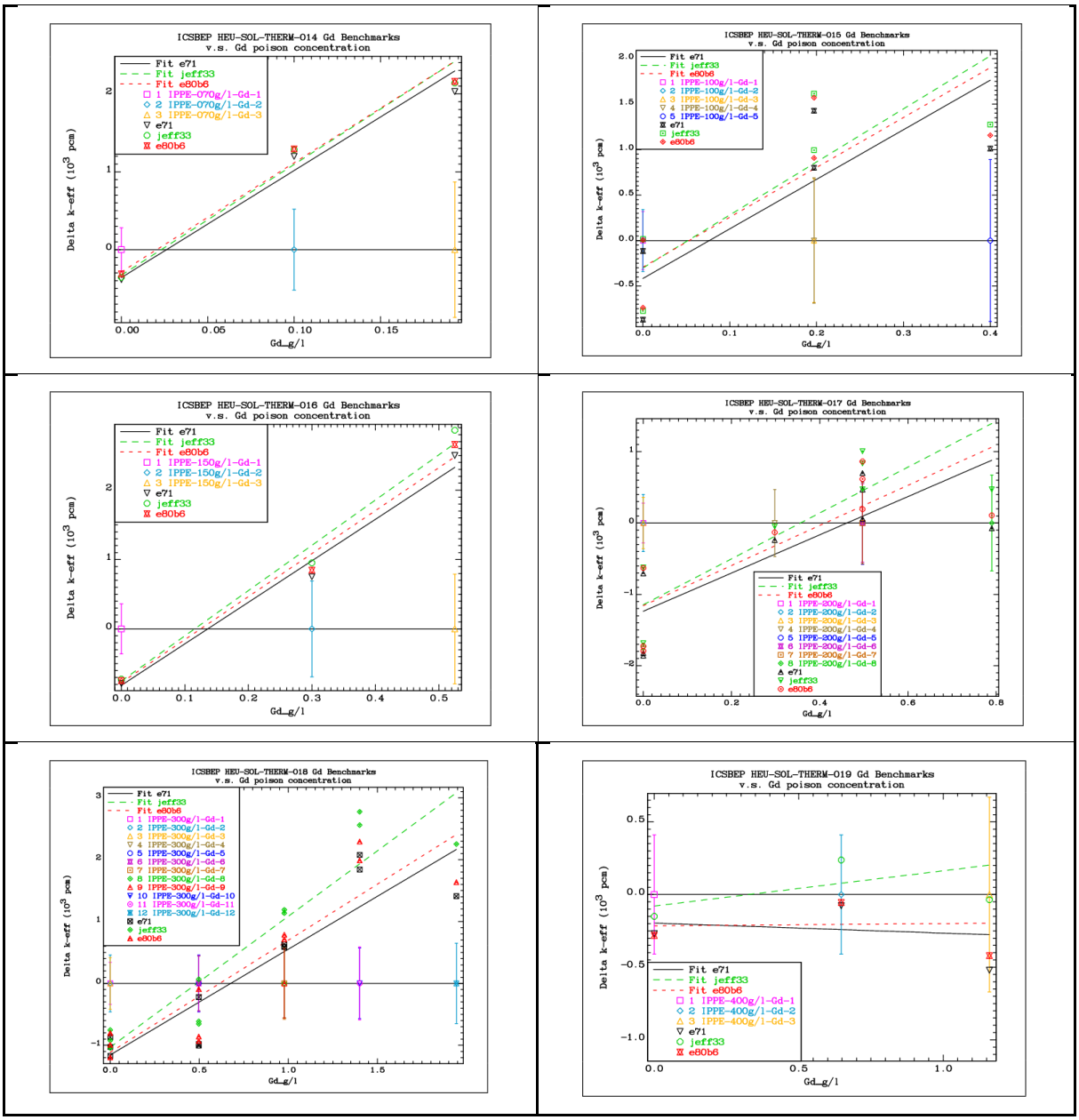

FIG. 4.9.9. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the IPPE highly-enriched solution benchmarks as a function of the gadolinium concentration.

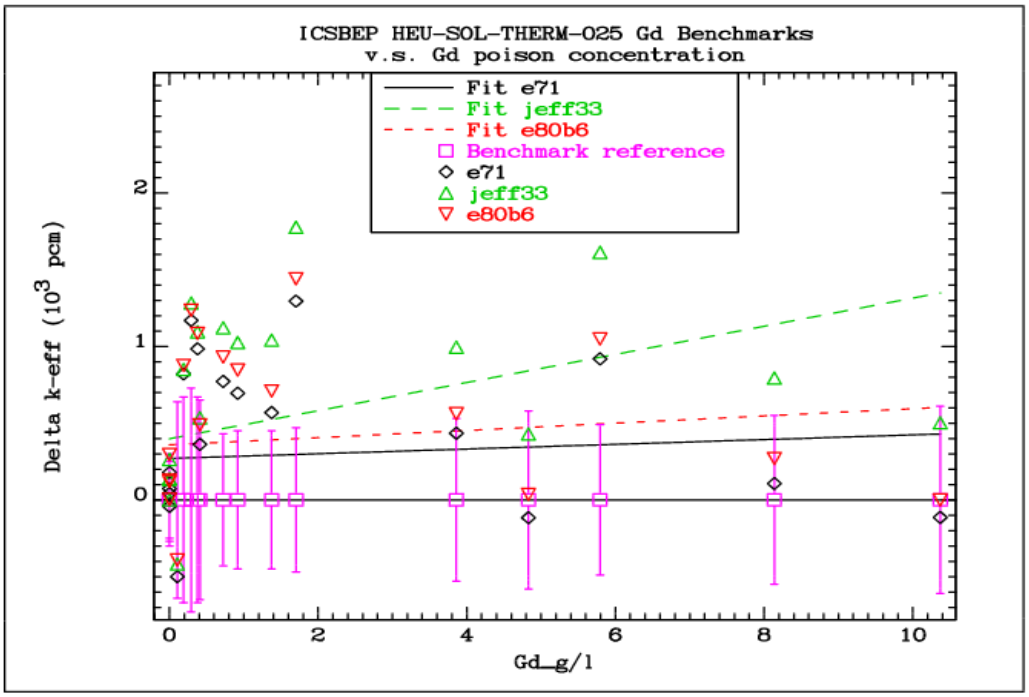

FIG. 4.9.10. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-SOL-THERM-025 benchmarks as a function of gadolinium concentration.

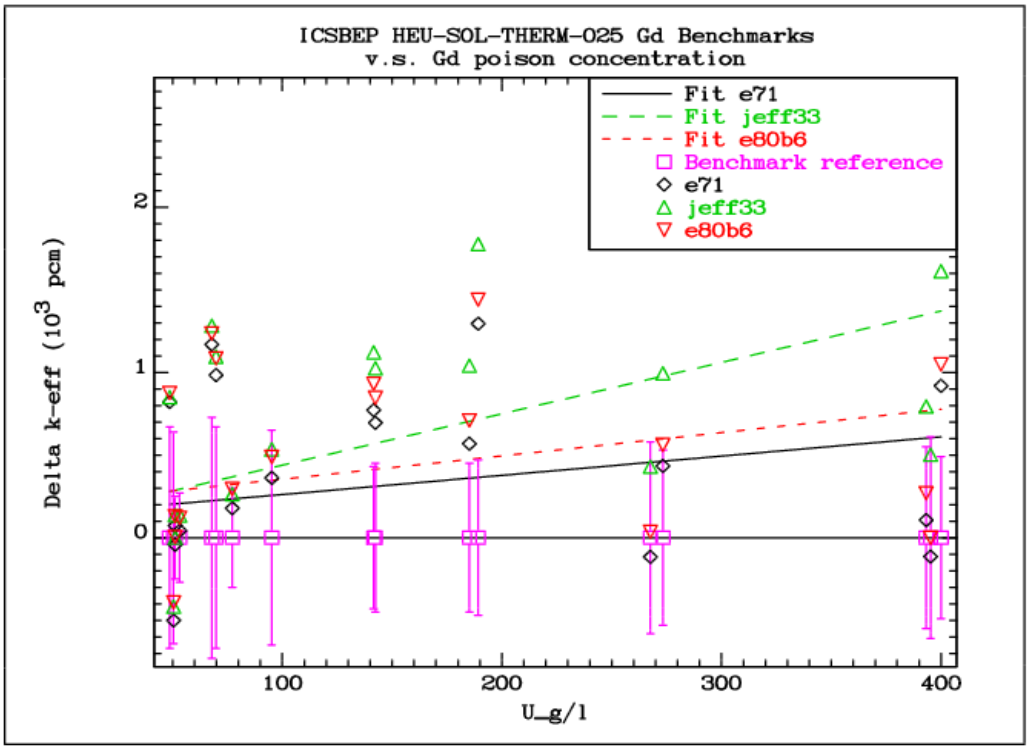

FIG. 4.9.11. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the HEU-SOL-THERM-025 benchmarks as a function of uranium concentration.

There are several cases with different uranium concentrations and no gadolinium. The results are shown in Fig. 4.9.12. The figure shows that there is huge scatter of nearly 2 % in k_{eff} even without any gadolinium in the solution and there is practically no correlation with uranium concentration, which ranges from 50 g/l to 400 g/l. Cases 1 – 3 from HEU-SOL-THERM-017 (benchmark numbers 5 – 7 in Fig. 4.9.12) are a good example: they belong to the same series with uranium concentration of 200 g/l, but even within the same benchmark series the predicted reactivity discrepancy changes by nearly 1000 pcm and reaches close to four-sigma standard deviation from the quoted benchmark uncertainty. Considering that these benchmarks have similar sensitivity profiles for nuclear data, which involve mainly ^{235}U and water, such discrepancies are not likely to be caused by incorrect nuclear data.

In these cases that should not be affected by gadolinium it was not possible to establish any correlations between the discrepancies and the inner tank radius or the excess water height, either. The results indicate that there must be some experimental parameter, which is not well under control between different measurements even when no gadolinium is present.

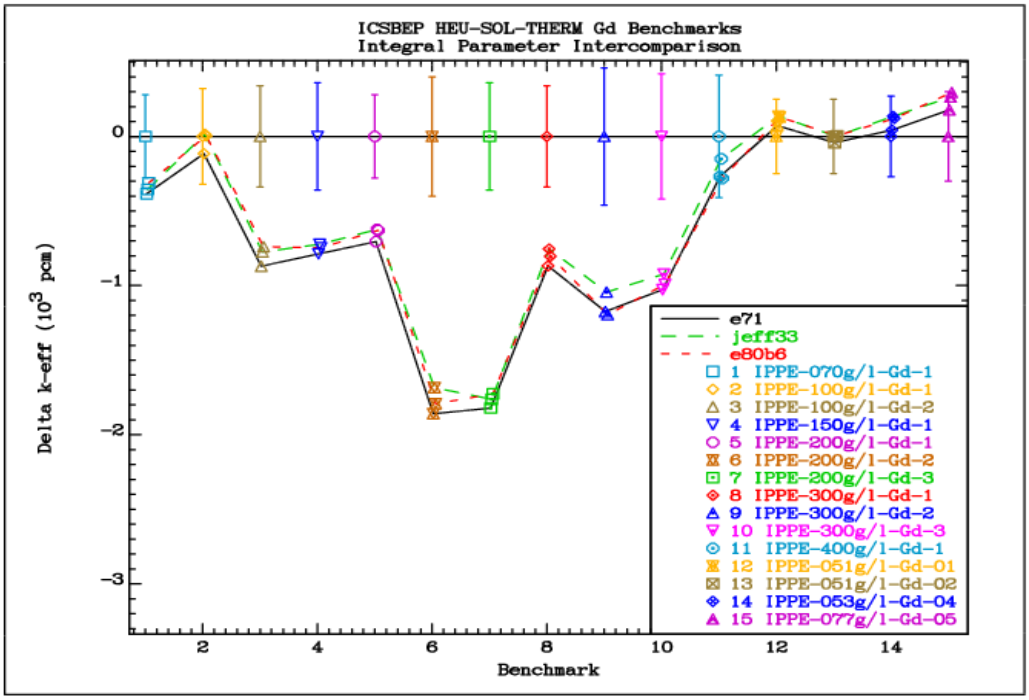

FIG. 4.9.12. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the IPPE highly-enriched solution benchmarks with different uranium concentrations and no gadolinium.

In view of the discrepancies between measured and calculated k_{eff} it seems that some parameter is not well under control even when no gadolinium is present. Thus, the series of the experiments without gadolinium cannot be used for data validation. Consequently, the trends with increasing gadolinium content are also unreliable and cannot be used for the validation of the gadolinium data. Possible additional sources of uncertainty should be investigated (e.g. traces of Gd from a previous experiment contaminating an experiment with a low Gd concentration, incomplete mixing of Gd solution, etc.). If such sources of uncertainty cannot be quantified, at least an upper estimate should be made; otherwise the experiments should include a disclaimer, warning a potential user of the problem.

5. Reactor systems with intermediate enrichment

5.1. IEU-COMP-FAST and IEU-COMP-INTER

In the first group there are only the ZPR-3/12 and KBR-18 benchmarks. In the second group there are only ZPR-6/6A, KBR-19 and KBR-20. The ZPR-6/6A benchmark is discussed in Section 7.1. The ZPR-2/12 benchmark is not analysed separately. The remaining KBR benchmarks involve Th and polyethylene and are outside the scope of the present analysis.

5.2. IEU-COMP-THERM

The two groups of benchmarks are merged because only a few cases are included in the analysis. In addition, KBR-21 is excluded because it is a k_{inf} measurement of Th and polyethylene. The list of benchmarks in this group is given in Table 5.1 below. As evident from Fig. 5.2.1, the calculated k_{eff} is practically within the uncertainty band, except for some slightly higher deviations with the JEFF-3.3 library.

TABLE 5.1. LIST OF INTERMEDIATE-ENRICHED COMPOUND THERMAL SYSTEMS

No.	ICSBEP label	Short name	Common name
1	IEU-COMP-THERM-002	ict002-001	IPPE-MATR_22.7C
2	IEU-COMP-THERM-002	ict002-003	IPPE-MATR_16.4C_Gd
3	IEU-COMP-THERM-002	ict002-005	IPPE-MATR_14.5C_Cd
4	IEU-COMP-THERM-003	ict003-001	TRIGA
5	IEU-COMP-THERM-003	ict003-002	TRIGA
6	IEU-COMP-THERM-009	ict009-001	PBF-1
7	IEU-COMP-THERM-009	ict009-002	PBF-2

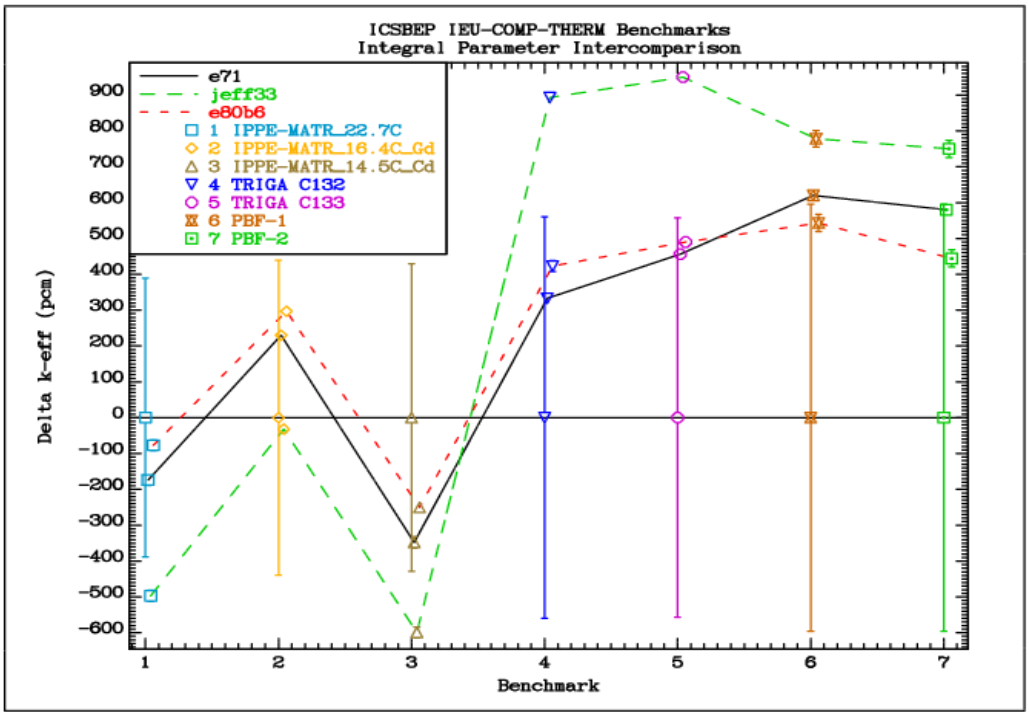

FIG. 5.2.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the IEU-COMP-THERM group of benchmarks.

5.3. IEU-MET-FAST and IEU-MET-INTER

Several groups of benchmarks were considered, which are listed in Table 5.2 below. The differences between the calculated k_{eff} values and the reference benchmark values are shown in Fig. 5.3.1. Very large discrepancies are observed in the copper-reflected IEU-MET-FAST-020 group of benchmarks with ENDF/B-VII.1 and JEFF-3.3 data. Great improvement with the ENDF/B-VIII data is achieved due to the changes in the angular distributions of the copper data.

Table 5.2. List of intermediate-enriched metal fast assemblies

No.	ICSBEP Label	Short name	Common name
1	IEU-MET-FAST-007	imf007	Big_Ten
2	IEU-MET-FAST-007	imf007d	Big_Ten(detailed)
3	IEU-MET-FAST-001	imf001-001d	Jemima-1d
4	IEU-MET-FAST-001	imf001-002d	Jemima-2d
5	IEU-MET-FAST-001	imf001-003d	Jemima-3d
6	IEU-MET-FAST-001	imf001-004d	Jemima-4d
7	IEU-MET-FAST-002	imf002	Pajarito
8	IEU-MET-FAST-003	imf003-001d	VNIIEF-CTF-3
9	IEU-MET-FAST-004	imf004-001d	VNIIEF-CTF-4
10	IEU-MET-FAST-005	imf005	VNIIEF-CTF-5
11	IEU-MET-FAST-005	imf005-s	VNIIEF-CTF-5s
12	IEU-MET-FAST-006	imf006	VNIIEF-CTF-6
13	IEU-MET-FAST-006	imf006-s	VNIIEF-CTF-6s
14	IEU-MET-FAST-010	imf010	ZPR-6/9(U9)
15	IEU-MET-FAST-012	imf012	ZPR-3/41
16	IEU-MET-FAST-020	imf020-001s	FR0_T0/1E-S
17	IEU-MET-FAST-020	imf020-002s	FR0_T1-S
18	IEU-MET-FAST-020	imf020-003s	FR0_T2-S
19	IEU-MET-FAST-020	imf020-004s	FR0_T3-S
20	IEU-MET-FAST-020	imf020-005s	FR0_T4a-S
21	IEU-MET-FAST-020	imf020-006s	FR0_T5-S
22	IEU-MET-FAST-020	imf020-007s	FR0_T6a-S
23	IEU-MET-FAST-021	imf021-001s	FR0_4-S
24	IEU-MET-FAST-022	imf022-001	FR0_3X-S
25	IEU-MET-FAST-022	imf022-002	FR0_5-S
26	IEU-MET-FAST-022	imf022-003	FR0_6A-S
27	IEU-MET-FAST-022	imf022-004	FR0_7-S
28	IEU-MET-FAST-022	imf022-005	FR0_8-S
29	IEU-MET-FAST-022	imf022-006	FR0_9-S
30	IEU-MET-FAST-022	imf022-007	FR0_10-S
31	IEU-MET-FAST-013	imf013	ZPR-9/1
32	IEU-MET-FAST-014	imf014-002	ZPR-9/2
33	IEU-MET-FAST-014	imf014-003	ZPR-9/3

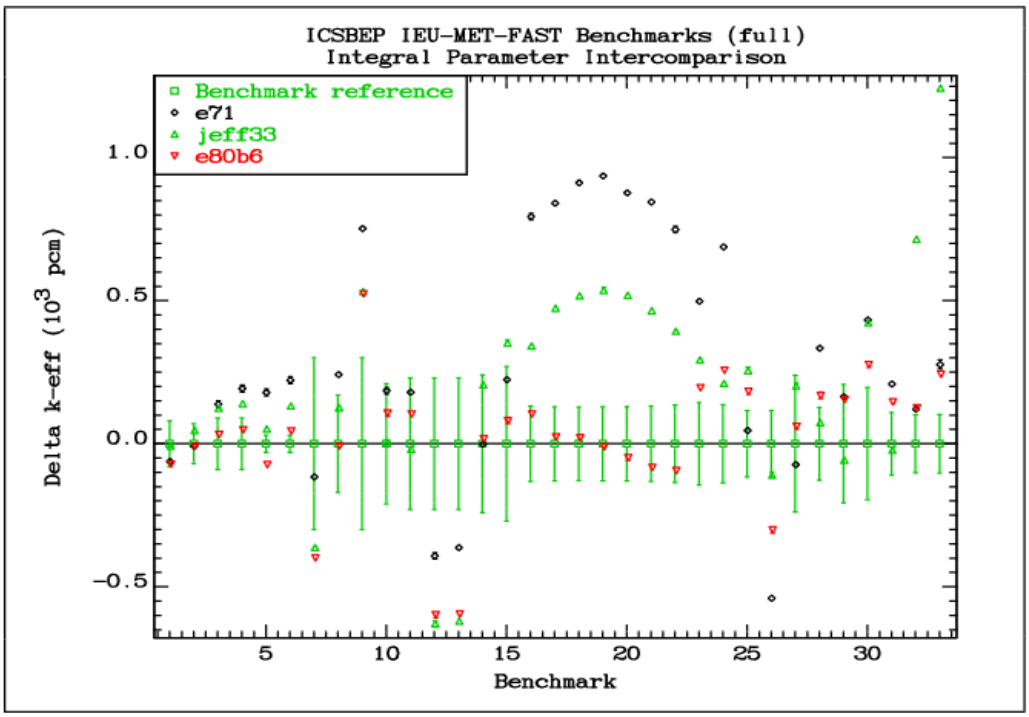

FIG. 5.3.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the IEU-MET-FAST group of benchmarks.

5.4. IEU-SOL-THERM

A single benchmark case "ist005" was included in the analysis. The assigned benchmark uncertainty is of the order of 600 pcm. All libraries predict reactivity within this uncertainty interval.

6. Low-enriched uranium systems

6.1. LEU-COMP-THERM

This group of benchmarks available at the IAEA includes 254 cases that are listed in Table 6.1 below. The differences in the calculated k_{eff} from the benchmark values are shown in Fig. 6.1.1. The figure shows that there are obvious outliers, which need to be looked at more carefully. In order to reach meaningful conclusions, emphasis is placed on benchmarks without many additional components like metal reflectors, separator plates, etc. Some cases involving soluble poisons may be acceptable. The outliers that are candidates for exclusion are discussed below.

LEU-COMP-THERM-003 are benchmark cases 14-31 in Table 6.1. They are declared as having a Gd impurity in water, which is worth close to 1000 pcm, what is comparable to the observed discrepancy. Considering the discrepancies by about a factor of two in the reported values of the Gd impurity in the benchmark specifications, one is led to the suspicion that these are detection limits, rather than best estimates. The benchmark group LEU-COMP-THERM-004 contains similar specifications and was not even considered in the analysis. The benchmark group LEU-COMP-THERM-003 is excluded from further consideration.

LEU-COMP-THERM-005 are benchmark cases 32-44 in Table 6.1 and contain Gd solution in the moderator. Inputs for the assemblies with 4.3% enriched fuel were available only (benchmark cases

1-12). There is a clear trend of reactivity over-prediction with increasing Gd concentration with the JEFF-3.3 library, as shown in Fig. 6.1.2. Fairly large uncertainty is seen in the case with 0.21 g/l of Gd as well, but the experimental uncertainty is large (seeee also the LEU-COMP-THERM-028 and LEU-COMP-THERM-035 benchmark description below). The benchmark group LEU-COMP-THERM-005 is nevertheless included in the final analysis of the low-enriched compound thermal systems.

LEU-COMP-THERM-007 are the French Valduc experiments (cases 63-72 in Table 6.1) with different pin pitch values, ranging from 1.26 cm to 2.52 cm. The pitch is inversely proportional to the epithermal fission fraction (FEPIT), as shown in Fig. 6.1.3. The quoted uncertainties are very small (less than 100 pcm). All libraries under-predict reactivity, with a different slope as a function of FEPIT. The benchmark group LEU-COMP-THERM-007 is included in the final analysis of the low-enriched compound thermal systems.

LEU-COMP-THERM-009 benchmarks (cases 88-111) in Table 6.1) contain separator plates between fuel clusters. Practically all libraries predict reactivity within the uncertainty intervals, as seen from Fig. 6.1.4. For consistency, the benchmark group LEU-COMP-THERM-009 is excluded from the final analysis due to the presence of additional materials as separator plates.

LEU-COMP-THERM-010 are benchmarks reflected by lead, uranium or steel (cases 112-141). Generally, there is good agreement between the measured and the predicted reactivity, except for the lead-reflected systems, which are the big outlies in Fig. 6.1.5. The results excluding the lead-reflected cases are shown in Fig. 6.1.5a. The cases with the epithermal fission fraction near 18 % could be affected by the Cr data in stainless steel. For consistency, the benchmark group LEU-COMP-THERM-010 is excluded from the final analysis due to the presence of additional materials as reflectors.

LEU-COMP-THERM-022, 24, 25 are benchmarks from the Kurchatov Institute (cases 151-163 in Table 6.1). They are grouped together because of their similarity and are shown in Fig. 6.1.6. The calculated results seem to be wildly scattered, far outside the uncertainty intervals, without any distinct trend as a function of the epithermal fission fraction. Due to the inexplicable discrepancies, the benchmark groups LEU-COMP-THERM-022, 24, 25 are excluded in the final analysis of the low-enriched compound thermal systems.

LEU-COMP-THERM-028 benchmarks (cases 164-183 in Table 6.1) are similar to LEU-COMP-THERM-005, but the range of Gd concentrations is narrower. All results lie within the experimental uncertainties, as seen from Fig.6.1.2a. The benchmarks are included in the final analysis.

LEU-COMP-THERM-035 benchmarks (cases 184-186 in Table 6.1) are from the Japanese TCA facility with either boron or gadolinium in the solution. They are complementary to the LEU-COMP-THERM-006 Case 8 without any dissolved absorber. The cases with the boron absorber are within experimental uncertainties, but the case with the gadolinium absorber seems to under-predict reactivity, contrary to the trends in LEU-COMP-005 and LEU-COMP-28. The benchmarks are included in the final analysis. The benchmarks are included in the final analysis.

LEU-COMP-THERM-042 benchmarks (cases 187-195 in Table 6.1) belong to a group of cases performed at Pacific North-West Laboratories with separator plates between fuel clusters and steel reflectors on the sides. The results of calculations are shown in Fig. 6.1.7. For consistency, the

benchmark group LEU-COMP-THERM-042 is excluded from the final analysis due to the presence of additional materials as separator plates and reflectors.

LEU-COMP-THERM-052 are Valduc benchmarks with different amounts of gadolinium absorber in the solution and varying pin pitch. The first three cases had hexagonal pin arrangement and the last three were cylindricised. In principle they are complementary to LEU-COMP-THERM-007 that contained no absorber in the solution. There were some problems related to the MCNP inputs and the results are inconclusive, as seen in Fig. 6.1.3a. The benchmarks are not included in the final analysis.

LEU-COMP-THERM-064 are VVER benchmarks (cases 203-209 in Table 6.1). It is already evident from Fig. 6.1.1 that these benchmarks are discrepant in k_{eff} prediction by 1-2 %, which is unreasonable. The benchmark group LEU-COMP-THERM-064 is excluded from further consideration.

LEU-COMP-THERM-078, 80, 96 are the 7uPCX benchmarks cases 210-254 in Table6.1) performed very recently at the Sandia National Laboratory (the last one in 2015). They are assigned very small uncertainties. In Fig. 6.1.8 the cases LEU-COMP-THERM-078 and LEU-COMP-THERM-80 can be seen as bunched groups around 17 % and 23 % of epithermal fission fraction, respectively. The LEU-COMP-THERM-096 cases fill a broader range. The ENDF/B-VIII library tends to under-predict reactivity by as much as 300 pcm, particularly with increasing FEPIT, while the JEFF-3.3 library results are within the uncertainty interval. The benchmarks are included in the final analysis.

TABLE 6.1. LIST OF LOW-ENRICHED COMPOUND THERMAL SYSTEMS FROM THE ICSBEP COLLECTION

No.	ICSBEP label	Short name	Common name
1	LEU-COMP-THERM-001	lct001-001	PNL_2.032p-1
2	LEU-COMP-THERM-001	lct001-002	PNL_2.032p-2
3	LEU-COMP-THERM-001	lct001-003	PNL_2.032p-3
4	LEU-COMP-THERM-001	lct001-004	PNL_2.032p-4
5	LEU-COMP-THERM-001	lct001-005	PNL_2.032p-5
6	LEU-COMP-THERM-001	lct001-006	PNL_2.032p-6
7	LEU-COMP-THERM-001	lct001-007	PNL_2.032p-7
8	LEU-COMP-THERM-001	lct001-008	PNL_2.032p-8
9	LEU-COMP-THERM-002	lct002-001	PNL_2.54p-1
10	LEU-COMP-THERM-002	lct002-002	PNL_2.54p-2
11	LEU-COMP-THERM-002	lct002-003	PNL_2.54p-3
12	LEU-COMP-THERM-002	lct002-004	PNL_2.54p-4
13	LEU-COMP-THERM-002	lct002-005	PNL_2.54p-5
14	LEU-COMP-THERM-003	lct003-001	PNL_1.64p-01
15	LEU-COMP-THERM-003	lct003-002	PNL_1.64p-02
16	LEU-COMP-THERM-003	lct003-003	PNL_1.64p-03
17	LEU-COMP-THERM-003	lct003-004	PNL_1.64p-04
18	LEU-COMP-THERM-003	lct003-005	PNL_1.64p-05
19	LEU-COMP-THERM-003	lct003-006	PNL_1.64p-06
20	LEU-COMP-THERM-003	lct003-007	PNL_1.64p-07
21	LEU-COMP-THERM-003	lct003-008	PNL_1.64p-08
22	LEU-COMP-THERM-003	lct003-009	PNL_1.64p-09
23	LEU-COMP-THERM-003	lct003-014	PNL_1.64p-14
24	LEU-COMP-THERM-003	lct003-015	PNL_1.64p-15
25	LEU-COMP-THERM-003	lct003-016	PNL_1.64p-16
26	LEU-COMP-THERM-003	lct003-017	PNL_1.64p-17
27	LEU-COMP-THERM-003	lct003-018	PNL_1.64p-18
28	LEU-COMP-THERM-003	lct003-019	PNL_1.64p-19
29	LEU-COMP-THERM-003	lct003-020	PNL_1.64p-20
30	LEU-COMP-THERM-003	lct003-021	PNL_1.64p-21
31	LEU-COMP-THERM-003	lct003-022	PNL_1.64p-22
32	LEU-COMP-THERM-005	lct005-001	PNL_2.398p_Gd0

33	LEU-COMP-THERM-005	lct005-002	PNL_2.398p_Gd0.068
34	LEU-COMP-THERM-005	lct005-003	PNL_2.398p_Gd0.438
35	LEU-COMP-THERM-005	lct005-004	PNL_2.398p_Gd0.482
36	LEU-COMP-THERM-005	lct005-005	PNL_1.801p_Gd0
37	LEU-COMP-THERM-005	lct005-006	PNL_1.801p_Gd0.122
38	LEU-COMP-THERM-005	lct005-007	PNL_1.801p_Gd0.400
39	LEU-COMP-THERM-005	lct005-008	PNL_1.801p_Gd0.908
40	LEU-COMP-THERM-005	lct005-009	PNL_1.801p_Gd1.246
41	LEU-COMP-THERM-005	lct005-010	PNL_1.801p_Gd1.448
42	LEU-COMP-THERM-005	lct005-011	PNL_1.801p_Gd1.481
43	LEU-COMP-THERM-005	lct005-012	PNL_1.598p_Gd0
44	LEU-COMP-THERM-005	lct005-013	PNL_1.598p_Gd0.121
45	LEU-COMP-THERM-006	lct006-001	TCA-1.50U-01
46	LEU-COMP-THERM-006	lct006-002	TCA-1.50U-02
47	LEU-COMP-THERM-006	lct006-003	TCA-1.50U-03
48	LEU-COMP-THERM-006	lct006-004	TCA-1.83U-04
49	LEU-COMP-THERM-006	lct006-005	TCA-1.83U-05
50	LEU-COMP-THERM-006	lct006-006	TCA-1.83U-06
51	LEU-COMP-THERM-006	lct006-007	TCA-1.83U-07
52	LEU-COMP-THERM-006	lct006-008	TCA-1.83U-08
53	LEU-COMP-THERM-006	lct006-009	TCA-2.48U-09
54	LEU-COMP-THERM-006	lct006-010	TCA-2.48U-10
55	LEU-COMP-THERM-006	lct006-011	TCA-2.48U-11
56	LEU-COMP-THERM-006	lct006-012	TCA-2.48U-12
57	LEU-COMP-THERM-006	lct006-013	TCA-2.48U-13
58	LEU-COMP-THERM-006	lct006-014	TCA-3.00U-14
59	LEU-COMP-THERM-006	lct006-015	TCA-3.00U-15
60	LEU-COMP-THERM-006	lct006-016	TCA-3.00U-16
61	LEU-COMP-THERM-006	lct006-017	TCA-3.00U-17
62	LEU-COMP-THERM-006	lct006-018	TCA-3.00U-18
63	LEU-COMP-THERM-007	lct007-001	Valduc-sq-1.26p
64	LEU-COMP-THERM-007	lct007-002	Valduc-sq-1.60p
65	LEU-COMP-THERM-007	lct007-003	Valduc-sq-2.10p
66	LEU-COMP-THERM-007	lct007-004	Valduc-sq-2.52p
67	LEU-COMP-THERM-007	lct007-005	Valduc-tr-1.35p
68	LEU-COMP-THERM-007	lct007-006	Valduc-tr-1.72p
69	LEU-COMP-THERM-007	lct007-007	Valduc-tr-2.26p
70	LEU-COMP-THERM-007	lct007-008	Valduc-tr-1.35p
71	LEU-COMP-THERM-007	lct007-009	Valduc-tr-1.72p
72	LEU-COMP-THERM-007	lct007-010	Valduc-tr-2.26p
73	LEU-COMP-THERM-008	lct008-001	BW-XI-1
74	LEU-COMP-THERM-008	lct008-002	BW-XI-2
75	LEU-COMP-THERM-008	lct008-003	BW-XI-3
76	LEU-COMP-THERM-008	lct008-004	BW-XI-4
77	LEU-COMP-THERM-008	lct008-005	BW-XI-5
78	LEU-COMP-THERM-008	lct008-006	BW-XI-6
79	LEU-COMP-THERM-008	lct008-007	BW-XI-7
80	LEU-COMP-THERM-008	lct008-008	BW-XI-8
81	LEU-COMP-THERM-008	lct008-009	BW-XI-9
82	LEU-COMP-THERM-008	lct008-010	BW-XI-10
83	LEU-COMP-THERM-008	lct008-011	BW-XI-11
84	LEU-COMP-THERM-008	lct008-012	BW-XI-12
85	LEU-COMP-THERM-008	lct008-013	BW-XI-13
86	LEU-COMP-THERM-008	lct008-014	BW-XI-14
87	LEU-COMP-THERM-008	lct008-015	BW-XI-15
88	LEU-COMP-THERM-009	lct009-001	PNL_2.54p_SSnoB
89	LEU-COMP-THERM-009	lct009-002	PNL_2.54p_SSnoB
90	LEU-COMP-THERM-009	lct009-003	PNL_2.54p_SSnoB
91	LEU-COMP-THERM-009	lct009-004	PNL_2.54p_SSnoB
92	LEU-COMP-THERM-009	lct009-005	PNL_2.54p_SS1.1B
93	LEU-COMP-THERM-009	lct009-006	PNL_2.54p_SS1.1B
94	LEU-COMP-THERM-009	lct009-007	PNL_2.54p_SS1.6B
95	LEU-COMP-THERM-009	lct009-008	PNL_2.54p_SS1.6B
96	LEU-COMP-THERM-009	lct009-010	PNL_2.54p_CuNoCd
97	LEU-COMP-THERM-009	lct009-011	PNL_2.54p_CuNoCd
98	LEU-COMP-THERM-009	lct009-013	PNL_2.54p_CuNoCd
99	LEU-COMP-THERM-009	lct009-015	PNL_2.54p_Cu1.0Cd
100	LEU-COMP-THERM-009	lct009-016	PNL_2.54p_Cd

101	LEU-COMP-THERM-009	lct009-017	PNL_2.54p_Cd
102	LEU-COMP-THERM-009	lct009-018	PNL_2.54p_Cd
103	LEU-COMP-THERM-009	lct009-019	PNL_2.54p_Cd
104	LEU-COMP-THERM-009	lct009-020	PNL_2.54p_Cd
105	LEU-COMP-THERM-009	lct009-021	PNL_2.54p_Cd
106	LEU-COMP-THERM-009	lct009-022	PNL_2.54p_Cd
107	LEU-COMP-THERM-009	lct009-023	PNL_2.54p_Cd
108	LEU-COMP-THERM-009	lct009-024	PNL_2.54p_Al
109	LEU-COMP-THERM-009	lct009-025	PNL_2.54p_Al
110	LEU-COMP-THERM-009	lct009-026	PNL_2.54p_Zr
111	LEU-COMP-THERM-009	lct009-027	PNL_2.54p_Zr
112	LEU-COMP-THERM-010	lct010-001	PNL_2.54p_Pb-1
113	LEU-COMP-THERM-010	lct010-002	PNL_2.54p_Pb-2
114	LEU-COMP-THERM-010	lct010-003	PNL_2.54p_Pb-3
115	LEU-COMP-THERM-010	lct010-004	PNL_2.54p_Pb-4
116	LEU-COMP-THERM-010	lct010-005	PNL_2.54p_DU-1
117	LEU-COMP-THERM-010	lct010-006	PNL_2.54p_DU-2
118	LEU-COMP-THERM-010	lct010-007	PNL_2.54p_DU-3
119	LEU-COMP-THERM-010	lct010-008	PNL_2.54p_DU-4
120	LEU-COMP-THERM-010	lct010-009	PNL_2.54p_SS-1
121	LEU-COMP-THERM-010	lct010-010	PNL_2.54p_SS-2
122	LEU-COMP-THERM-010	lct010-011	PNL_2.54p_SS-3
123	LEU-COMP-THERM-010	lct010-012	PNL_2.54p_SS-4
124	LEU-COMP-THERM-010	lct010-013	PNL_2.54p_SS-5
125	LEU-COMP-THERM-010	lct010-014	PNL_1.892p_SS-6
126	LEU-COMP-THERM-010	lct010-015	PNL_1.892p_SS-7
127	LEU-COMP-THERM-010	lct010-016	PNL_1.892p_SS-8
128	LEU-COMP-THERM-010	lct010-017	PNL_1.892p_SS-9
129	LEU-COMP-THERM-010	lct010-018	PNL_1.892p_SS-10
130	LEU-COMP-THERM-010	lct010-019	PNL_1.892p_SS-11
131	LEU-COMP-THERM-010	lct010-020	PNL_1.892p_Pb-5
132	LEU-COMP-THERM-010	lct010-021	PNL_1.892p_Pb-6
133	LEU-COMP-THERM-010	lct010-022	PNL_1.892p_Pb-7
134	LEU-COMP-THERM-010	lct010-023	PNL_1.892p_Pb-8
135	LEU-COMP-THERM-010	lct010-024	PNL_1.892p_DU-5
136	LEU-COMP-THERM-010	lct010-025	PNL_1.892p_DU-6
137	LEU-COMP-THERM-010	lct010-026	PNL_1.892p_DU-7
138	LEU-COMP-THERM-010	lct010-027	PNL_1.892p_DU-8
139	LEU-COMP-THERM-010	lct010-028	PNL_1.892p_DU-9
140	LEU-COMP-THERM-010	lct010-029	PNL_1.892p_DU-10
141	LEU-COMP-THERM-010	lct010-030	PNL_1.892p_DU-11
142	LEU-COMP-THERM-011	lct011-002	BW_CX-10-II(2)
143	LEU-COMP-THERM-011	lct011-003	BW_CX-10-IIIA(3)
144	LEU-COMP-THERM-011	lct011-004	BW_CX-10-IIIB(4)
145	LEU-COMP-THERM-011	lct011-005	BW_CX-10-IIIC(5)
146	LEU-COMP-THERM-011	lct011-006	BW_CX-10-IIID(6)
147	LEU-COMP-THERM-011	lct011-007	BW_CX-10-IIIE(7)
148	LEU-COMP-THERM-011	lct011-008	BW_CX-10-IIIF(8)
149	LEU-COMP-THERM-011	lct011-009	BW_CX-10-IIIG(9)
150	LEU-COMP-THERM-011	lct011-015	BW_CX-10-IX(15)
151	LEU-COMP-THERM-022	lct022-001	RRC-KI-0.70p_hx
152	LEU-COMP-THERM-022	lct022-002	RRC-KI-0.80p_hx
153	LEU-COMP-THERM-022	lct022-003	RRC-KI-1.00p_hx
154	LEU-COMP-THERM-022	lct022-004	RRC-KI-1.22p_hx
155	LEU-COMP-THERM-022	lct022-005	RRC-KI-1.40p_hx
156	LEU-COMP-THERM-022	lct022-006	RRC-KI-1.83p_hx
157	LEU-COMP-THERM-022	lct022-007	RRC-KI-1.85p_hx
158	LEU-COMP-THERM-024	lct024-001	RRC-KI-0.62p_hx
159	LEU-COMP-THERM-024	lct024-002	RRC-KI-0.88p_hx
160	LEU-COMP-THERM-025	lct025-001	RRC-KI-0.70p_sq
161	LEU-COMP-THERM-025	lct025-002	RRC-KI-0.80p_sq
162	LEU-COMP-THERM-025	lct025-003	RRC-KI-1.00p_sq
163	LEU-COMP-THERM-025	lct025-004	RRC-KI-1.22p_sq
164	LEU-COMP-THERM-028	lct028-001	PNL_2.286p_B0
165	LEU-COMP-THERM-028	lct028-002	PNL_2.286p_B.2307
166	LEU-COMP-THERM-028	lct028-003	PNL_2.286p_B.4514
167	LEU-COMP-THERM-028	lct028-004	PNL_2.286p_B.6053
168	LEU-COMP-THERM-028	lct028-005	PNL_2.286p_Cd0.429

169	LEU-COMP-THERM-028	lct028-006	PNL_2.286p_Cd1.06
170	LEU-COMP-THERM-028	lct028-007	PNL_2.286p_Gd.0722
171	LEU-COMP-THERM-028	lct028-008	PNL_2.286p_Gd.145
172	LEU-COMP-THERM-028	lct028-009	PNL_2.286p_Gd.213
173	LEU-COMP-THERM-028	lct028-010	PNL_2.794p_B0
174	LEU-COMP-THERM-028	lct028-011	PNL_2.794p_B.158
175	LEU-COMP-THERM-028	lct028-012	PNL_2.794p_B.38
176	LEU-COMP-THERM-028	lct028-013	PNL_2.794p_Gd.0547
177	LEU-COMP-THERM-028	lct028-014	PNL_2.794p_Gd.1169
178	LEU-COMP-THERM-028	lct028-015	PNL_3.302p_B0
179	LEU-COMP-THERM-028	lct028-016	PNL_3.302p_B.0643
180	LEU-COMP-THERM-028	lct028-017	PNL_3.302p_B.2154
181	LEU-COMP-THERM-028	lct028-018	PNL_3.302p_B.1507
182	LEU-COMP-THERM-028	lct028-019	PNL_3.302p_Gd.0257
183	LEU-COMP-THERM-028	lct028-020	PNL_3.302p_Gd.044
184	LEU-COMP-THERM-035	lct035-001	TCA-B.07
185	LEU-COMP-THERM-035	lct035-002	TCA-B.1477
186	LEU-COMP-THERM-035	lct035-003	TCA-Gd.0645
187	LEU-COMP-THERM-042	lct042-1	lct042-1
188	LEU-COMP-THERM-042	lct042-2	lct042-2
189	LEU-COMP-THERM-042	lct042-001	lct042-001
190	LEU-COMP-THERM-042	lct042-002	lct042-002
191	LEU-COMP-THERM-042	lct042-003	lct042-003
192	LEU-COMP-THERM-042	lct042-004	lct042-004
193	LEU-COMP-THERM-042	lct042-005	lct042-005
194	LEU-COMP-THERM-042	lct042-006	lct042-006
195	LEU-COMP-THERM-042	lct042-007	lct042-007
196	LEU-COMP-THERM-043	lct043-002	IPEN/MB-01
197	LEU-COMP-THERM-052	lct052-001	Valduc_hxGd0.600
198	LEU-COMP-THERM-052	lct052-002	Valduc_hxGd0.430
199	LEU-COMP-THERM-052	lct052-003	Valduc_hxGd0.171
200	LEU-COMP-THERM-052	lct052-004	Valduc_cyGd0.600
201	LEU-COMP-THERM-052	lct052-005	Valduc_cyGd0.440
202	LEU-COMP-THERM-052	lct052-006	Valduc_cyGd0.182
203	LEU-COMP-THERM-064	lct064-001	VVER_1.27p-01
204	LEU-COMP-THERM-064	lct064-002	VVER_1.27p-02
205	LEU-COMP-THERM-064	lct064-003	VVER_1.27p-03
206	LEU-COMP-THERM-064	lct064-004	VVER_1.27p-04
207	LEU-COMP-THERM-064	lct064-005	VVER_1.27p-05
208	LEU-COMP-THERM-064	lct064-006	VVER_1.27p-06
209	LEU-COMP-THERM-064	lct064-007	VVER_1.27p-07
210	LEU-COMP-THERM-078	lct078-001	SNL-7uPCXp.855-01
211	LEU-COMP-THERM-078	lct078-002	SNL-7uPCXp.855-02
212	LEU-COMP-THERM-078	lct078-003	SNL-7uPCXp.855-03
213	LEU-COMP-THERM-078	lct078-004	SNL-7uPCXp.855-04
214	LEU-COMP-THERM-078	lct078-005	SNL-7uPCXp.855-05
215	LEU-COMP-THERM-078	lct078-006	SNL-7uPCXp.855-06
216	LEU-COMP-THERM-078	lct078-007	SNL-7uPCXp.855-07
217	LEU-COMP-THERM-078	lct078-008	SNL-7uPCXp.855-08
218	LEU-COMP-THERM-078	lct078-009	SNL-7uPCXp.855-09
219	LEU-COMP-THERM-078	lct078-010	SNL-7uPCXp.855-10
220	LEU-COMP-THERM-078	lct078-011	SNL-7uPCXp.855-11
221	LEU-COMP-THERM-078	lct078-012	SNL-7uPCXp.855-12
222	LEU-COMP-THERM-078	lct078-013	SNL-7uPCXp.855-13
223	LEU-COMP-THERM-078	lct078-014	SNL-7uPCXp.855-14
224	LEU-COMP-THERM-078	lct078-015	SNL-7uPCXp.855-15
225	LEU-COMP-THERM-080	lct080-001	SNL-7uPCXp.800-01
226	LEU-COMP-THERM-080	lct080-002	SNL-7uPCXp.800-02
227	LEU-COMP-THERM-080	lct080-003	SNL-7uPCXp.800-03
228	LEU-COMP-THERM-080	lct080-004	SNL-7uPCXp.800-04
229	LEU-COMP-THERM-080	lct080-005	SNL-7uPCXp.800-05
230	LEU-COMP-THERM-080	lct080-006	SNL-7uPCXp.800-06
231	LEU-COMP-THERM-080	lct080-007	SNL-7uPCXp.800-07
232	LEU-COMP-THERM-080	lct080-008	SNL-7uPCXp.800-08
233	LEU-COMP-THERM-080	lct080-009	SNL-7uPCXp.800-09
234	LEU-COMP-THERM-080	lct080-010	SNL-7uPCXp.800-10
235	LEU-COMP-THERM-080	lct080-011	SNL-7uPCXp.800-11
236	LEU-COMP-THERM-096	lct096-001	SNL-7uPCXp.800R-01

237	LEU-COMP-THERM-096	lct096-002	SNL-7uPCXp.800R-02
238	LEU-COMP-THERM-096	lct096-003	SNL-7uPCXp.800R-03
239	LEU-COMP-THERM-096	lct096-004	SNL-7uPCXp.800R-04
240	LEU-COMP-THERM-096	lct096-005	SNL-7uPCXp.800R-05
241	LEU-COMP-THERM-096	lct096-006	SNL-7uPCXp.800R-06
242	LEU-COMP-THERM-096	lct096-007	SNL-7uPCXp.800R-07
243	LEU-COMP-THERM-096	lct096-008	SNL-7uPCXp.800R-08
244	LEU-COMP-THERM-096	lct096-009	SNL-7uPCXp.800R-09
245	LEU-COMP-THERM-096	lct096-010	SNL-7uPCXp.800R-10
246	LEU-COMP-THERM-096	lct096-011	SNL-7uPCXp.800R-11
247	LEU-COMP-THERM-096	lct096-012	SNL-7uPCXp.800R-12
248	LEU-COMP-THERM-096	lct096-013	SNL-7uPCXp.800R-13
249	LEU-COMP-THERM-096	lct096-014	SNL-7uPCXp.800R-14
250	LEU-COMP-THERM-096	lct096-015	SNL-7uPCXp.800R-15
251	LEU-COMP-THERM-096	lct096-016	SNL-7uPCXp.800R-16
252	LEU-COMP-THERM-096	lct096-017	SNL-7uPCXp.800R-17
253	LEU-COMP-THERM-096	lct096-018	SNL-7uPCXp.800R-18
254	LEU-COMP-THERM-096	lct096-019	SNL-7uPCXp.800R-19

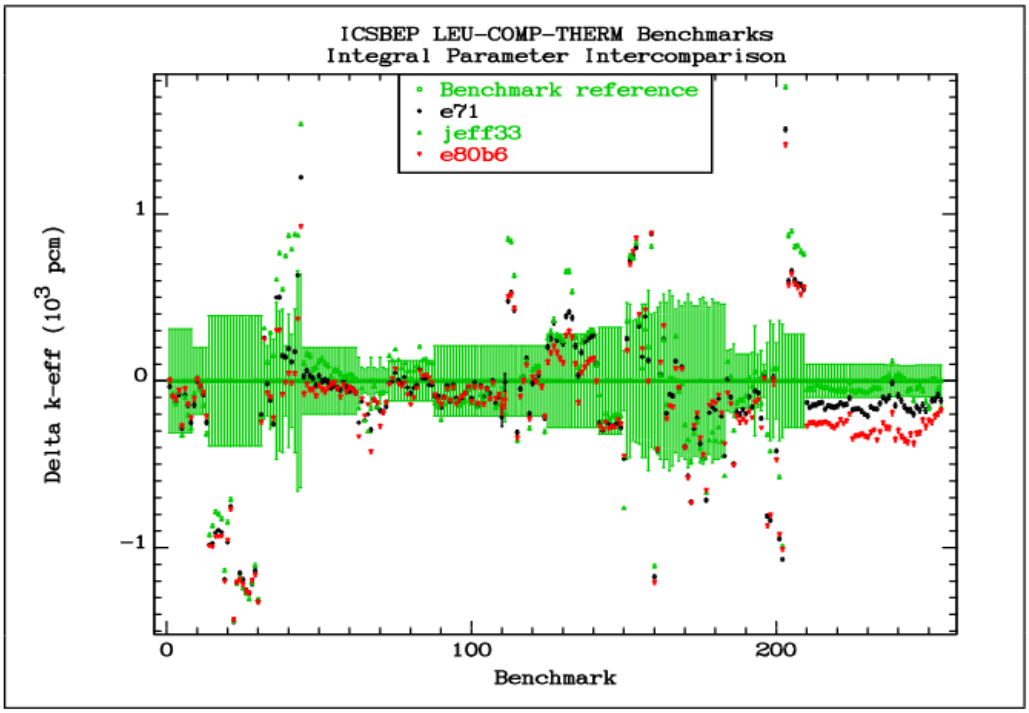

FIG. 6.1.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-COMP-THERM group of benchmarks.

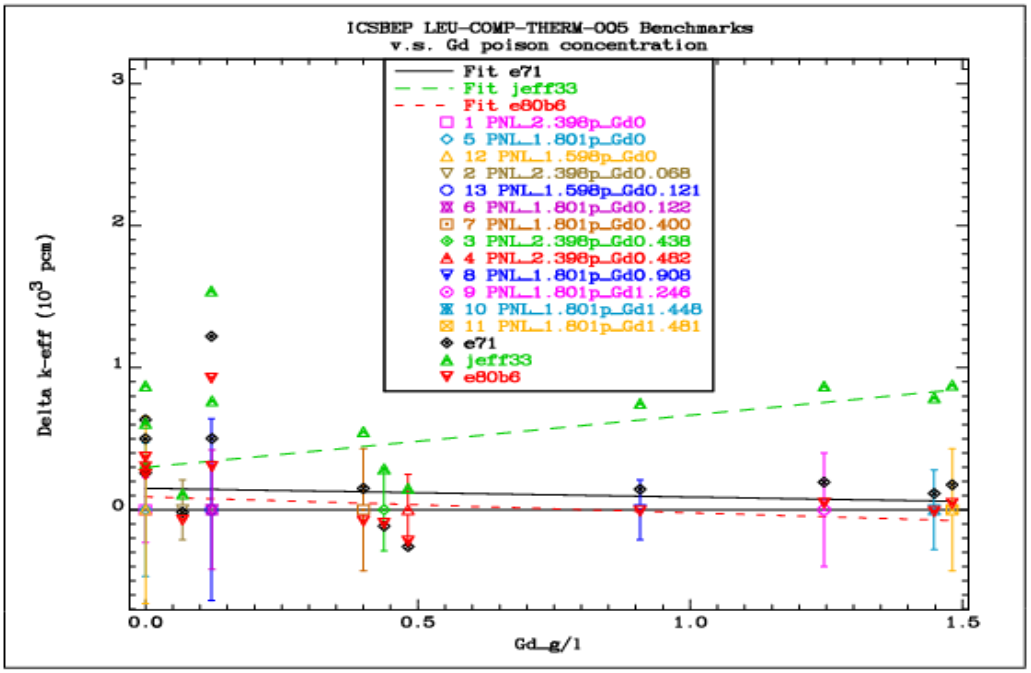

FIG. 6.1.2. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-COMP-THERM-005 group of benchmarks as a function of Gd concentration.

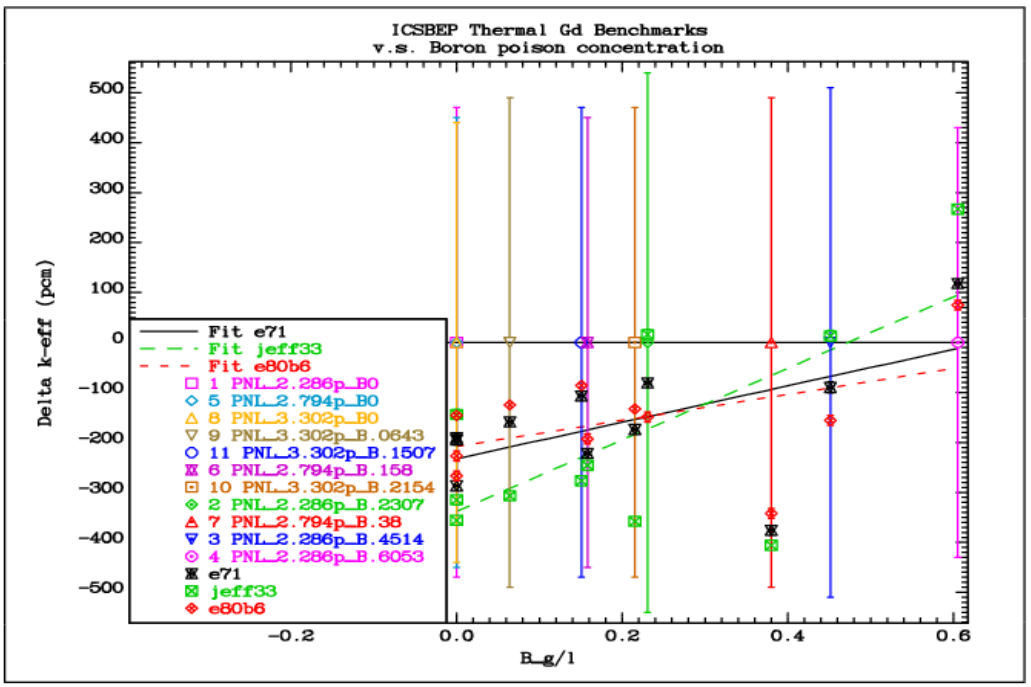

FIG. 6.1.2a. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-COMP-THERM-028 group of benchmarks as a function of Gd concentration.

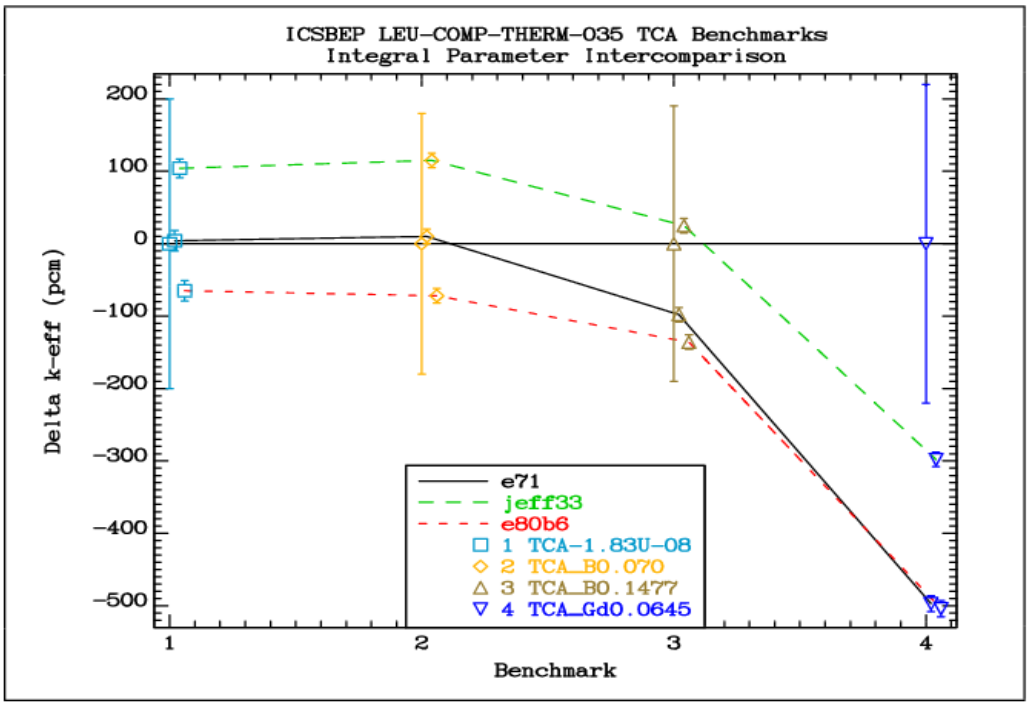

FIG. 6.1.2b. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-COMP-THERM-035 group of benchmarks; the first case is the reference LEU-COMP-THERM-006 Case 8 without any absorber in the solution.

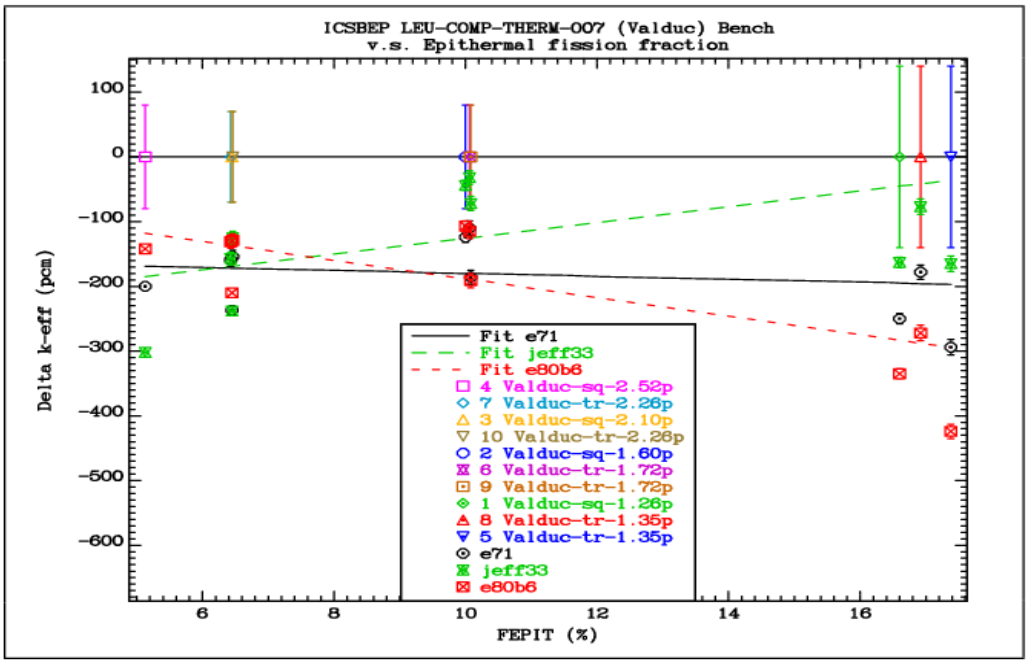

FIG. 6.1.3. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the Valduc LEU-COMP-THERM-007 group of benchmarks as a function of the epithermal fission fraction.

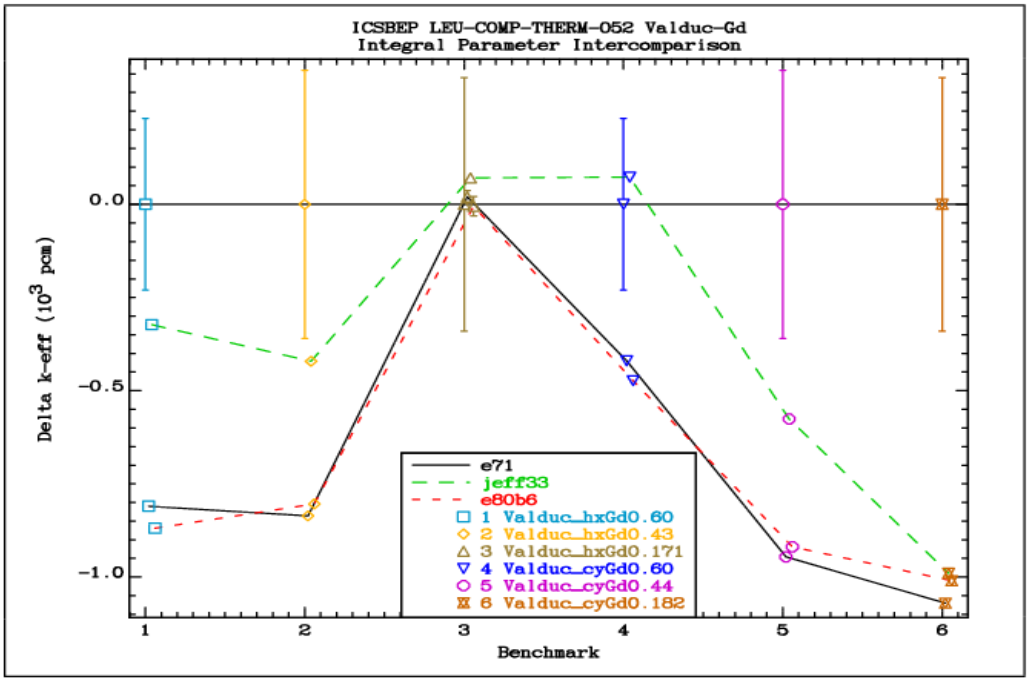

FIG. 6.1.3a. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the Valduc LEU-COMP-THERM-052 group of benchmarks that contain gadolinium in the solution.

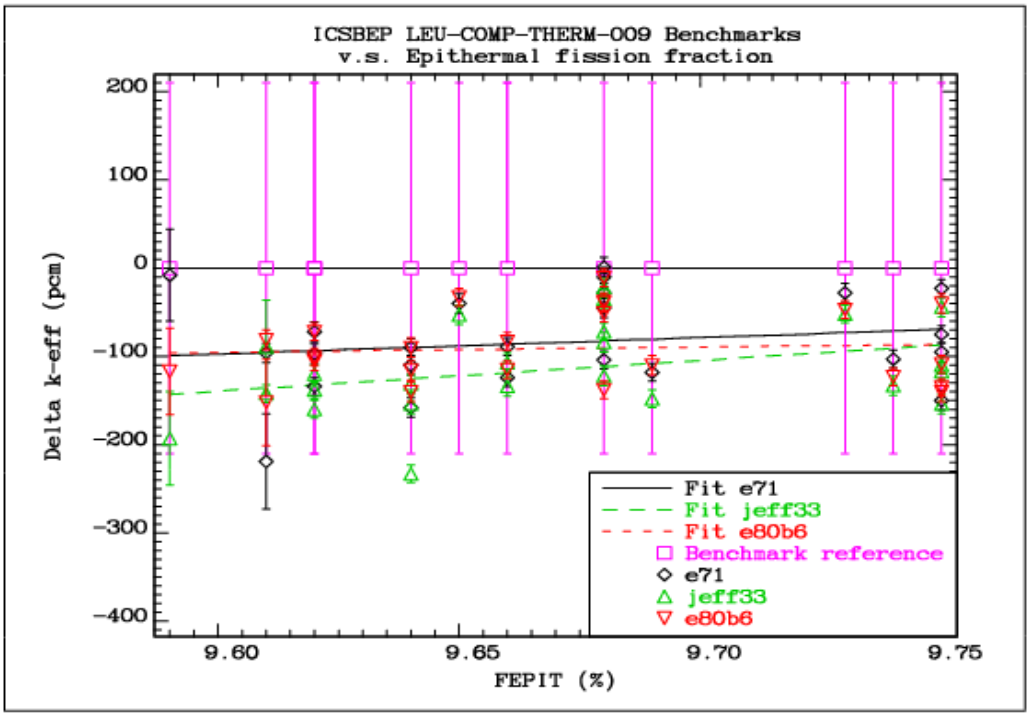

FIG. 6.1.4. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-COMP-THERM-009 group of benchmarks as a function of the epithermal fission fraction.

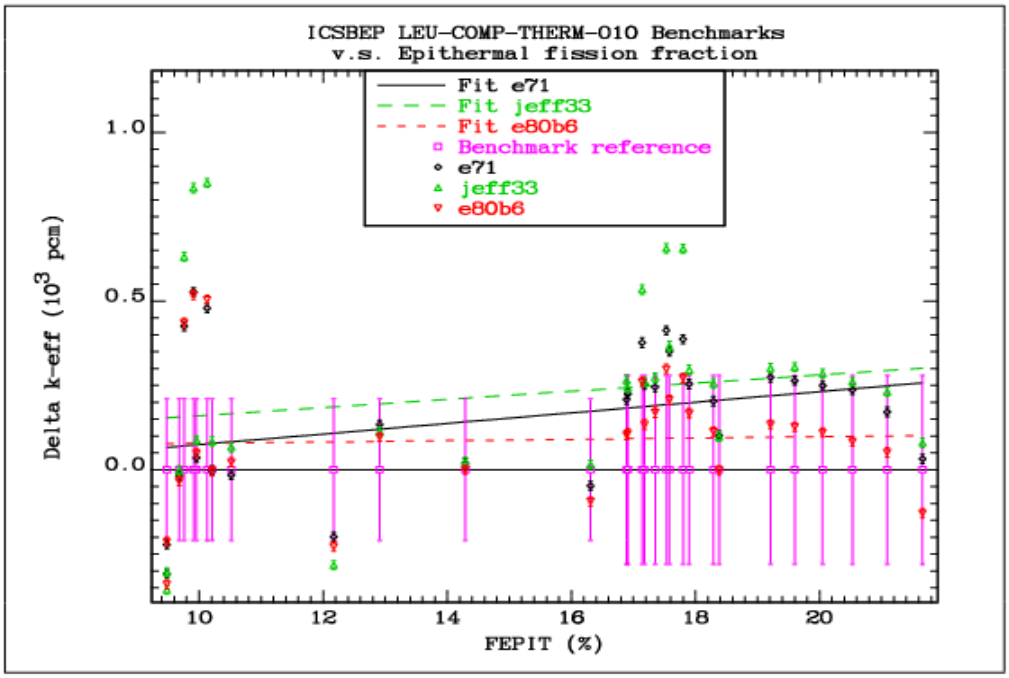

FIG. 6.1.5. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-COMP-THERM-010 group of benchmarks as a function of the epithermal fission fraction.

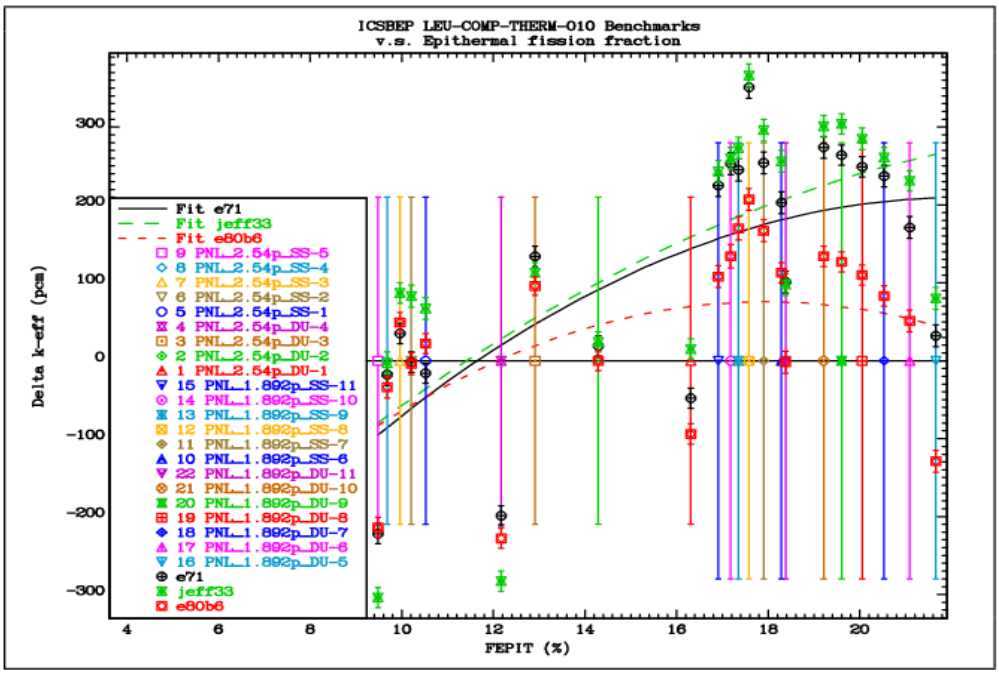

FIG. 6.1.5a. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-COMP-THERM-010 group of benchmarks (excluding the lead-reflected cases) as a function of the epithermal fission fraction. The trendlines are parabolic fits.

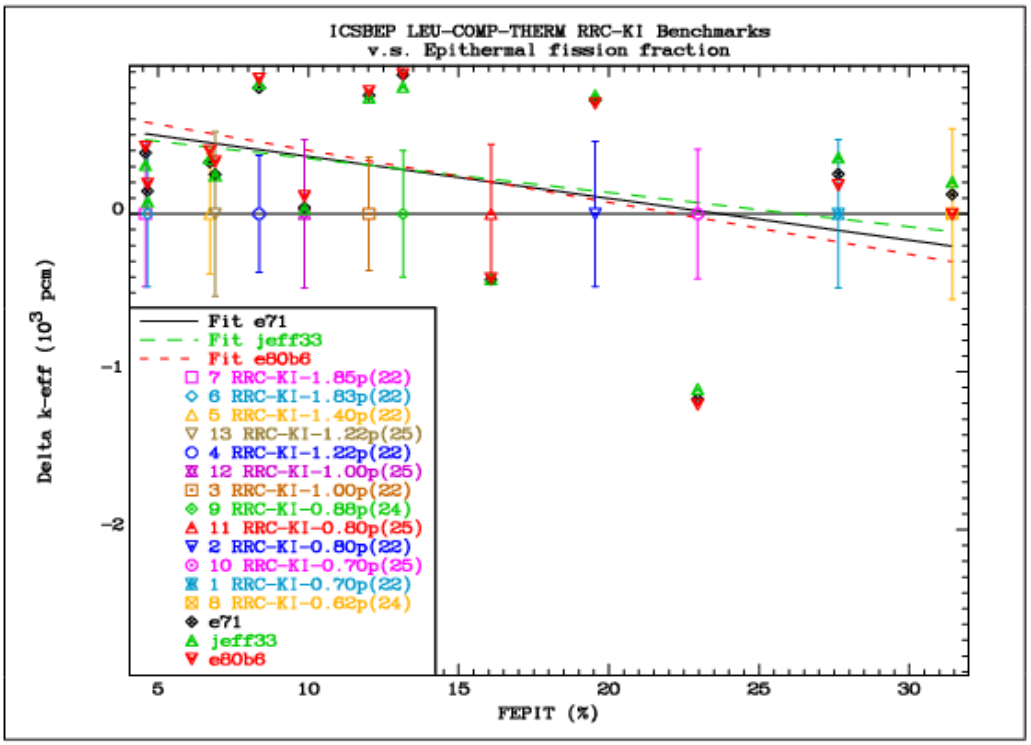

FIG. 6.1.6. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-COMP-THERM-022, 24, 25 group of benchmarks as a function of the epithermal fission fraction.

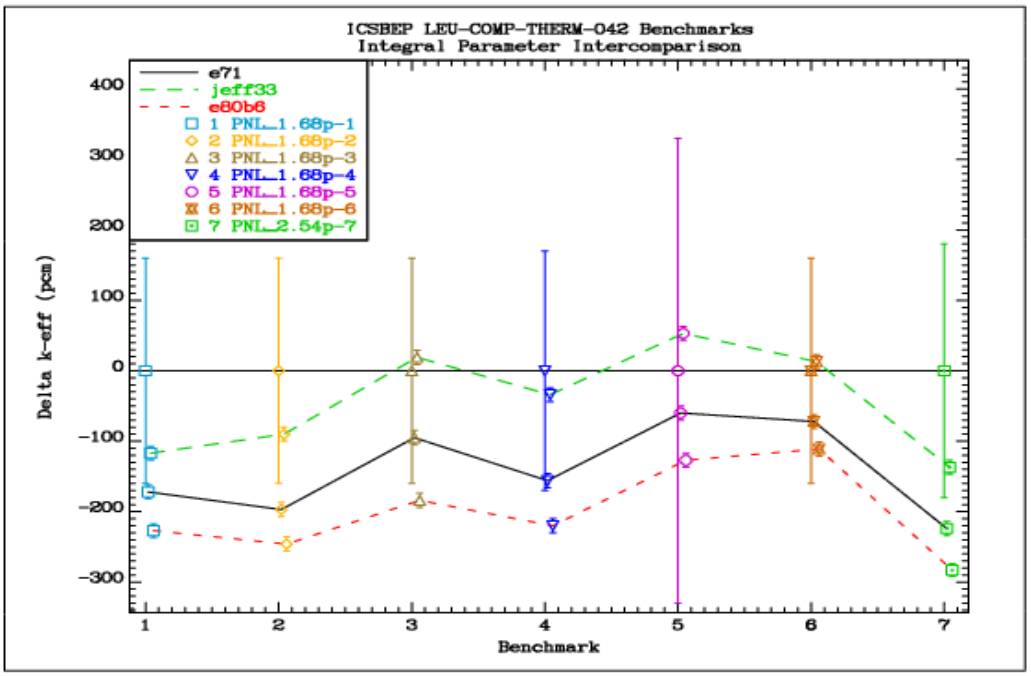

FIG. 6.1.7. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-COMP-THERM-042 group of.

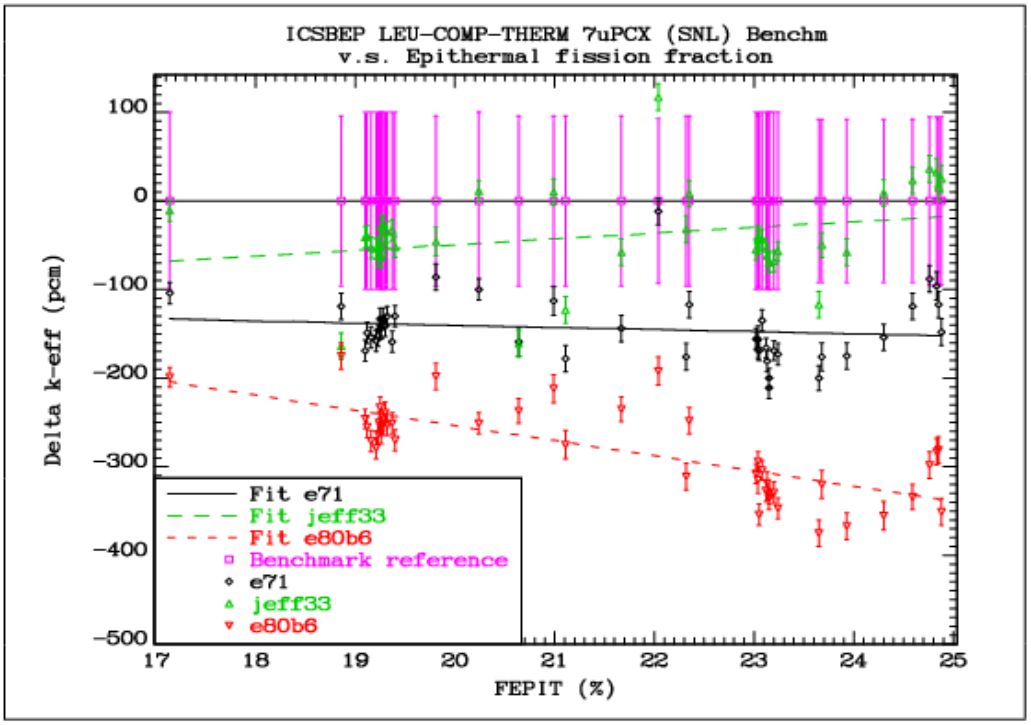

FIG. 6.1.8. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-COMP-THERM-078, 80 and 96 group of benchmarks as a function of the epithermal fission fraction.

The remaining 124 benchmark cases and their corresponding epithermal fission fractions (FEPIT) are listed in Table 6.2. The differences between the calculated and the benchmark k_{eff} are shown in Fig. 6.1.9. If the small uncertainty of the 7uPCX benchmarks is to be trusted, the ENDF/B-VIII library tends to underestimate the reactivity slightly, the effect being stronger as the fraction of epithermal fissions increases. This tendency is not supported by the PNL benchmarks of the LEU-COMP-THERM-005 group, although these benchmarks have significantly higher assigned uncertainties and many of them contain Gd in the moderator.

The overall conclusion is that the reactivity of the low-enriched compound systems is generally predicted within about 300 pcm. The predicted reactivity based on the JEFF-3.3 library is slightly higher than the one obtained with ENDF/B-VIII data, except in systems with very soft spectra. Cases with Gd in the moderator seem to be overpredicted with the JEFF-3.3 library.

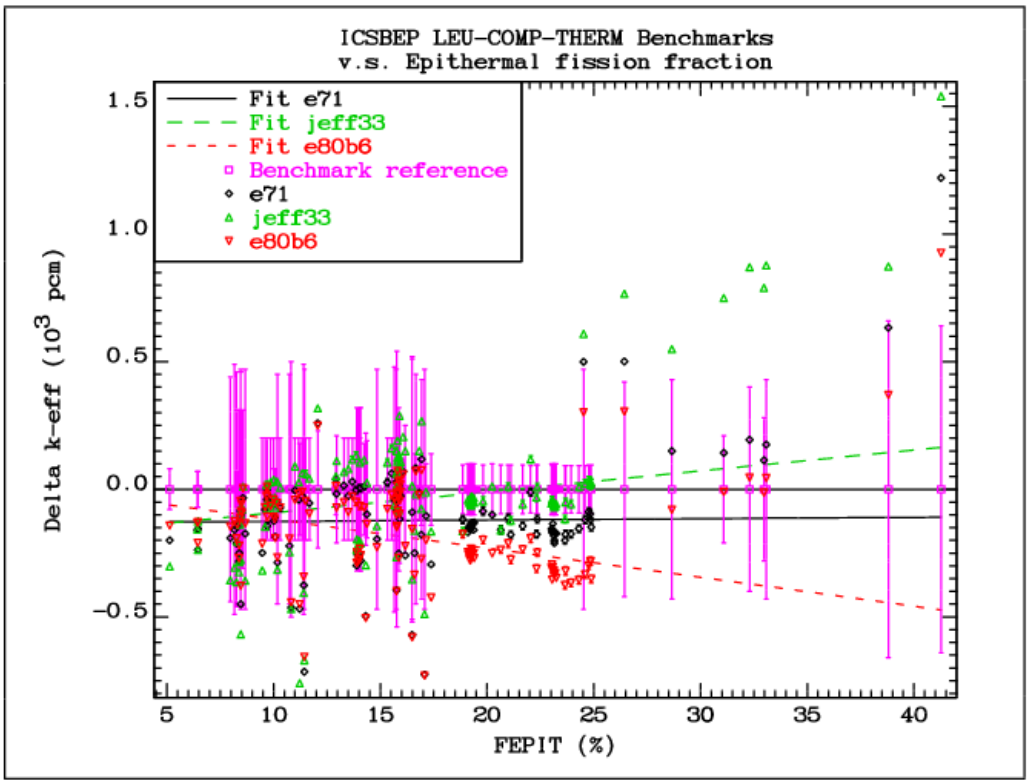

FIG. 6.1.9. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the selected groups of benchmarks as a function of the epithermal fission fraction.

TABLE 6.2. LIST OF SELECTED LOW-ENRICHED COMPOUND THERMAL BENCHMARKS FOR THE ANALYSIS OF THE PERFORMANCE OF DIFFERENT LIBRARIES AND THEIR CORRESPONDING EPITHERMAL FISSION FRACTIONS (FEPITH)

FEPIT[%]	ICSBEP Label	Short name	Common name
5.1300	LEU-COMP-THERM-007	lct007-004	Valduc-sq-2.52p
6.4300	LEU-COMP-THERM-007	lct007-005	Valduc-tr-2.26p
6.4500	LEU-COMP-THERM-007	lct007-003	Valduc-sq-2.10p
6.4600	LEU-COMP-THERM-007	lct007-005	Valduc-tr-2.26p
7.9700	LEU-COMP-THERM-028	lct028-001	PNL_3.302p_B0
8.1700	LEU-COMP-THERM-028	lct028-016	PNL_3.302p_B.0643
8.2600	LEU-COMP-THERM-028	lct028-019	PNL_3.302p_Gd.0257
8.3000	LEU-COMP-THERM-001-		PNL_2.032p-7
8.3800	LEU-COMP-THERM-001-		PNL_2.032p-5
8.3900	LEU-COMP-THERM-001-		PNL_2.032p-8
8.4300	LEU-COMP-THERM-001-		PNL_2.032p-3
8.4500	LEU-COMP-THERM-001-		PNL_2.032p-6
8.4600	LEU-COMP-THERM-028	lct028-018	PNL_3.302p_B.1507
8.4600	LEU-COMP-THERM-028	lct028-020	PNL_3.302p_Gd.044
8.4900	LEU-COMP-THERM-001-		PNL_2.032p-4
8.5100	LEU-COMP-THERM-001-		PNL_2.032p-2
8.5700	LEU-COMP-THERM-001-		PNL_2.032p-1
8.6700	LEU-COMP-THERM-028	lct028-017	PNL_3.302p_B.2154
9.4700	LEU-COMP-THERM-002	lct002-005	PNL_2.54p-5
9.6000	LEU-COMP-THERM-002	lct002-004	PNL_2.54p-4
9.6800	LEU-COMP-THERM-002	lct002-003	PNL_2.54p-3
9.6800	LEU-COMP-THERM-006	lct006-014	TCA-3.00U-14
9.6900	LEU-COMP-THERM-002	lct002-002	PNL_2.54p-2

9.7000	LEU-COMP-THERM-002	lct002-001	PNL_2.54p-1
9.8600	LEU-COMP-THERM-006	lct006-015	TCA-3.00U-15
10.0000	LEU-COMP-THERM-006	lct006-016	TCA-3.00U-16
10.0000	LEU-COMP-THERM-007	lct007-002	Valduc-sq-1.60p
10.0600	LEU-COMP-THERM-007	lct007-005	Valduc-tr-1.72p
10.0800	LEU-COMP-THERM-007	lct007-005	Valduc-tr-1.72p
10.1600	LEU-COMP-THERM-006	lct006-017	TCA-3.00U-17
10.1800	LEU-COMP-THERM-028	lct028-010	PNL_2.794p_B0
10.3100	LEU-COMP-THERM-006	lct006-018	TCA-3.00U-18
10.7400	LEU-COMP-THERM-028	lct028-011	PNL_2.794p_B.158
10.8200	LEU-COMP-THERM-028	lct028-013	PNL_2.794p_Gd.0547
11.0000	LEU-COMP-THERM-006	lct006-009	TCA-2.48U-09
11.1800	LEU-COMP-THERM-006	lct006-010	TCA-2.48U-10
11.2200	LEU-COMP-THERM-011	lct011-015	BW_CX-10-IX(15)
11.3400	LEU-COMP-THERM-006	lct006-011	TCA-2.48U-11
11.4100	LEU-COMP-THERM-028	lct028-012	PNL_2.794p_B.38
11.4400	LEU-COMP-THERM-028	lct028-014	PNL_2.794p_Gd.1169
11.5000	LEU-COMP-THERM-006	lct006-012	TCA-2.48U-12
11.6700	LEU-COMP-THERM-006	lct006-013	TCA-2.48U-13
12.0700	LEU-COMP-THERM-005	lct005-001	PNL_2.398p_Gd0
12.9200	LEU-COMP-THERM-043	lct043-002	IPEN/MB-01
12.9500	LEU-COMP-THERM-005	lct005-002	PNL_2.398p_Gd0.068
13.2900	LEU-COMP-THERM-006	lct006-004	TCA-1.83U-04
13.5000	LEU-COMP-THERM-006	lct006-005	TCA-1.83U-05
13.6900	LEU-COMP-THERM-006	lct006-006	TCA-1.83U-06
13.8700	LEU-COMP-THERM-006	lct006-007	TCA-1.83U-07
13.8900	LEU-COMP-THERM-011	lct011-003	BW_CX-10-IIIA(3)
13.9000	LEU-COMP-THERM-011	lct011-004	BW_CX-10-IIIB(4)
13.9300	LEU-COMP-THERM-011	lct011-005	BW_CX-10-IIIC(5)
13.9800	LEU-COMP-THERM-011	lct011-006	BW_CX-10-IIID(6)
14.0100	LEU-COMP-THERM-011	lct011-007	BW_CX-10-IIIE(7)
14.0400	LEU-COMP-THERM-011	lct011-008	BW_CX-10-IIIF(8)
14.0500	LEU-COMP-THERM-006	lct006-008	TCA-1.83U-08
14.0800	LEU-COMP-THERM-011	lct011-009	BW_CX-10-IIIG(9)
14.2400	LEU-COMP-THERM-035	lct035-001	TCA_B0.070
14.3200	LEU-COMP-THERM-035	lct035-003	TCA_Gd0.0645
14.3700	LEU-COMP-THERM-035	lct035-002	TCA_B0.1477
14.8400	LEU-COMP-THERM-028	lct028-001	PNL_2.286p_B0
15.3300	LEU-COMP-THERM-006	lct006-001	TCA-1.50U-01
15.5300	LEU-COMP-THERM-006	lct006-002	TCA-1.50U-02
15.6600	LEU-COMP-THERM-028	lct028-005	PNL_2.286p_Cd0.429
15.7500	LEU-COMP-THERM-006	lct006-003	TCA-1.50U-03
15.7500	LEU-COMP-THERM-008	lct008-009	BW-XI-9
15.7600	LEU-COMP-THERM-028	lct028-007	PNL_2.286p_Gd.0722
15.7700	LEU-COMP-THERM-008	lct008-008	BW-XI-8
15.7700	LEU-COMP-THERM-028	lct028-002	PNL_2.286p_B.2307
15.8000	LEU-COMP-THERM-008	lct008-002	BW-XI-2
15.8000	LEU-COMP-THERM-008	lct008-003	BW-XI-3
15.8000	LEU-COMP-THERM-008	lct008-006	BW-XI-6
15.8200	LEU-COMP-THERM-008	lct008-007	BW-XI-7
15.8300	LEU-COMP-THERM-008	lct008-004	BW-XI-4
15.8300	LEU-COMP-THERM-008	lct008-005	BW-XI-5
15.8600	LEU-COMP-THERM-011	lct011-002	BW_CX-10-II(2)
15.8700	LEU-COMP-THERM-008	lct008-012	BW-XI-12
15.8700	LEU-COMP-THERM-008	lct008-013	BW-XI-13
15.9000	LEU-COMP-THERM-005	lct005-003	PNL_2.398p_Gd0.438
15.9100	LEU-COMP-THERM-008	lct008-010	BW-XI-10
15.9400	LEU-COMP-THERM-008	lct008-014	BW-XI-14
15.9500	LEU-COMP-THERM-008	lct008-015	BW-XI-15
16.0700	LEU-COMP-THERM-008	lct008-011	BW-XI-11
16.1700	LEU-COMP-THERM-005	lct005-004	PNL_2.398p_Gd0.482
16.4900	LEU-COMP-THERM-028	lct028-003	PNL_2.286p_B.4514
16.4900	LEU-COMP-THERM-028	lct028-008	PNL_2.286p_Gd.145
16.6000	LEU-COMP-THERM-007	lct007-001	Valduc-sq-1.26p
16.6600	LEU-COMP-THERM-028	lct028-006	PNL_2.286p_Cd1.06
16.8200	LEU-COMP-THERM-008	lct008-001	BW-XI-1
16.9200	LEU-COMP-THERM-007	lct007-005	Valduc-tr-1.35p
16.9300	LEU-COMP-THERM-028	lct028-004	PNL_2.286p_B.6053

17.0700	LEU-COMP-THERM-028	lct028-009	PNL_2.286p_Gd.213
17.1400	LEU-COMP-THERM-078	lct078-015	SNL-7uPCXp.855-15
17.3800	LEU-COMP-THERM-007	lct007-005	Valduc-tr-1.35p
18.8600	LEU-COMP-THERM-096	lct096-019	SNL-7uPCXp.800R-19
19.1000	LEU-COMP-THERM-078	lct078-007	SNL-7uPCXp.855-07
19.1200	LEU-COMP-THERM-078	lct078-008	SNL-7uPCXp.855-08
19.1600	LEU-COMP-THERM-078	lct078-009	SNL-7uPCXp.855-09
19.2100	LEU-COMP-THERM-078	lct078-010	SNL-7uPCXp.855-10
19.2300	LEU-COMP-THERM-078	lct078-011	SNL-7uPCXp.855-11
19.2400	LEU-COMP-THERM-078	lct078-003	SNL-7uPCXp.855-03
19.2500	LEU-COMP-THERM-078	lct078-012	SNL-7uPCXp.855-12
19.2600	LEU-COMP-THERM-078	lct078-004	SNL-7uPCXp.855-04
19.2600	LEU-COMP-THERM-078	lct078-013	SNL-7uPCXp.855-13
19.2800	LEU-COMP-THERM-078	lct078-005	SNL-7uPCXp.855-05
19.3000	LEU-COMP-THERM-078	lct078-014	SNL-7uPCXp.855-14
19.3200	LEU-COMP-THERM-078	lct078-006	SNL-7uPCXp.855-06
19.3700	LEU-COMP-THERM-078	lct078-002	SNL-7uPCXp.855-02
19.4000	LEU-COMP-THERM-078	lct078-001	SNL-7uPCXp.855-01
19.8100	LEU-COMP-THERM-096	lct096-018	SNL-7uPCXp.800R-18
20.2400	LEU-COMP-THERM-080	lct080-011	SNL-7uPCXp.800-11
20.6400	LEU-COMP-THERM-096	lct096-015	SNL-7uPCXp.800R-15
20.9900	LEU-COMP-THERM-096	lct096-017	SNL-7uPCXp.800R-17
21.1100	LEU-COMP-THERM-096	lct096-014	SNL-7uPCXp.800R-14
21.6700	LEU-COMP-THERM-096	lct096-013	SNL-7uPCXp.800R-13
22.0400	LEU-COMP-THERM-080	lct080-003	SNL-7uPCXp.800R-03
22.3200	LEU-COMP-THERM-096	lct096-012	SNL-7uPCXp.800R-12
22.3500	LEU-COMP-THERM-096	lct096-016	SNL-7uPCXp.800R-16
23.0200	LEU-COMP-THERM-080	lct080-007	SNL-7uPCXp.800-07
23.0400	LEU-COMP-THERM-080	lct080-008	SNL-7uPCXp.800-08
23.0400	LEU-COMP-THERM-096	lct096-011	SNL-7uPCXp.800R-11
23.0500	LEU-COMP-THERM-080	lct080-009	SNL-7uPCXp.800-09
23.0800	LEU-COMP-THERM-080	lct080-010	SNL-7uPCXp.800-10
23.1200	LEU-COMP-THERM-080	lct080-003	SNL-7uPCXp.800-03
23.1300	LEU-COMP-THERM-080	lct080-004	SNL-7uPCXp.800-04
23.1500	LEU-COMP-THERM-080	lct080-005	SNL-7uPCXp.800-05
23.1500	LEU-COMP-THERM-080	lct080-006	SNL-7uPCXp.800-06
23.2000	LEU-COMP-THERM-080	lct080-002	SNL-7uPCXp.800-02
23.2400	LEU-COMP-THERM-080	lct080-001	SNL-7uPCXp.800-01
23.6500	LEU-COMP-THERM-096	lct096-010	SNL-7uPCXp.800R-10
23.6800	LEU-COMP-THERM-096	lct096-009	SNL-7uPCXp.800R-09
23.9300	LEU-COMP-THERM-096	lct096-008	SNL-7uPCXp.800R-08
24.3000	LEU-COMP-THERM-096	lct096-007	SNL-7uPCXp.800R-07
24.5200	LEU-COMP-THERM-005	lct005-005	PNL_1.801p_Gd0
24.5900	LEU-COMP-THERM-096	lct096-006	SNL-7uPCXp.800R-06
24.7600	LEU-COMP-THERM-096	lct096-005	SNL-7uPCXp.800R-05
24.8300	LEU-COMP-THERM-096	lct096-002	SNL-7uPCXp.800R-02
24.8500	LEU-COMP-THERM-096	lct096-001	SNL-7uPCXp.800R-01
24.8800	LEU-COMP-THERM-096	lct096-004	SNL-7uPCXp.800R-04
26.4300	LEU-COMP-THERM-005	lct005-006	PNL_1.801p_Gd0.122
28.6600	LEU-COMP-THERM-005	lct005-007	PNL_1.801p_Gd0.400
31.0900	LEU-COMP-THERM-005	lct005-008	PNL_1.801p_Gd0.908
32.3000	LEU-COMP-THERM-005	lct005-009	PNL_1.801p_Gd1.246
32.9700	LEU-COMP-THERM-005	lct005-010	PNL_1.801p_Gd1.448
33.0800	LEU-COMP-THERM-005	lct005-011	PNL_1.801p_Gd1.481
38.8000	LEU-COMP-THERM-005	lct005-012	PNL_1.598p_Gd0
41.2700	LEU-COMP-THERM-005	lct005-013	PNL_1.598p_Gd0.121

6.2. LEU-MET-THERM

In this group of benchmarks we must distinguish between cases moderated by heavy water and those moderated by light water. The complete list of heavy water benchmarks is given in Table 6.3 below. The LEU-MET-THERM-001 and LEU-MET-THERM-002 are the older experiments from Vinča, while the LEU-MET-THERM-015 are newer with smaller uncertainties. The LEU-MET-THERM-003 are the Canadian ZED experiments. The latter have the hardest spectra. From Fig. 6.2.1 plotted as a function of the epithermal fission fraction it is seen that the calculated reactivity is practically within experimental uncertainties in most cases. Big improvement is observed using newer libraries compared to ENDF/B-VII.1. Note however that, with the exception of the three ZED cases, all the rest are done on the same facility and are strongly correlated.

TABLE 6.3. LIST OF LOW-ENRICHED METAL URANIUM THERMAL ASSEMBLIES MODERATED BY HEAVY WATER

No.	ICSBEP label	Short name	Common name	
1	LEU-MET-THERM-001	lmt001	RB-Vinca(1)	D2O
2	LEU-MET-THERM-002	lmt002-001	RB-Vinca(2-01)	D2O
3	LEU-MET-THERM-002	lmt002-002	RB-Vinca(2-02)	D2O
4	LEU-MET-THERM-002	lmt002-003	RB-Vinca(2-03)	D2O
5	LEU-MET-THERM-002	lmt002-011	RB-Vinca(2-11)	D2O
6	LEU-MET-THERM-002	lmt002-012	RB-Vinca(2-12)	D2O
7	LEU-MET-THERM-003	lmt003-001	ZED-2_1	D2O
8	LEU-MET-THERM-003	lmt003-002	ZED-2_2	D2O
9	LEU-MET-THERM-003	lmt003-003	ZED-2_3	D2O
10	LEU-MET-THERM-015	lmt015-001	RB-Vinca-01	LEU in D2O
11	LEU-MET-THERM-015	lmt015-002	RB-Vinca-02	LEU in D2O
12	LEU-MET-THERM-015	lmt015-003	RB-Vinca-03	LEU in D2O
13	LEU-MET-THERM-015	lmt015-004	RB-Vinca-04	LEU in D2O
14	LEU-MET-THERM-015	lmt015-005	RB-Vinca-05	LEU in D2O
15	LEU-MET-THERM-015	lmt015-006	RB-Vinca-06	LEU in D2O
16	LEU-MET-THERM-015	lmt015-007	RB-Vinca-07	LEU in D2O
17	LEU-MET-THERM-015	lmt015-008	RB-Vinca-08	LEU in D2O
18	LEU-MET-THERM-015	lmt015-009	RB-Vinca-09	LEU in D2O
19	LEU-MET-THERM-015	lmt015-010	RB-Vinca-10	LEU in D2O
20	LEU-MET-THERM-015	lmt015-011	RB-Vinca-11	LEU in D2O
21	LEU-MET-THERM-015	lmt015-012	RB-Vinca-12	LEU in D2O
22	LEU-MET-THERM-015	lmt015-013	RB-Vinca-13	LEU in D2O
23	LEU-MET-THERM-015	lmt015-014	RB-Vinca-14	LEU in D2O
24	LEU-MET-THERM-015	lmt015-015	RB-Vinca-15	LEU in D2O
25	LEU-MET-THERM-015	lmt015-016	RB-Vinca-16	LEU in D2O
26	LEU-MET-THERM-015	lmt015-017	RB-Vinca-17	LEU in D2O
27	LEU-MET-THERM-015	lmt015-018	RB-Vinca-18	LEU in D2O
28	LEU-MET-THERM-015	lmt015-019	RB-Vinca-19	LEU in D2O
29	LEU-MET-THERM-015	lmt015-020	RB-Vinca-20	LEU in D2O
30	LEU-MET-THERM-015	lmt015-021	RB-Vinca-21	LEU in D2O
31	LEU-MET-THERM-015	lmt015-022	RB-Vinca-22	LEU in D2O

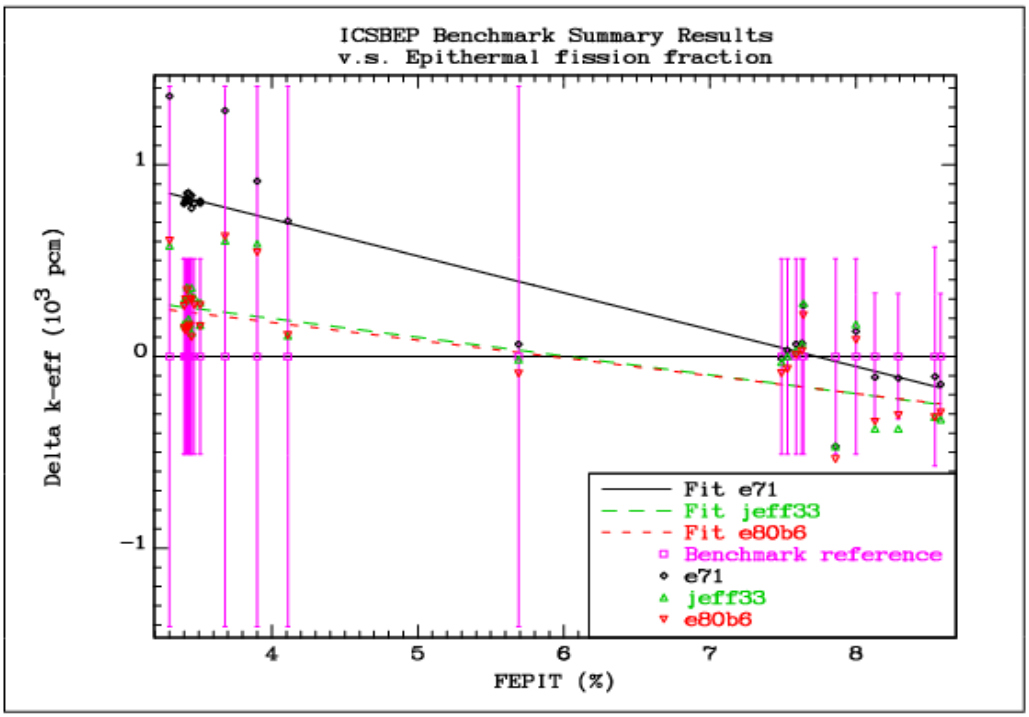

FIG. 6.2.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values as a function of EALF for the LEU-MET-THERM benchmarks with a heavy water moderator.

The list of LEU-MET-THERM assemblies moderated by light water are listed below. They consist of the LEU-MET-THERM-004 experiment (ORCEF) from ORNL, the French LEU-MET-THERM-006 (Bugey) experiments and the Oak Ridge LEU-MET-THERM-007 experiments. The differences between the calculated k_{eff} values and the reference benchmark values are shown in Fig. 6.2.3 and seem to favour the JEFF-3.3 results. Unfortunately, the experiments are not comparable with each other and a more detailed analysis is required.

The LEU-MET-THERM-007 experiments were done at ORNL with thick (1" diameter) unclad metal rods with different pitches and fuel lengths. The LEU-MET-THERM-004 experiments were done with thinner rods by the same experimentalist. The results are shown in Figs 6.2.4 and 6.2.5, respectively. The first set of measurements does not show any strong dependence on the nuclear data libraries and has a positive gradient with the epithermal fission fraction. On the contrary, the second set with thinner fuel rods shows a very strong dependence on nuclear data, which reverses the gradient with ENDF/B-VIII data. There is also a bias in reactivity: in the overlapping region around 17 % of the epithermal fission fraction the JEFF-3.3 data in LEU-COMP-THERM-004 predict a significantly lower reactivity compared to other libraries and to LEU-COMP-THERM-007.

The LEU-COMP-THERM-006 experiments were done at the Valduc facility within the Bugey programme and refer to low-enriched uranium tubes immersed in water. From Fig. 6.2.3 it is seen that for these benchmarks (cases 9-38 according to Table 6.4) the bulk of the JEFF-3.3 results lie within the uncertainty interval, while the ENDF/B-VII.1 and ENDF/B-VIII results are systematically higher by up to about 400 pcm. However, a more careful look at the results reveals that the trend with the epithermal

fission fraction is the same for all libraries. The differences between the calculated k_{eff} values and the reference benchmark values as a function of the epithermal fission fraction are shown in Fig. 6.2.6.

The inherent differences between the experiments prevent us from drawing definite conclusions from these experiments. A more detailed investigation is needed, particularly regarding the strong impact of nuclear data in the LEU-MET-THERM-004 set of benchmarks.

TABLE 6.4. LIST OF LOW-ENRICHED METAL URANIUM THERMAL ASSEMBLIES MODERATED BY LIGHT WATER

No.	ICSBEP Label	Short name	Common name
1	LEU-MET-THERM-004	lmt004-001	ORCEF-1
2	LEU-MET-THERM-004	lmt004-002	ORCEF-2
3	LEU-MET-THERM-004	lmt004-003	ORCEF-3
4	LEU-MET-THERM-004	lmt004-004	ORCEF-4
5	LEU-MET-THERM-004	lmt004-005	ORCEF-5
6	LEU-MET-THERM-004	lmt004-006	ORCEF-6
7	LEU-MET-THERM-004	lmt004-007	ORCEF-7
8	LEU-MET-THERM-004	lmt004-008	ORCEF-8
9	LEU-MET-THERM-006	lmt006-001d	Bugey-28
10	LEU-MET-THERM-006	lmt006-002d	Bugey-27
11	LEU-MET-THERM-006	lmt006-003d	Bugey-26
12	LEU-MET-THERM-006	lmt006-004d	Bugey-10
13	LEU-MET-THERM-006	lmt006-005d	Bugey-09
14	LEU-MET-THERM-006	lmt006-006d	Bugey-13
15	LEU-MET-THERM-006	lmt006-007d	Bugey-07
16	LEU-MET-THERM-006	lmt006-008d	Bugey-06
17	LEU-MET-THERM-006	lmt006-009d	Bugey-05
18	LEU-MET-THERM-006	lmt006-010d	Bugey-12
19	LEU-MET-THERM-006	lmt006-011d	Bugey-04
20	LEU-MET-THERM-006	lmt006-012d	Bugey-16
21	LEU-MET-THERM-006	lmt006-013d	Bugey-14
22	LEU-MET-THERM-006	lmt006-014d	Bugey-20
23	LEU-MET-THERM-006	lmt006-015d	Bugey-19
24	LEU-MET-THERM-006	lmt006-016d	Bugey-18
25	LEU-MET-THERM-006	lmt006-017d	Bugey-24
26	LEU-MET-THERM-006	lmt006-018d	Bugey-23
27	LEU-MET-THERM-006	lmt006-019d	Bugey-51
28	LEU-MET-THERM-006	lmt006-020d	Bugey-50
29	LEU-MET-THERM-006	lmt006-021d	Bugey-49
30	LEU-MET-THERM-006	lmt006-022d	Bugey-46
31	LEU-MET-THERM-006	lmt006-023d	Bugey-45
32	LEU-MET-THERM-006	lmt006-024d	Bugey-44
33	LEU-MET-THERM-006	lmt006-025d	Bugey-33
34	LEU-MET-THERM-006	lmt006-026d	Bugey-32
35	LEU-MET-THERM-006	lmt006-027d	Bugey-31
36	LEU-MET-THERM-006	lmt006-028d	Bugey-30
37	LEU-MET-THERM-006	lmt006-029d	Bugey-42
38	LEU-MET-THERM-006	lmt006-030d	Bugey-43
39	LEU-MET-THERM-007	lmt007-001	ORNL_196-1602
40	LEU-MET-THERM-007	lmt007-002	ORNL_180-1440
41	LEU-MET-THERM-007	lmt007-003	ORNL_161-0907
42	LEU-MET-THERM-007	lmt007-004	ORNL_149-0955
43	LEU-MET-THERM-007	lmt007-005	ORNL_171-1400
44	LEU-MET-THERM-007	lmt007-006	ORNL_245-1115

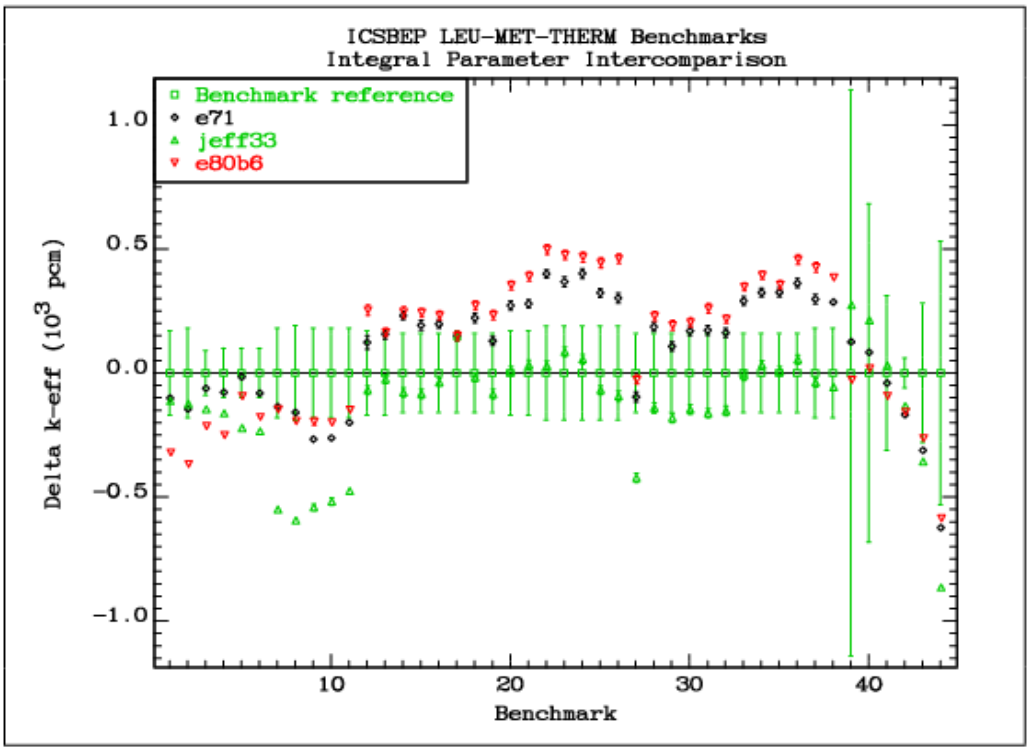

FIG. 6.2.3. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the LEU-MET-THERM benchmarks with a light water moderator.

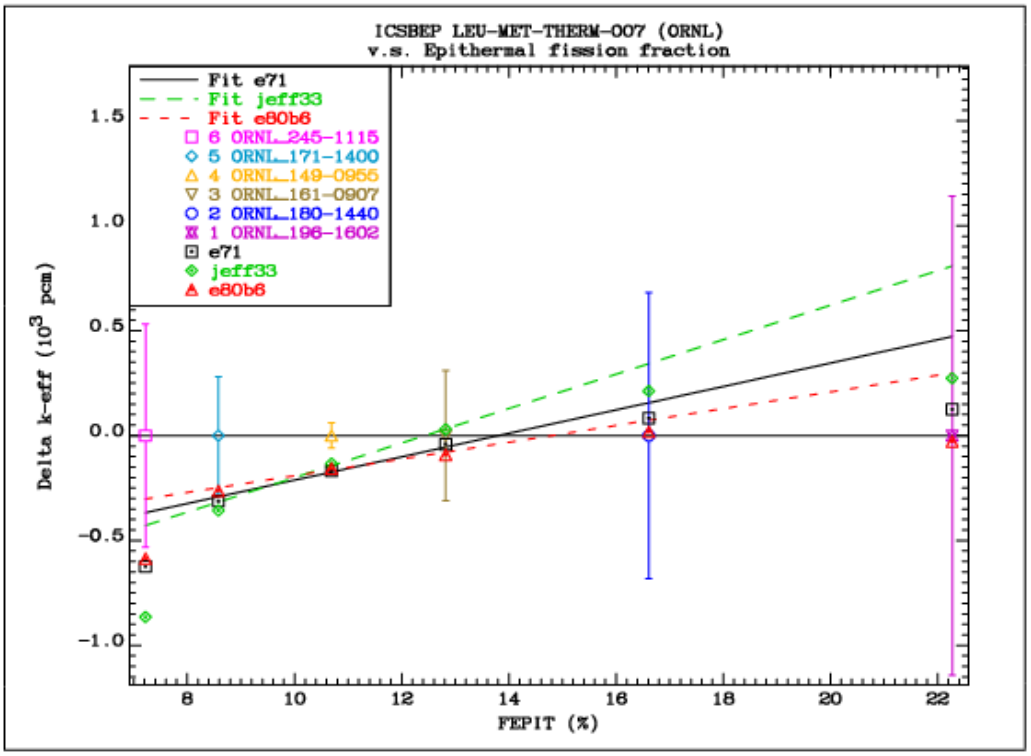

FIG. 6.2.4. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values as a function of the epithermal fission fraction for the LEU-MET-THERM-007 benchmarks with a light water moderator.

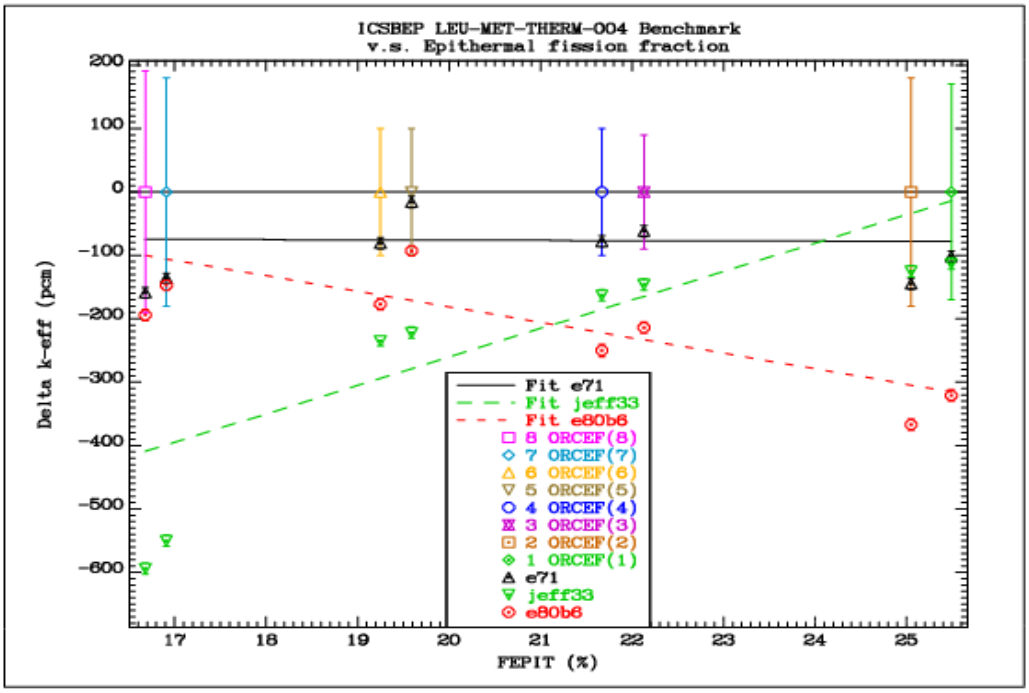

FIG. 6.2.5. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values as a function of the epithermal fission fraction for the LEU-MET-THERM-004 benchmarks with a light water moderator.

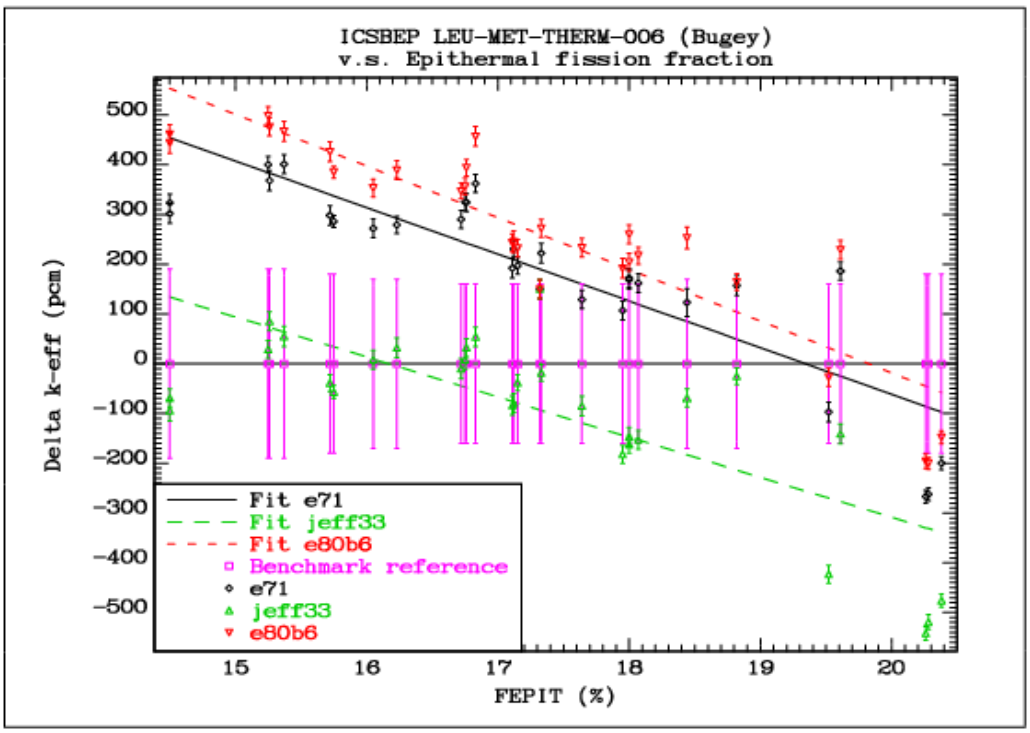

FIG. 6.2.6. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values as a function of the epithermal fission fraction for the LEU-MET-THERM-006 benchmarks with a light water moderator.

6.3. LEU-SOL-THERM

There 58 benchmarks in this group, but they come mainly from the STACEY facility. The list of benchmarks is given in Table 6.5 below. At first sight there appears to be a significant positive reactivity gradient with spectrum hardness, represented by the above-thermal leakage fraction (ATLF), as shown in Fig. 6.3.1. The bulk of benchmarks, which exhibit the gradient are shown separately in Fig. 6.3.2. Benchmarks LEU-SOL-THERM-002, LEU-SOL-THERM-007, LEU-SOL-THERM-020 and LEU-SOL-THERM-021 do not seem to show any gradient and are shown in Fig. 6.3.3, but all of these have a much smaller fraction of epithermal fissions. One could conclude that there exist problems in the data at energies just above the thermal range in all libraries.

TABLE 6.5. LIST OF LOW-ENRICHED URANIUM SOLUTION BENCHMARKS

No.	ICSBEP Label	Short name	Common name
1	LEU-SOL-THERM-001	lst001-001	SHEBA-II
2	LEU-SOL-THERM-002	lst002-001	ORNL-UO2F2-1
3	LEU-SOL-THERM-002	lst002-002	ORNL-UO2F2-2
4	LEU-SOL-THERM-002	lst002-003	ORNL-UO2F2-3
5	LEU-SOL-THERM-004	lst004-001	STACY-1
6	LEU-SOL-THERM-004	lst004-002	STACY-29
7	LEU-SOL-THERM-004	lst004-003	STACY-33
8	LEU-SOL-THERM-004	lst004-004	STACY-34
9	LEU-SOL-THERM-004	lst004-005	STACY-46
10	LEU-SOL-THERM-004	lst004-006	STACY-51
11	LEU-SOL-THERM-004	lst004-007	STACY-54
12	LEU-SOL-THERM-007	lst007-001	STACY-14
13	LEU-SOL-THERM-007	lst007-002	STACY-30
14	LEU-SOL-THERM-007	lst007-003	STACY-32
15	LEU-SOL-THERM-007	lst007-004	STACY-36
16	LEU-SOL-THERM-007	lst007-005	STACY-49
17	LEU-SOL-THERM-010	lst010-83	STACY-83
18	LEU-SOL-THERM-010	lst010-85	STACY-85
19	LEU-SOL-THERM-010	lst010-86	STACY-86
20	LEU-SOL-THERM-010	lst010-88	STACY-88
21	LEU-SOL-THERM-011	lst011-001	STACY-460
22	LEU-SOL-THERM-011	lst011-002	STACY-461
23	LEU-SOL-THERM-011	lst011-003	STACY-464
24	LEU-SOL-THERM-011	lst011-004	STACY-470
25	LEU-SOL-THERM-011	lst011-005	STACY-471
26	LEU-SOL-THERM-011	lst011-006	STACY-485
27	LEU-SOL-THERM-011	lst011-007	STACY-486
28	LEU-SOL-THERM-011	lst011-008	STACY-459
29	LEU-SOL-THERM-011	lst011-009	STACY-462
30	LEU-SOL-THERM-011	lst011-010	STACY-463
31	LEU-SOL-THERM-011	lst011-011	STACY-469
32	LEU-SOL-THERM-011	lst011-012	STACY-472
33	LEU-SOL-THERM-011	lst011-013	STACY-484
34	LEU-SOL-THERM-012	lst012-001	TRACY-203c
35	LEU-SOL-THERM-012	lst012-002	TRACY-203t
36	LEU-SOL-THERM-016	lst016-001	STACY-105
37	LEU-SOL-THERM-016	lst016-002	STACY-113
38	LEU-SOL-THERM-016	lst016-003	STACY-125
39	LEU-SOL-THERM-016	lst016-004	STACY-129
40	LEU-SOL-THERM-016	lst016-005	STACY-131
41	LEU-SOL-THERM-016	lst016-006	STACY-140
42	LEU-SOL-THERM-016	lst016-007	STACY-196
43	LEU-SOL-THERM-017	lst017-001	STACY-104
44	LEU-SOL-THERM-017	lst017-002	STACY-122

45	LEU-SOL-THERM-017	lst017-003	STACY-123
46	LEU-SOL-THERM-017	lst017-004	STACY-126
47	LEU-SOL-THERM-017	lst017-005	STACY-130
48	LEU-SOL-THERM-017	lst017-006	STACY-147
49	LEU-SOL-THERM-018	lst018-001	STACY-133
50	LEU-SOL-THERM-018	lst018-002	STACY-142
51	LEU-SOL-THERM-018	lst018-003	STACY-143
52	LEU-SOL-THERM-018	lst018-004	STACY-144
53	LEU-SOL-THERM-018	lst018-005	STACY-145
54	LEU-SOL-THERM-018	lst018-006	STACY-146
55	LEU-SOL-THERM-019	lst019-001	STACY-149
56	LEU-SOL-THERM-019	lst019-002	STACY-150
57	LEU-SOL-THERM-019	lst019-003	STACY-151
58	LEU-SOL-THERM-019	lst019-004	STACY-152
59	LEU-SOL-THERM-019	lst019-005	STACY-153
60	LEU-SOL-THERM-019	lst019-006	STACY-183
61	LEU-SOL-THERM-020	lst020-216	STACY-216
62	LEU-SOL-THERM-020	lst020-217	STACY-217
63	LEU-SOL-THERM-020	lst020-220	STACY-220
64	LEU-SOL-THERM-020	lst020-226	STACY-226
65	LEU-SOL-THERM-021	lst021-215	STACY-215
66	LEU-SOL-THERM-021	lst021-218	STACY-218
67	LEU-SOL-THERM-021	lst021-221	STACY-221
68	LEU-SOL-THERM-021	lst021-223	STACY-223

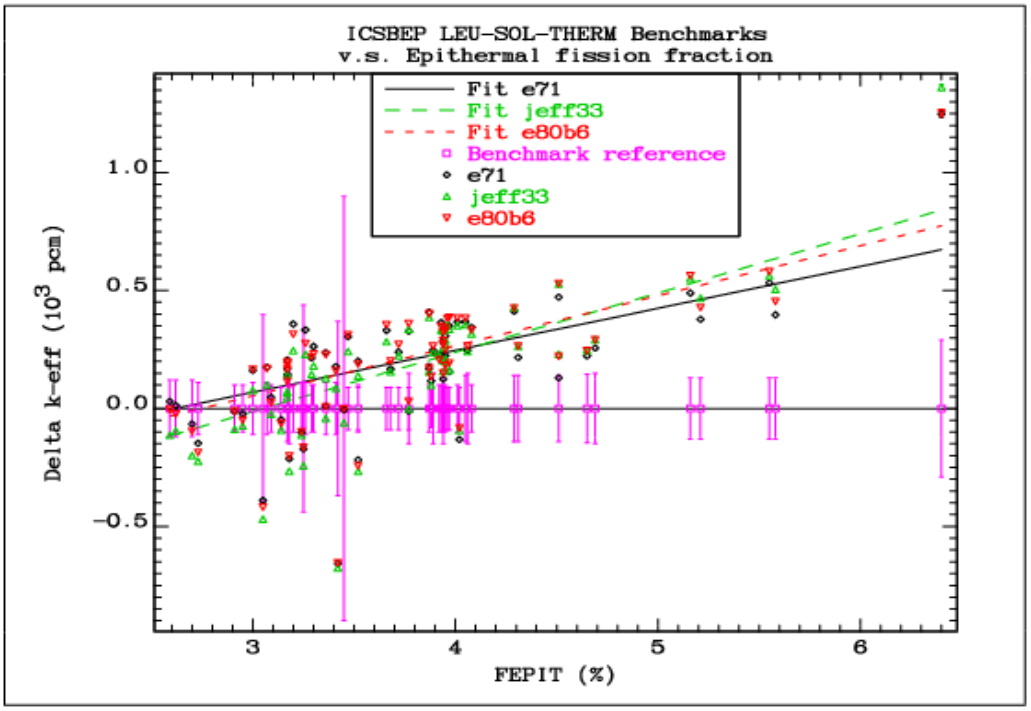

FIG. 6.3.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values as a function of the epithermal fission fraction for the LEU-SOL-THERM benchmarks.

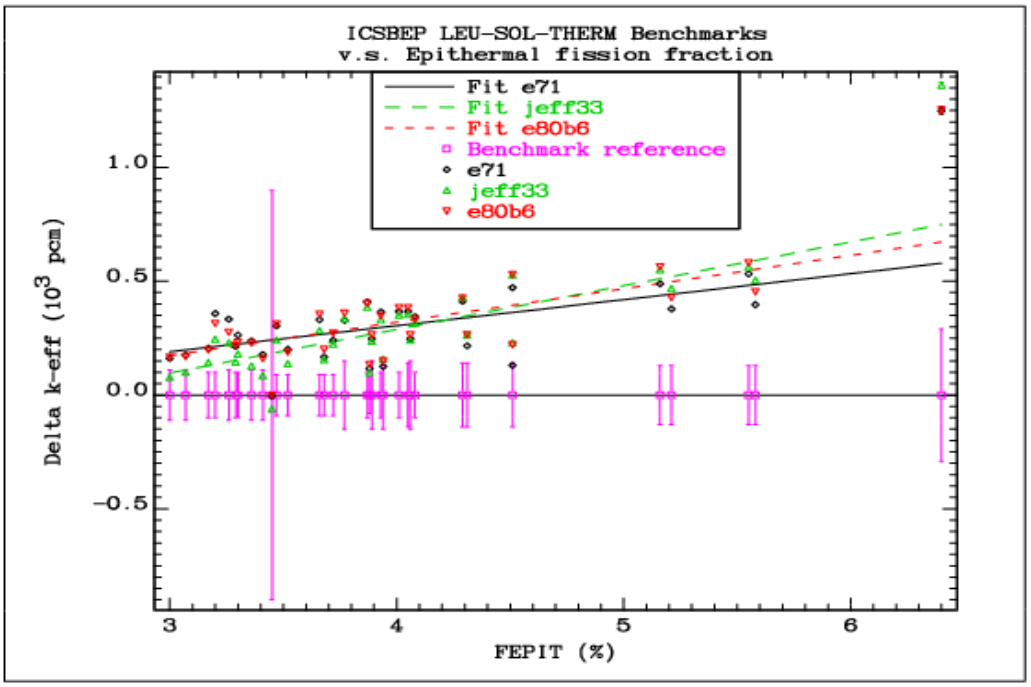

FIG. 6.3.2. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values as a function of the epithermal fission fraction for the LEU-SOL-THERM benchmarks, which exhibit a gradient in reactivity.

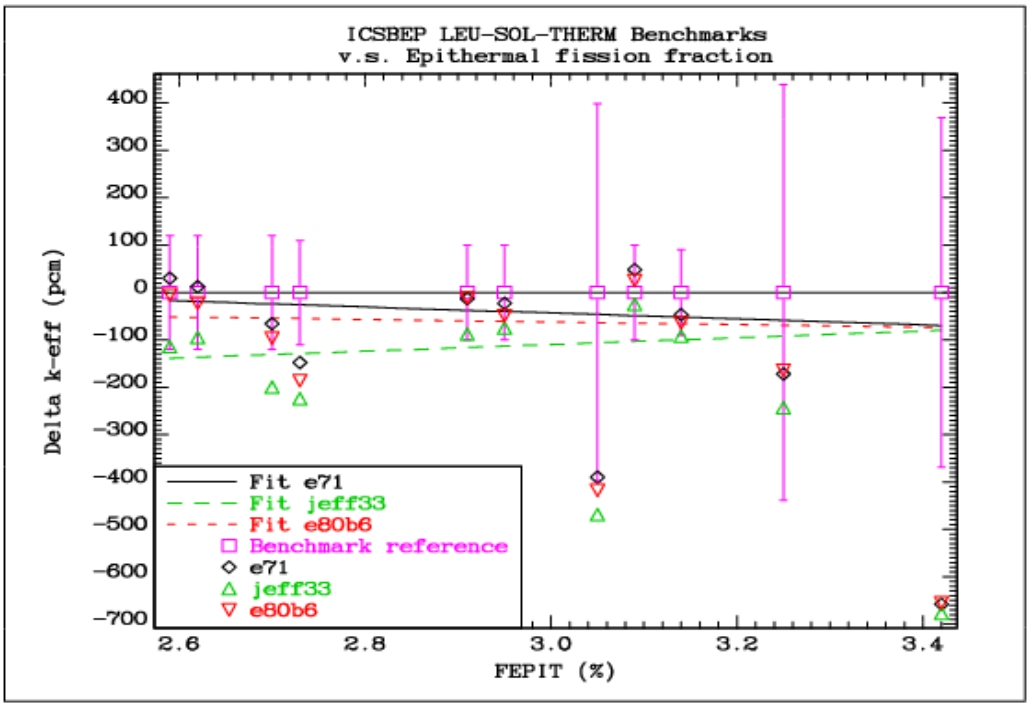

FIG. 6.3.3. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values as a function of the epithermal fission fraction for the LEU-SOL-THERM benchmarks, which do not exhibit a gradient in reactivity.

7. Miscellaneous materials

7.1. Iron and stainless-steel reflected systems

Several iron- and stainless-steel-reflected assemblies are available in the ICSBEP compilation. A selection was made based on the high sensitivities as obtained from the DICE system of the NEA Data Bank. The list does not include the stainless steel reflected cases in LEU-COMP-THERM-010 group, which is discussed in Section 6.1. The selected list of benchmarks is given in Table 7.1 below.

The plot of the cumulative Chi^2/DoF in Fig. 7.1.1 shows that the ENDF/B-VII.1 library failed mainly on two specific benchmarks, namely PU-MET-FAST-015 (BR-1-3) and PU-MET-INTER-002 (ZPR-6/10). Significant improvement is obtained with the ENDF/B-VIII library, even though some differences still exist. The JEFF-3.3 library seems to have problems with the HEU-MET-FAST-088, HEU-MET-INTER-001, HEU-MET-THERM-013 and HEU-MET-THERM-015 cases, which increase the final Chi^2/DoF to the level of the ENDF/B-VII.1 library. The results are shown in Fig. 7.1.2.

TABLE 7.1. LIST OF IRON AND STAINLESS STEEL REFLECTED BENCHMARKS

No.	ICSBEP Label	Short name	Common name
1	HEU-MET-FAST-013	hmf013	VNIITF-CTF-SS-13
2	HEU-MET-FAST-021	hmf021	VNIITF-CTF-SS-21
3	HEU-MET-FAST-024	hmf024	VNIITF-CTF-SS-24
4	HEU-MET-FAST-087	hmf087	VNIITF-CTF-Fe
5	HEU-MET-FAST-088	hmf088-001	hmf088-001
6	HEU-MET-FAST-088	hmf088-002	hmf088-002
7	HEU-MET-INTER-001	hmi001	ZPR-9/34
8	HEU-MET-THERM-013	hmt013-002	Planet_Fe-2
9	HEU-MET-THERM-015	hmt015	
10	IEU-MET-FAST-005	imf005	VNIIEF-CTF-5
11	IEU-MET-FAST-006	imf006	VNIIEF-CTF-6
12	LEU-COMP-THERM-042	lct042-001	lct042-001
13	LEU-COMP-THERM-042	lct042-002	lct042-002
14	LEU-COMP-THERM-043	lct043-002	IPEN/MB-01
15	LEU-MET-THERM-015	lmt015-001	RB-Vinca(01)
16	MIX-COMP-FAST-001	mcf001	ZPR-6/7
17	MIX-COMP-FAST-005	mcf005-s	ZPR-9/31
18	MIX-COMP-FAST-006	mcf006-s	ZPPR-2
19	PU-MET-FAST-015	pmf015	BR-1-3
20	PU-MET-FAST-025	pmf025	pmf025
21	PU-MET-FAST-026	pmf026	pmf026
22	PU-MET-FAST-028	pmf028	pmf028
23	PU-MET-FAST-032	pmf032	pmf032
24	PU-MET-INTER-002	pmi002	ZPR-6/10
25	PU-MET-INTER-003	pmi003-001s	ZPR-3/58(U)
26	PU-MET-INTER-004	pmi004-001s	ZPR-4/59(Pb)
27	IEU-COMP-INTER-005	ici005	ZPR-6/6A

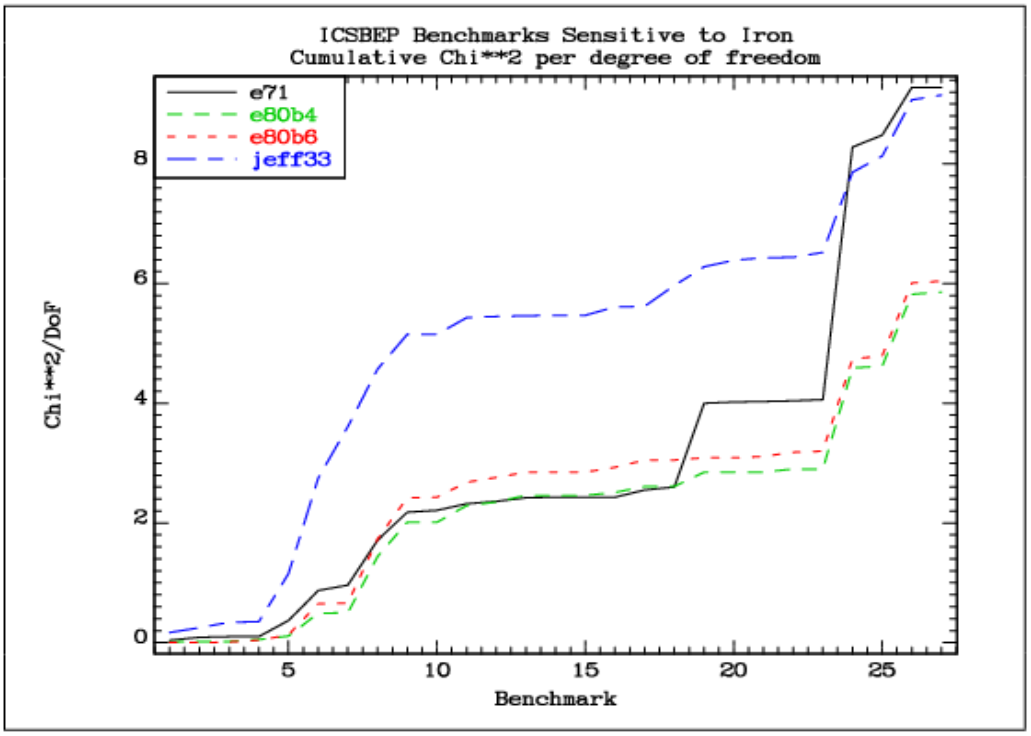

FIG. 7.1.1. Cumulative Chi-square per degree of freedom for the iron benchmarks from the full IAEA suite of benchmark cases.

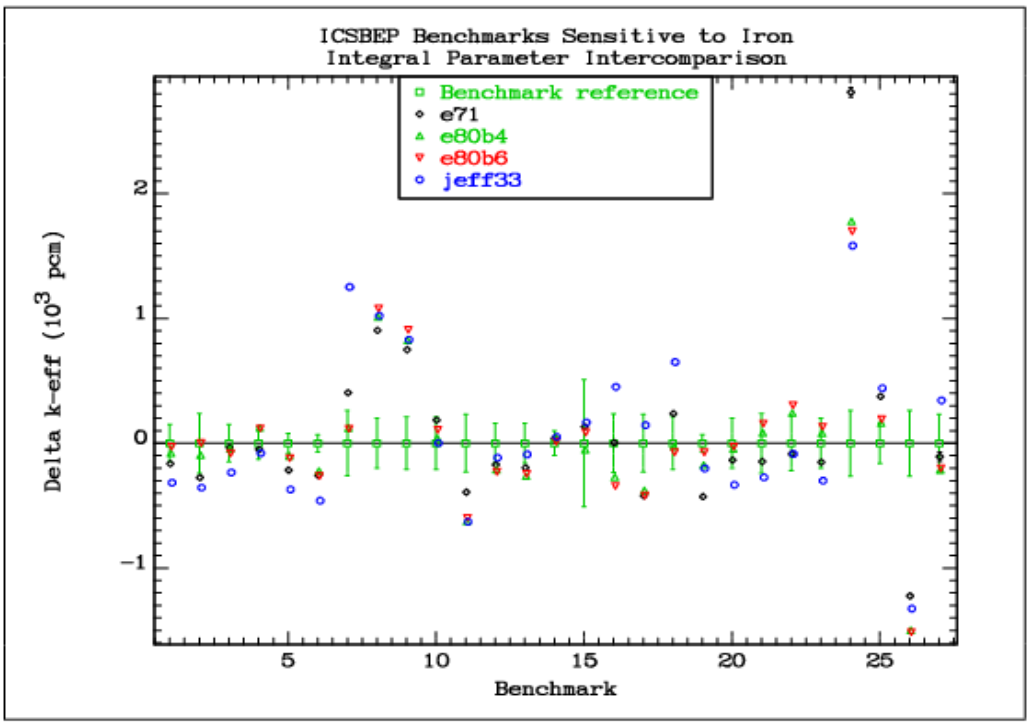

FIG. 7.1.2. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the iron- or stainless steel-reflected assemblies of the HEU-MET-FAST group of benchmarks.

7.2. Copper-reflected systems

Most of the fast assemblies involving copper use this material as a reflector. These are mainly HEU-MET-FAST-020, HEU-MET-FAST-022, HEU-MET-FAST-085 and the Zeus assemblies HEU-MET-FAST-072 and HEU-MET-FAST-073. For the sake of completeness, the Zeus intermediate spectrum assemblies HEU-MET-INTER-006 and thermal assemblies HEU-COMP-THERM-007 and LEU-COMP-THERM-042 are also listed. The full list of benchmarks is given below. The results are shown in Fig. 7.2.1.

TABLE 7.2. LIST OF BENCHMARKS CONTAINING COPPER

No.	ICSBEP label	Short name	Common name
1	HEU-MET-FAST-085	hmf085-001	Comet-Cu_2in
2	HEU-MET-FAST-085	hmf085-002	Comet-Cu_4in
3	HEU-MET-FAST-085	hmf085-004	Comet-SS_4in
4	IEU-MET-FAST-020	imf020-001s	FR0_T0/1E-S
5	IEU-MET-FAST-020	imf020-002s	FR0_T1-S
6	IEU-MET-FAST-020	imf020-003s	FR0_T2-S
7	IEU-MET-FAST-020	imf020-004s	FR0_T3-S
8	IEU-MET-FAST-020	imf020-005s	FR0_T4a-S
9	IEU-MET-FAST-020	imf020-006s	FR0_T5-S
10	IEU-MET-FAST-020	imf020-007s	FR0_T6a-S
11	IEU-MET-FAST-022	imf022-01	FR0_3X-S
12	IEU-MET-FAST-022	imf022-02	FR0_5-S
13	IEU-MET-FAST-022	imf022-03	FR0_6A-S
14	IEU-MET-FAST-022	imf022-04	FR0_7-S
15	IEU-MET-FAST-022	imf022-05	FR0_8-S
16	IEU-MET-FAST-022	imf022-06	FR0_9-S
17	IEU-MET-FAST-022	imf022-07	FR0_10-S
18	HEU-MET-FAST-072	hmf072-1	ZEUS_Fe/Cu-1
19	HEU-MET-FAST-072	hmf072-3	ZEUS_Fe/Cu-3
20	HEU-MET-FAST-073	hmf073	ZEUS/Cu
21	HEU-MET-INTER-006	hmi006-001	Zeus-1/Gr
22	HEU-MET-INTER-006	hmi006-002	Zeus-2/Gr
23	HEU-MET-INTER-006	hmi006-003	Zeus-3/Gr
24	HEU-MET-INTER-006	hmi006-004	Zeus-4/Gr
25	HEU-COMP-THERM-007	hct007-2	RRCt-2
26	LEU-COMP-THERM-042	lct042-006	lct042-006
27	LEU-COMP-THERM-042	lct042-007	lct042-007
1	HEU-MET-FAST-085	hmf085-001	Comet-Cu_2in
2	HEU-MET-FAST-085	hmf085-002	Comet-Cu_4in
3	HEU-MET-FAST-085	hmf085-004	Comet-SS_4in
4	IEU-MET-FAST-020	imf020-001s	FR0_T0/1E-S
5	IEU-MET-FAST-020	imf020-002s	FR0_T1-S
6	IEU-MET-FAST-020	imf020-003s	FR0_T2-S
7	IEU-MET-FAST-020	imf020-004s	FR0_T3-S
8	IEU-MET-FAST-020	imf020-005s	FR0_T4a-S
9	IEU-MET-FAST-020	imf020-006s	FR0_T5-S
10	IEU-MET-FAST-020	imf020-007s	FR0_T6a-S
11	IEU-MET-FAST-022	imf022-01	FR0_3X-S
12	IEU-MET-FAST-022	imf022-02	FR0_5-S
13	IEU-MET-FAST-022	imf022-03	FR0_6A-S
14	IEU-MET-FAST-022	imf022-04	FR0_7-S
15	IEU-MET-FAST-022	imf022-05	FR0_8-S
16	IEU-MET-FAST-022	imf022-06	FR0_9-S
17	IEU-MET-FAST-022	imf022-07	FR0_10-S
18	HEU-MET-FAST-072	hmf072-1	ZEUS_Fe/Cu-1
19	HEU-MET-FAST-072	hmf072-3	ZEUS_Fe/Cu-3
20	HEU-MET-FAST-073	hmf073	ZEUS/Cu
21	HEU-MET-INTER-006	hmi006-001	Zeus-1/Gr

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 22  HEU-MET-INTER-006   hmi006-002  Zeus-2/Gr
 23  HEU-MET-INTER-006   hmi006-003  Zeus-3/Gr
 24  HEU-MET-INTER-006   hmi006-004  Zeus-4/Gr
 25  HEU-COMP-THERM-007  hct007-2    RRCt-2
 26  LEU-COMP-THERM-042  lct042-006  lct042-006
 27  LEU-COMP-THERM-042  lct042-007  lct042-007
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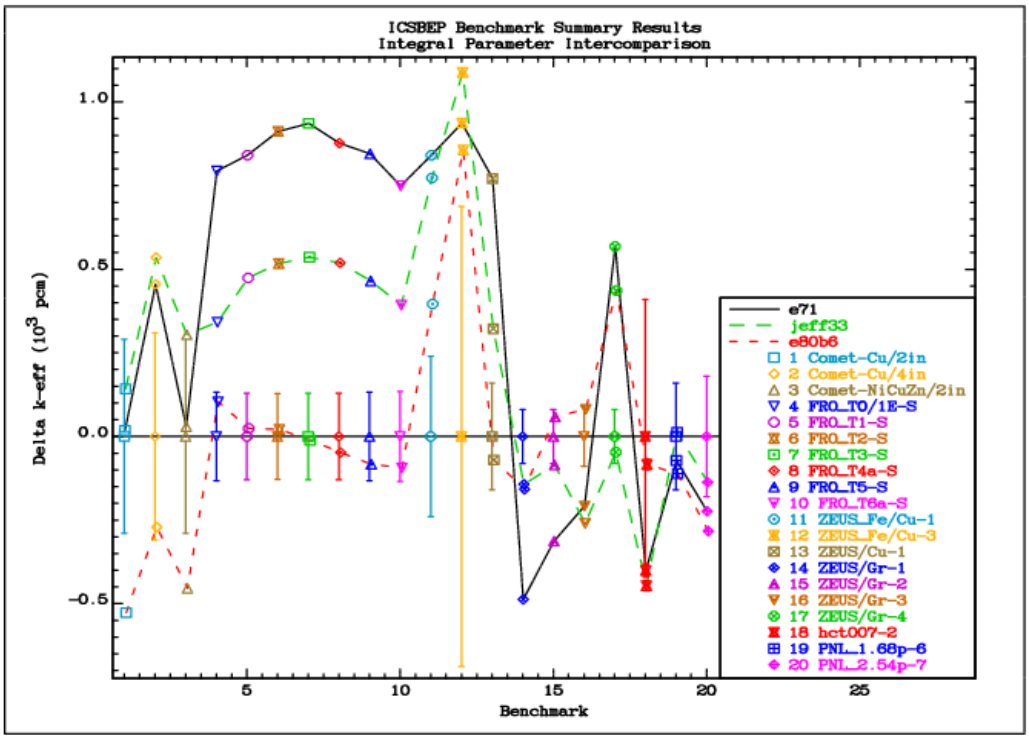

FIG. 7.2.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the copper-reflected assemblies.

7.3. Systems containing tungsten

The benchmarks that contain significant amounts of tungsten are listed below. The differences in the calculated keff from the reference benchmark values as a function of the fast fission fraction (FFAST) are shown in Fig. 7.3.1. The benchmarks in which tungsten is a fuel dilutant all have FFAST<80 %; the reactivity in these benchmarks tends to be systematically overpredicted by all libraries, except for the KFBN2-f1 case, where the FFAST value is by far the smallest.

Tungsten-reflected benchmarks are shown in Fig. 7.3.2 as a function of reflector thickness. The cases with a ^{233}U core were excluded because they have unreasonably small uncertainties. The calculated results seem to be in reasonable agreement with the benchmark reference values (considering the benchmark uncertainties), but a considerable trend of over-predicting the reactivity with increasing reflector thickness is indicated.

TABLE 7.3. LIST OF BENCHMARKS CONTAINING TUNGSTEN

No.	ICSBEP label	Short name	Common name
1	IEU-MET-FAST-013	imf013	ZPR-9/1
2	IEU-MET-FAST-014	imf014-002	ZPR-9/2
3	IEU-MET-FAST-014	imf014-003	ZPR-9/3
4	HEU-MET-FAST-060	hmf060-004	ZPR-9/4
5	HEU-MET-FAST-067	hmf067-005	ZPR-9/5
6	HEU-MET-FAST-067	hmf067-006	ZPR-9/6
7	HEU-MET-FAST-070	hmf070-007	ZPR-9/7
8	HEU-MET-FAST-070	hmf070-008	ZPR-9/8
9	HEU-MET-FAST-070	hmf070-009	ZPR-9/9
10	HEU-MET-FAST-003	hmf003-008	Topsy-W_1.9in
11	HEU-MET-FAST-003	hmf003-009	Topsy-W_2.9in
12	HEU-MET-FAST-003	hmf003-010	Topsy-W_4.5in
13	HEU-MET-FAST-003	hmf003-011	Topsy-W_6.5in
14	HEU-MET-FAST-049	hmf049-001	KFBN2-1cm
15	HEU-MET-FAST-049	hmf049-002	KFBN2-3cm
16	HEU-MET-FAST-049	hmf049-003	KFBN2-8cm
17	HEU-MET-FAST-050	hmf050	KFBN2-f1
18	HEU-MET-FAST-052	hmf052	KFBN2-f2
19	HEU-MET-MIXED-017	hmm017	KFBN2-f3
20	HEU-MET-FAST-084	hmf084-14	Comet-W_1.0in
21	HEU-MET-FAST-084	hmf084-25	Comet-W_0.5in
22	HEU-MET-FAST-085	hmf085-006	Comet-W_2.0in
23	PU-MET-FAST-005	pmf005	Planet-Pu/W1.8in
24	U233-MET-FAST-004	umf004-001	Planet-U3/W_1in
25	U233-MET-FAST-004	umf004-002	Planet-U3/W_2in

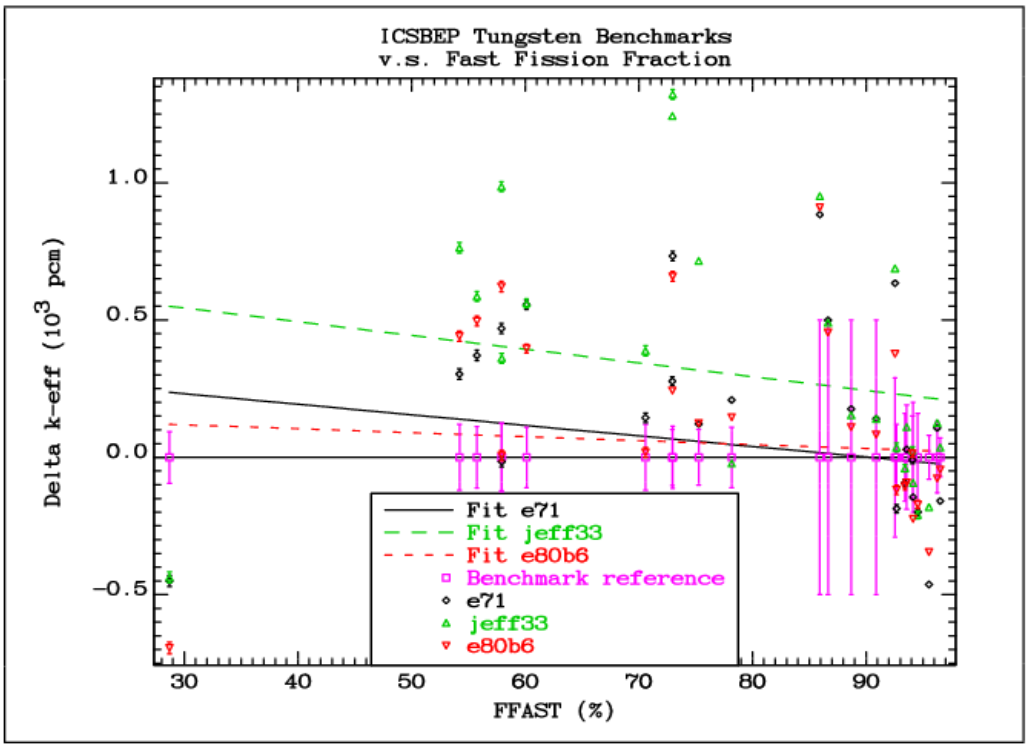

FIG. 7.3.1. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for all benchmarks containing tungsten. Benchmarks in which tungsten is the fuel dilutant have the softer spectrum.

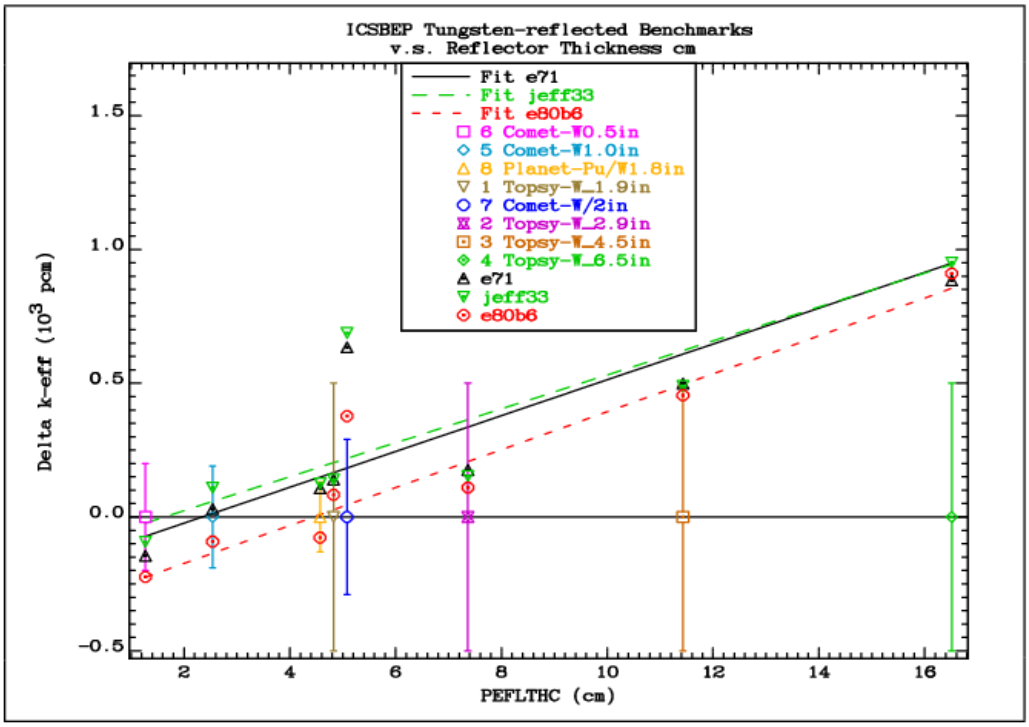

FIG. 7.3.2. Comparison of the differences between the calculated k_{eff} values and the reference benchmark values for the benchmarks with a tungsten reflector as a function of reflector thickness.

8. Conclusions

8.1. Benchmarks

Generally, the criteria defining the benchmark uncertainties in the ICSBEP Handbook are not uniform and may lead to misleading figures of merit in statistical analyses. In some cases, where several benchmark sets for similar assemblies are available, it is obvious that there exist unrecognised systematic sources of uncertainty (USU), which by a rough judgement amount to anything between 200 pcm and 500 pcm (not counting benchmarks, which are clearly in error). This has implications on the claims that the uncertainties based purely on the uncertainties of the differential data in evaluated data files are grossly overestimated. It is true that the measured fission cross section and the average number of neutrons par fission are practically uncorrelated because they are obtained from totally different kind of measurements; however, they are strongly correlated in any criticality problem. It can be shown that including ad-hoc estimated correlations between the fission cross section and the number of neutrons per fission in evaluated data files reduces the uncertainties in k_{eff} by several hundred pcm, bringing them close to the uncertainties of integral benchmarks that account for the USU. However, this is the domain of library adjustment and requires more rigorous techniques to be employed.

Specifically, a number of issues with certain groups of benchmarks were identified, as discussed below.

HEU-COMP-MIXED-003 benchmark k_{eff} uncertainty only includes the uncertainty in the measured reactivity, which is 1 pcm. This benchmark is completely useless for data validation purposes.

HEU-MET-FAST bare assemblies should be a clean case, since they depend mainly on the ^{235}U cross sections, but they show a scatter of 1500 pcm. Benchmark specifications need to be reviewed.

HEU-MET-FAST-051 bare cylinders from ORNL have low assigned uncertainties, particularly the last few with assigned uncertainties of 10 pcm.

HEU-MET-THERM-011 Valduc series of benchmarks over-predict the reactivity of well-thermalised systems, with a trend of decreasing reactivity with increasing spectrum hardness. If this trend is due to nuclear data, it should be confirmed by an independent experiment.

HEU-SOL-THERM-048: differences from the benchmark k_{eff} values seems to be strongly correlated to the assigned bias that accounts for model simplifications. A revision of the ICSBEP benchmark specifications is expected.

H**EU-SOL-THERM-049**: The presence of cadmium in the surrounding reflector adds another dimension to the benchmark analysis. The discrepancies between the predicted and the measured reactivity requires further investigation before any conclusions can be made.

HEU-SOL-THERM with gadolinium: several groups of benchmarks from IPPE, namely HEU-SOL-THERM-014, HEU-SOL-THERM-015, HEU-SOL-THERM-016, HEU-SOL-THERM-017, HEU-SOL-THERM-018, HEU-SOL-THERM-019 and HEU-SOL-THERM-025 show inconsistencies that are not likely to originate from nuclear data. The measurements and/or the models require further investigation. Potential users should be warned of the problem.

8.2. Nuclear data

Some of the issues that could be associated with nuclear data are listed below.

Cr — The HEU-COMP-INTER-005 (KBR) benchmark Case-4 suggests a problem with Cr cross sections, which is further supported by Case-2 containing stainless steel. In both cases the reactivity is over-predicted.

W — There is still a problem with benchmarks containing tungsten, giving rise to some over-prediction of reactivity when significant quantities of tungsten are present either in the reflector or as the fuel dilutant.

^{235}U — Several thermal benchmarks show a gradient as a function of the epithermal fission fraction, which could be an indication of some problems with the data just above the thermal energy region.

^{238}U — The HEU-MET-FAST benchmarks with a thick ^{238}U reflector show an increasing trend in reactivity as a function of reflector thickness that should be investigated further.

Pb — The LEU-COMP-THERM-010 benchmarks with a lead reflector show significant over-prediction of reactivity, which is not present in other similar cases without lead. This leads to the hypothesis that there could be a problem with lead data.

Cu — Although the ENDF/B-VIII evaluation seems to solve the problem of benchmarks containing copper, the adjustment to the angular distributions was done in a somewhat ad-hoc manner. A more detailed investigation is warranted.

APPENDIX

A.1 Mosteller (LANL) suite of criticality benchmarks

Case	ICSBEP name	Short name	Common name
1	HEU-MET-FAST-001	hmf001	Godiva
2	HEU-MET-FAST-028	hmf028	Flattop-25
3	IEU-MET-FAST-007	imf007d	Big_Ten(d)
4	PU-MET-FAST-001	pmf001	Jezebel
5	PU-MET-FAST-002	pmf002	Jezebel-240
6	PU-MET-FAST-006	pmf006	Flattop-Pu
7	U233-MET-FAST-001	umf001	Jezebel-U233
8	U233-MET-FAST-006	umf006	Flattop-23
9	PU-MET-FAST-022	pmf022	pmf022
10	IEU-MET-FAST-001	imf001-001d	Jemima-1d
11	IEU-MET-FAST-001	imf001-002d	Jemima-2d
12	IEU-MET-FAST-001	imf001-003d	Jemima-3d
13	IEU-MET-FAST-001	imf001-004d	Jemima-4d
14	PU-MET-FAST-010	pmf010	pmf010
15	PU-MET-FAST-011	pmf011	pmf011
16	PU-MET-FAST-018	pmf018	pmf018
17	PU-MET-FAST-019	pmf019	pmf019
18	PU-MET-FAST-020	pmf020	pmf020
19	PU-MET-FAST-021	pmf021-001	pmf021-1
20	PU-MET-FAST-021	pmf021-002	pmf021-2
21	PU-MET-FAST-023	pmf023	pmf023
22	PU-MET-FAST-024	pmf024	pmf024
23	PU-MET-FAST-003	pmf003-003	LLNL_Pu_buttons-3
24	HEU-COMP-INTER-003	hci003-006	COMET-UH3-6
25	IEU-MET-FAST-002	imf002	Pajarito
26	HEU-MET-FAST-003	hmf003-001	Topsy-U_2.0in
27	HEU-MET-FAST-003	hmf003-002	Topsy-U_3.0in
28	HEU-MET-FAST-003	hmf003-003	Topsy-U_4.0in
29	HEU-MET-FAST-003	hmf003-004	Topsy-U_5.0in
30	HEU-MET-FAST-003	hmf003-005	Topsy-U_6.0in
31	HEU-MET-FAST-003	hmf003-006	Topsy-U_8.0in
32	HEU-MET-FAST-003	hmf003-007	Topsy-U_11.in
33	HEU-MET-FAST-008	hmf008	VNIIEF-CTF-bare
34	HEU-MET-FAST-009	hmf009-001	VNIITF-CTF-009-1
35	HEU-MET-FAST-009	hmf009-002	VNIITF-CTF-009-2
36	HEU-MET-FAST-011	hmf011	VNIITF-CTF-011
37	HEU-MET-FAST-012	hmf012	VNIITF-CTF-012
38	HEU-MET-FAST-013	hmf013	VNIITF-CTF-SS-13
39	HEU-MET-FAST-014	hmf014	VNIIEF-CTF-DU
40	HEU-MET-FAST-015	hmf015	VNIIEF-CTF-UnrCyl
41	IEU-MET-FAST-003	imf003-001d	VNIIEF-CTF-3
42	IEU-MET-FAST-004	imf004-001d	VNIIEF-CTF-4
43	IEU-MET-FAST-005	imf005-s	VNIIEF-CTF-5s
44	IEU-MET-FAST-006	imf006-s	VNIIEF-CTF-6s
45	LEU-COMP-THERM-008	lct008-001	BW-XI-1
46	LEU-COMP-THERM-008	lct008-002	BW-XI-2
47	LEU-COMP-THERM-008	lct008-005	BW-XI-5
48	LEU-COMP-THERM-008	lct008-007	BW-XI-7
49	LEU-COMP-THERM-008	lct008-008	BW-XI-8
50	LEU-COMP-THERM-008	lct008-011	BW-XI-11
51	LEU-SOL-THERM-002	lst002-001	ORNL-UO2F2-1
52	LEU-SOL-THERM-002	lst002-002	ORNL-UO2F2-2
53	LEU-SOL-THERM-007	lst007-001	STACY-14
54	LEU-SOL-THERM-007	lst007-002	STACY-30

55	LEU-SOL-THERM-007	lst007-003	STACY-32
56	LEU-SOL-THERM-007	lst007-004	STACY-36
57	LEU-SOL-THERM-007	lst007-005	STACY-49
58	HEU-SOL-THERM-013	hst013-001	ORNL_T1
59	HEU-SOL-THERM-013	hst013-002	ORNL_T2
60	HEU-SOL-THERM-013	hst013-003	ORNL_T3
61	HEU-SOL-THERM-013	hst013-004	ORNL_T4
62	HEU-SOL-THERM-032	hst032	ORNL_T5
63	HEU-MET-INTER-006	hmi006-001	Zeus-1/Gr
64	HEU-MET-INTER-006	hmi006-002	Zeus-2/Gr
65	HEU-MET-INTER-006	hmi006-003	Zeus-3/Gr
66	HEU-MET-INTER-006	hmi006-004	Zeus-4/Gr
67	HEU-MET-FAST-018	hmf018	VNIIEF_sphere
68	HEU-MET-FAST-019	hmf019	hmf019
69	PU-SOL-THERM-009	pst009-3a	PNL-48R-3a
70	PU-SOL-THERM-011	pst011-165	PNL-16R-5
71	PU-SOL-THERM-011	pst011-181	PNL-18R-1
72	PU-SOL-THERM-011	pst011-186	PNL-18R-6
73	PU-SOL-THERM-018	pst018-009	PNL-11-9
74	PU-SOL-THERM-021	pst021-001	PNL-11(15.2)-01
75	PU-SOL-THERM-021	pst021-003	PNL-11(15.2)-03
76	PU-SOL-THERM-034	pst034-001	PNL-10-Gd-01
77	U233-SOL-INTER-001	usi001	Falstaff-1.1
78	U233-SOL-THERM-001	ust001-001	U3ORNL-S1
79	U233-SOL-THERM-001	ust001-002	U3ORNL-S2
80	U233-SOL-THERM-001	ust001-003	U3ORNL-S3
81	U233-SOL-THERM-001	ust001-004	U3ORNL-S4
82	U233-SOL-THERM-001	ust001-005	U3ORNL-S5
83	U233-SOL-THERM-008	ust008	U3ORNL-11
84	PU-MET-FAST-008	pmf008	Thor
85	U233-COMP-THERM-001	uct001-025	SB-2+h
86	U233-COMP-THERM-001	uct001-060	SB-6
87	HEU-MET-FAST-003	hmf003-008	Topsy-W_1.9in
88	HEU-MET-FAST-003	hmf003-009	Topsy-W_2.9in
89	HEU-MET-FAST-003	hmf003-010	Topsy-W_4.5in
90	HEU-MET-FAST-003	hmf003-011	Topsy-W_6.5in
91	HEU-MET-FAST-003	hmf003-012	Topsy-Ni
92	HEU-MET-FAST-004	hmf004	hmf004
93	PU-MET-FAST-005	pmf005	Planet-Pu/W1.8in
94	U233-MET-FAST-002	umf002-001	umf002-001
95	U233-MET-FAST-002	umf002-002	umf002-002
96	U233-MET-FAST-003	umf003-001	umf003-001
97	U233-MET-FAST-003	umf003-002	umf003-002
98	U233-MET-FAST-004	umf004-001	Planet-U3/W_1in
99	U233-MET-FAST-004	umf004-002	Planet-U3/W_2in
100	U233-MET-FAST-005	umf005-001	umf005-001
101	U233-MET-FAST-005	umf005-002	umf005-002
102	PU-MET-FAST-009	pmf009	LANL-pmf009
103	IEU-COMP-THERM-002	ict002-003	IPPE-MATR_16.4C_Gd
104	MIX-MET-FAST-001	mmf001	LANL_mmf001
105	MIX-MET-FAST-003	mmf003	VNIITF-CTF_mmf003
106	MIX-MET-FAST-008	mmf008-007	ZEBRA-8H
107	PU-MET-FAST-025	pmf025	pmf025
108	PU-MET-FAST-026	pmf026	pmf026
109	HEU-MET-FAST-020	hmf020	hmf020
110	HEU-MET-FAST-021	hmf021	VNIITF-CTF-SS-21
111	HEU-MET-FAST-022	hmf022	hmf022
112	HEU-MET-FAST-026	hmf026-021	hmf026-c11
113	PU-COMP-INTER-001	pci001	pci001
114	MIX-COMP-THERM-002	mct002-001	PNL-PRCF-30
115	MIX-COMP-THERM-002	mct002-002	PNL-PRCF-31

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 116  MIX-COMP-THERM-002  mct002-003  PNL-PRCF-32
 117  MIX-COMP-THERM-002  mct002-004  PNL-PRCF-33
 118  MIX-COMP-THERM-002  mct002-005  PNL-PRCF-34
 119  MIX-COMP-THERM-002  mct002-006  PNL-PRCF-35
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A.2 Full suite of criticality benchmarks implemented at the IAEA

Case	ICSBEP name	Short name	Common name
1	HEU-MET-FAST-001	hmf001	Godiva
2	HEU-MET-FAST-028	hmf028	Flattop-25
3	IEU-MET-FAST-007	imf007	Big_Ten
4	IEU-MET-FAST-007	imf007d	Big_Ten(detailed)
5	PU-MET-FAST-001	pmf001	Jezebel
6	PU-MET-FAST-002	pmf002	Jezebel-240
7	PU-MET-FAST-006	pmf006	Flattop-Pu
8	U233-MET-FAST-001	umf001	Jezebel-U233
9	U233-MET-FAST-006	umf006	Flattop-23
10	PU-MET-FAST-001	pmf001-1d	Jezebel-1d
11	PU-MET-FAST-001	pmf001-2d	Jezebel-2d
12	PU-MET-FAST-001	pmf001-3d	Jezebel-3d
13	PU-MET-FAST-001	pmf001-4d	Jezebel-4d
14	PU-MET-FAST-001	pmf001-001d	Jezebel-1d
15	PU-MET-FAST-001	pmf001-002d	Jezebel-2d
16	PU-MET-FAST-001	pmf001-003d	Jezebel-3d
17	PU-MET-FAST-001	pmf001-004d	Jezebel-4d
18	PU-MET-FAST-022	pmf022	pmf022
19	HEU-MET-FAST-002	hmf002-001	Topsy-1
20	HEU-MET-FAST-002	hmf002-002	Topsy-2
21	HEU-MET-FAST-002	hmf002-003	Topsy-3
22	HEU-MET-FAST-002	hmf002-004	Topsy-4
23	HEU-MET-FAST-002	hmf002-005	Topsy-5
24	HEU-MET-FAST-002	hmf002-006	Topsy-6
25	IEU-MET-FAST-001	imf001-001d	Jemima-1d
26	IEU-MET-FAST-001	imf001-002d	Jemima-2d
27	IEU-MET-FAST-001	imf001-003d	Jemima-3d
28	IEU-MET-FAST-001	imf001-004d	Jemima-4d
29	IEU-MET-FAST-001	imf001-001	Jemima-1
30	IEU-MET-FAST-001	imf001-002	Jemima-2
31	IEU-MET-FAST-001	imf001-003	Jemima-3
32	IEU-MET-FAST-001	imf001-004	Jemima-4
33	PU-MET-FAST-010	pmf010	pmf010
34	PU-MET-FAST-011	pmf011	pmf011
35	PU-MET-FAST-012	pmf012	pmf012
36	PU-MET-FAST-016	pmf016-001	pmf016_1
37	PU-MET-FAST-016	pmf016-002	pmf016_2
38	PU-MET-FAST-016	pmf016-003	pmf016_3
39	PU-MET-FAST-016	pmf016-004	pmf016_6-9
40	PU-MET-FAST-016	pmf016-005	pmf016_10
41	PU-MET-FAST-016	pmf016-006	pmf016_13
42	PU-MET-FAST-018	pmf018	pmf018
43	PU-MET-FAST-019	pmf019	pmf019
44	PU-MET-FAST-020	pmf020	pmf020
45	PU-MET-FAST-021	pmf021-001	pmf021-1
46	PU-MET-FAST-021	pmf021-002	pmf021-2
47	PU-MET-FAST-023	pmf023	pmf023
48	PU-MET-FAST-024	pmf024	pmf024
49	PU-MET-FAST-027	pmf027d	pmf027d
50	PU-MET-FAST-029	pmf029	pmf029
51	PU-MET-FAST-031	pmf031-001	VNIIEF_Pu9(a,88%)
52	PU-MET-FAST-041	pmf041	pmf041
53	PU-MET-FAST-044	pmf044-001	pmf044-001
54	PU-MET-FAST-044	pmf044-002	pmf044-002
55	PU-MET-FAST-044	pmf044-003	pmf044-003
56	PU-MET-FAST-044	pmf044-004	pmf044-004
57	PU-MET-FAST-044	pmf044-005	pmf044-005

58	PU-MET-FAST-003	pmf003-001	LLNL_Pu_buttons-1
59	PU-MET-FAST-003	pmf003-002	LLNL_Pu_buttons-2
60	PU-MET-FAST-003	pmf003-003	LLNL_Pu_buttons-3
61	PU-MET-FAST-003	pmf003-004	LLNL_Pu_buttons-4
62	PU-MET-FAST-003	pmf003-005	LLNL_Pu_buttons-5
63	MIX-MET-INTER-004	mmi004	ZPR-3/53
64	MIX-MISC-FAST-001	mif001-001	BFS-35-1
65	MIX-MISC-FAST-001	mif001-002	BFS-35-2
66	MIX-MISC-FAST-001	mif001-003	BFS-35-3
67	MIX-MISC-FAST-001	mif001-009	BFS-31-4
68	MIX-MISC-FAST-001	mif001-010	BFS-31-5
69	MIX-MISC-FAST-001	mif001-011	BFS-42
70	MIX-MISC-FAST-002	mif002-001	BFS-49/1A
71	IEU-COMP-INTER-005	ici005	ZPR-6/6A
72	HEU-MET-FAST-085	hmf085-001	Comet-Cu_2in
73	HEU-MET-FAST-085	hmf085-002	Comet-Cu_4in
74	HEU-MET-FAST-085	hmf085-003	Comet-Fe_4in
75	HEU-MET-FAST-085	hmf085-004	Comet-SS_4in
76	HEU-COMP-INTER-003	hci003-001	COMET-UH3-1
77	HEU-COMP-INTER-003	hci003-004	COMET-UH3-4
78	HEU-COMP-INTER-003	hci003-006	COMET-UH3-6
79	HEU-COMP-INTER-003	hci003-007	COMET-UH3-7
80	IEU-MET-FAST-002	imf002	Pajarito
81	HEU-MET-FAST-003	hmf003-001	Topsy-U_2.0in
82	HEU-MET-FAST-003	hmf003-002	Topsy-U_3.0in
83	HEU-MET-FAST-003	hmf003-003	Topsy-U_4.0in
84	HEU-MET-FAST-003	hmf003-004	Topsy-U_5.0in
85	HEU-MET-FAST-003	hmf003-005	Topsy-U_6.0in
86	HEU-MET-FAST-003	hmf003-006	Topsy-U_8.0in
87	HEU-MET-FAST-003	hmf003-007	Topsy-U_11.in
88	HEU-MET-FAST-007	hmf007-001	HMF007-001
89	HEU-MET-FAST-007	hmf007-002	HMF007-002
90	HEU-MET-FAST-007	hmf007-003	HMF007-003
91	HEU-MET-FAST-007	hmf007-004	HMF007-004
92	HEU-MET-FAST-007	hmf007-005	HMF007-005
93	HEU-MET-FAST-007	hmf007-006	HMF007-006
94	HEU-MET-FAST-007	hmf007-007	HMF007-007
95	HEU-MET-FAST-007	hmf007-008	HMF007-008
96	HEU-MET-FAST-007	hmf007-009	HMF007-009
97	HEU-MET-FAST-007	hmf007-010	HMF007-010
98	HEU-MET-FAST-007	hmf007-011	HMF007-011
99	HEU-MET-FAST-007	hmf007-012	HMF007-012
100	HEU-MET-FAST-007	hmf007-013	HMF007-013
101	HEU-MET-FAST-007	hmf007-014	HMF007-014
102	HEU-MET-FAST-007	hmf007-015	HMF007-015
103	HEU-MET-FAST-007	hmf007-016	HMF007-016
104	HEU-MET-FAST-007	hmf007-017	HMF007-017
105	HEU-MET-FAST-007	hmf007-018	HMF007-018
106	HEU-MET-FAST-007	hmf007-019	HMF007-019
107	HEU-MET-FAST-007	hmf007-020	HMF007-020
108	HEU-MET-FAST-007	hmf007-021	HMF007-021
109	HEU-MET-FAST-007	hmf007-022	HMF007-022
110	HEU-MET-FAST-007	hmf007-023	HMF007-023
111	HEU-MET-FAST-007	hmf007-024	HMF007-024
112	HEU-MET-FAST-007	hmf007-025	HMF007-025
113	HEU-MET-FAST-007	hmf007-026	HMF007-026
114	HEU-MET-FAST-007	hmf007-035	HMF007-035
115	HEU-MET-FAST-007	hmf007-036	HMF007-036
116	HEU-MET-FAST-007	hmf007-037	HMF007-037
117	HEU-MET-FAST-007	hmf007-038	HMF007-038
118	HEU-MET-FAST-007	hmf007-039	HMF007-039

119	HEU-MET-FAST-007	hmf007-040	HMF007-040
120	HEU-MET-FAST-007	hmf007-041	HMF007-041
121	HEU-MET-FAST-007	hmf007-042	HMF007-042
122	HEU-MET-FAST-007	hmf007-043	HMF007-043
123	HEU-MET-FAST-008	hmf008	VNIIEF-CTF-bare
124	HEU-MET-FAST-009	hmf009-001	VNIITF-CTF-009-1
125	HEU-MET-FAST-009	hmf009-002	VNIITF-CTF-009-2
126	HEU-MET-FAST-011	hmf011	VNIITF-CTF-011
127	HEU-MET-FAST-012	hmf012	VNIITF-CTF-012
128	HEU-MET-FAST-013	hmf013	VNIITF-CTF-SS-13
129	HEU-MET-FAST-014	hmf014	VNIIEF-CTF-DU
130	HEU-MET-FAST-015	hmf015	VNIIEF-CTF-UnrCy1
131	HEU-MET-FAST-065	hmf065	VNIIEF-CTF-UnrCy2
132	HEU-MET-FAST-032	hmf032-001	COMET-TU1_3.93in
133	HEU-MET-FAST-032	hmf032-002	COMET-TU2_3.52in
134	HEU-MET-FAST-032	hmf032-003	COMET-TU3_1.742in
135	HEU-MET-FAST-032	hmf032-004	COMET-TU4_0.683in
136	IEU-MET-FAST-003	imf003-001d	VNIIEF-CTF-3
137	IEU-MET-FAST-004	imf004-001d	VNIIEF-CTF-4
138	IEU-MET-FAST-005	imf005	VNIIEF-CTF-5
139	IEU-MET-FAST-005	imf005-s	VNIIEF-CTF-5s
140	IEU-MET-FAST-006	imf006	VNIIEF-CTF-6
141	IEU-MET-FAST-006	imf006-s	VNIIEF-CTF-6s
142	IEU-MET-FAST-010	imf010	ZPR-6/9(U9)
143	LEU-COMP-THERM-001	lct001-001	PNL_2.032p-1
144	LEU-COMP-THERM-001	lct001-002	PNL_2.032p-2
145	LEU-COMP-THERM-001	lct001-003	PNL_2.032p-3
146	LEU-COMP-THERM-001	lct001-004	PNL_2.032p-4
147	LEU-COMP-THERM-001	lct001-005	PNL_2.032p-5
148	LEU-COMP-THERM-001	lct001-006	PNL_2.032p-6
149	LEU-COMP-THERM-001	lct001-007	PNL_2.032p-7
150	LEU-COMP-THERM-001	lct001-008	PNL_2.032p-8
151	LEU-COMP-THERM-002	lct002-001	PNL_2.54p-1
152	LEU-COMP-THERM-002	lct002-002	PNL_2.54p-2
153	LEU-COMP-THERM-002	lct002-003	PNL_2.54p-3
154	LEU-COMP-THERM-002	lct002-004	PNL_2.54p-4
155	LEU-COMP-THERM-002	lct002-005	PNL_2.54p-5
156	LEU-COMP-THERM-003	lct003-001	PNL_1.64p-01
157	LEU-COMP-THERM-003	lct003-002	PNL_1.64p-02
158	LEU-COMP-THERM-003	lct003-003	PNL_1.64p-03
159	LEU-COMP-THERM-003	lct003-004	PNL_1.64p-04
160	LEU-COMP-THERM-003	lct003-005	PNL_1.64p-05
161	LEU-COMP-THERM-003	lct003-006	PNL_1.64p-06
162	LEU-COMP-THERM-003	lct003-007	PNL_1.64p-07
163	LEU-COMP-THERM-003	lct003-008	PNL_1.64p-08
164	LEU-COMP-THERM-003	lct003-009	PNL_1.64p-09
165	LEU-COMP-THERM-003	lct003-014	PNL_1.64p-14
166	LEU-COMP-THERM-003	lct003-015	PNL_1.64p-15
167	LEU-COMP-THERM-003	lct003-016	PNL_1.64p-16
168	LEU-COMP-THERM-003	lct003-017	PNL_1.64p-17
169	LEU-COMP-THERM-003	lct003-018	PNL_1.64p-18
170	LEU-COMP-THERM-003	lct003-019	PNL_1.64p-19
171	LEU-COMP-THERM-003	lct003-020	PNL_1.64p-20
172	LEU-COMP-THERM-003	lct003-021	PNL_1.64p-21
173	LEU-COMP-THERM-003	lct003-022	PNL_1.64p-22
174	LEU-COMP-THERM-005	lct005-001	PNL_2.398p_Gd0
175	LEU-COMP-THERM-005	lct005-002	PNL_2.398p_Gd0.068
176	LEU-COMP-THERM-005	lct005-003	PNL_2.398p_Gd0.438
177	LEU-COMP-THERM-005	lct005-004	PNL_2.398p_Gd0.482
178	LEU-COMP-THERM-005	lct005-005	PNL_1.801p_Gd0
179	LEU-COMP-THERM-005	lct005-006	PNL_1.801p_Gd0.122

180	LEU-COMP-THERM-005	lct005-007	PNL_1.801p_Gd0.400
181	LEU-COMP-THERM-005	lct005-008	PNL_1.801p_Gd0.908
182	LEU-COMP-THERM-005	lct005-009	PNL_1.801p_Gd1.246
183	LEU-COMP-THERM-005	lct005-010	PNL_1.801p_Gd1.448
184	LEU-COMP-THERM-005	lct005-011	PNL_1.801p_Gd1.481
185	LEU-COMP-THERM-005	lct005-012	PNL_1.598p_Gd0
186	LEU-COMP-THERM-005	lct005-013	PNL_1.598p_Gd0.121
187	LEU-COMP-THERM-006	lct006-001	TCA-1.50U-01
188	LEU-COMP-THERM-006	lct006-002	TCA-1.50U-02
189	LEU-COMP-THERM-006	lct006-003	TCA-1.50U-03
190	LEU-COMP-THERM-006	lct006-004	TCA-1.83U-04
191	LEU-COMP-THERM-006	lct006-005	TCA-1.83U-05
192	LEU-COMP-THERM-006	lct006-006	TCA-1.83U-06
193	LEU-COMP-THERM-006	lct006-007	TCA-1.83U-07
194	LEU-COMP-THERM-006	lct006-008	TCA-1.83U-08
195	LEU-COMP-THERM-006	lct006-009	TCA-2.48U-09
196	LEU-COMP-THERM-006	lct006-010	TCA-2.48U-10
197	LEU-COMP-THERM-006	lct006-011	TCA-2.48U-11
198	LEU-COMP-THERM-006	lct006-012	TCA-2.48U-12
199	LEU-COMP-THERM-006	lct006-013	TCA-2.48U-13
200	LEU-COMP-THERM-006	lct006-014	TCA-3.00U-14
201	LEU-COMP-THERM-006	lct006-015	TCA-3.00U-15
202	LEU-COMP-THERM-006	lct006-016	TCA-3.00U-16
203	LEU-COMP-THERM-006	lct006-017	TCA-3.00U-17
204	LEU-COMP-THERM-006	lct006-018	TCA-3.00U-18
205	LEU-COMP-THERM-007	lct007-001	Valduc-sq-1.26p
206	LEU-COMP-THERM-007	lct007-002	Valduc-sq-1.60p
207	LEU-COMP-THERM-007	lct007-003	Valduc-sq-2.10p
208	LEU-COMP-THERM-007	lct007-004	Valduc-sq-2.52p
209	LEU-COMP-THERM-007	lct007-005	Valduc-tr-1.35p
210	LEU-COMP-THERM-007	lct007-006	Valduc-tr-1.72p
211	LEU-COMP-THERM-007	lct007-007	Valduc-tr-2.26p
212	LEU-COMP-THERM-007	lct007-008	Valduc-tr-1.35p
213	LEU-COMP-THERM-007	lct007-009	Valduc-tr-1.72p
214	LEU-COMP-THERM-007	lct007-010	Valduc-tr-2.26p
215	LEU-COMP-THERM-008	lct008-001	BW-XI-1
216	LEU-COMP-THERM-008	lct008-002	BW-XI-2
217	LEU-COMP-THERM-008	lct008-003	BW-XI-3
218	LEU-COMP-THERM-008	lct008-004	BW-XI-4
219	LEU-COMP-THERM-008	lct008-005	BW-XI-5
220	LEU-COMP-THERM-008	lct008-006	BW-XI-6
221	LEU-COMP-THERM-008	lct008-007	BW-XI-7
222	LEU-COMP-THERM-008	lct008-008	BW-XI-8
223	LEU-COMP-THERM-008	lct008-009	BW-XI-9
224	LEU-COMP-THERM-008	lct008-010	BW-XI-10
225	LEU-COMP-THERM-008	lct008-011	BW-XI-11
226	LEU-COMP-THERM-008	lct008-012	BW-XI-12
227	LEU-COMP-THERM-008	lct008-013	BW-XI-13
228	LEU-COMP-THERM-008	lct008-014	BW-XI-14
229	LEU-COMP-THERM-008	lct008-015	BW-XI-15
230	LEU-COMP-THERM-009	lct009-001	PNL_2.54p_SSnoB
231	LEU-COMP-THERM-009	lct009-002	PNL_2.54p_SSnoB
232	LEU-COMP-THERM-009	lct009-003	PNL_2.54p_SSnoB
233	LEU-COMP-THERM-009	lct009-004	PNL_2.54p_SSnoB
234	LEU-COMP-THERM-009	lct009-005	PNL_2.54p_SS1.1B
235	LEU-COMP-THERM-009	lct009-006	PNL_2.54p_SS1.1B
236	LEU-COMP-THERM-009	lct009-007	PNL_2.54p_SS1.6B
237	LEU-COMP-THERM-009	lct009-008	PNL_2.54p_SS1.6B
238	LEU-COMP-THERM-009	lct009-010	PNL_2.54p_CuNoCd
239	LEU-COMP-THERM-009	lct009-011	PNL_2.54p_CuNoCd
240	LEU-COMP-THERM-009	lct009-013	PNL_2.54p_CuNoCd

241	LEU-COMP-THERM-009	lct009-015	PNL_2.54p_Cu1.0Cd
242	LEU-COMP-THERM-009	lct009-016	PNL_2.54p_Cd
243	LEU-COMP-THERM-009	lct009-017	PNL_2.54p_Cd
244	LEU-COMP-THERM-009	lct009-018	PNL_2.54p_Cd
245	LEU-COMP-THERM-009	lct009-019	PNL_2.54p_Cd
246	LEU-COMP-THERM-009	lct009-020	PNL_2.54p_Cd
247	LEU-COMP-THERM-009	lct009-021	PNL_2.54p_Cd
248	LEU-COMP-THERM-009	lct009-022	PNL_2.54p_Cd
249	LEU-COMP-THERM-009	lct009-023	PNL_2.54p_Cd
250	LEU-COMP-THERM-009	lct009-024	PNL_2.54p_Al
251	LEU-COMP-THERM-009	lct009-025	PNL_2.54p_Al
252	LEU-COMP-THERM-009	lct009-026	PNL_2.54p_Zr
253	LEU-COMP-THERM-009	lct009-027	PNL_2.54p_Zr
254	LEU-COMP-THERM-010	lct010-001	PNL_2.54p_Pb-1
255	LEU-COMP-THERM-010	lct010-002	PNL_2.54p_Pb-2
256	LEU-COMP-THERM-010	lct010-003	PNL_2.54p_Pb-3
257	LEU-COMP-THERM-010	lct010-004	PNL_2.54p_Pb-4
258	LEU-COMP-THERM-010	lct010-005	PNL_2.54p_DU-1
259	LEU-COMP-THERM-010	lct010-006	PNL_2.54p_DU-2
260	LEU-COMP-THERM-010	lct010-007	PNL_2.54p_DU-3
261	LEU-COMP-THERM-010	lct010-008	PNL_2.54p_DU-4
262	LEU-COMP-THERM-010	lct010-009	PNL_2.54p_SS-1
263	LEU-COMP-THERM-010	lct010-010	PNL_2.54p_SS-2
264	LEU-COMP-THERM-010	lct010-011	PNL_2.54p_SS-3
265	LEU-COMP-THERM-010	lct010-012	PNL_2.54p_SS-4
266	LEU-COMP-THERM-010	lct010-013	PNL_2.54p_SS-5
267	LEU-COMP-THERM-010	lct010-014	PNL_1.892p_SS-6
268	LEU-COMP-THERM-010	lct010-015	PNL_1.892p_SS-7
269	LEU-COMP-THERM-010	lct010-016	PNL_1.892p_SS-8
270	LEU-COMP-THERM-010	lct010-017	PNL_1.892p_SS-9
271	LEU-COMP-THERM-010	lct010-018	PNL_1.892p_SS-10
272	LEU-COMP-THERM-010	lct010-019	PNL_1.892p_SS-11
273	LEU-COMP-THERM-010	lct010-020	PNL_1.892p_Pb-5
274	LEU-COMP-THERM-010	lct010-021	PNL_1.892p_Pb-6
275	LEU-COMP-THERM-010	lct010-022	PNL_1.892p_Pb-7
276	LEU-COMP-THERM-010	lct010-023	PNL_1.892p_Pb-8
277	LEU-COMP-THERM-010	lct010-024	PNL_1.892p_DU-5
278	LEU-COMP-THERM-010	lct010-025	PNL_1.892p_DU-6
279	LEU-COMP-THERM-010	lct010-026	PNL_1.892p_DU-7
280	LEU-COMP-THERM-010	lct010-027	PNL_1.892p_DU-8
281	LEU-COMP-THERM-010	lct010-028	PNL_1.892p_DU-9
282	LEU-COMP-THERM-010	lct010-029	PNL_1.892p_DU-10
283	LEU-COMP-THERM-010	lct010-030	PNL_1.892p_DU-11
284	LEU-COMP-THERM-011	lct011-002	BW_CX-10-II(2)
285	LEU-COMP-THERM-011	lct011-003	BW_CX-10-IIIA(3)
286	LEU-COMP-THERM-011	lct011-004	BW_CX-10-IIIB(4)
287	LEU-COMP-THERM-011	lct011-005	BW_CX-10-IIIC(5)
288	LEU-COMP-THERM-011	lct011-006	BW_CX-10-IIID(6)
289	LEU-COMP-THERM-011	lct011-007	BW_CX-10-IIIE(7)
290	LEU-COMP-THERM-011	lct011-008	BW_CX-10-IIIF(8)
291	LEU-COMP-THERM-011	lct011-009	BW_CX-10-IIIG(9)
292	LEU-COMP-THERM-011	lct011-015	BW_CX-10-IX(15)
293	LEU-COMP-THERM-022	lct022-001	RRC-KI-0.70p_hx
294	LEU-COMP-THERM-022	lct022-002	RRC-KI-0.80p_hx
295	LEU-COMP-THERM-022	lct022-003	RRC-KI-1.00p_hx
296	LEU-COMP-THERM-022	lct022-004	RRC-KI-1.22p_hx
297	LEU-COMP-THERM-022	lct022-005	RRC-KI-1.40p_hx
298	LEU-COMP-THERM-022	lct022-006	RRC-KI-1.83p_hx
299	LEU-COMP-THERM-022	lct022-007	RRC-KI-1.85p_hx
300	LEU-COMP-THERM-024	lct024-001	RRC-KI-0.62p_hx
301	LEU-COMP-THERM-024	lct024-002	RRC-KI-0.88p_hx

302	LEU-COMP-THERM-025	lct025-001	RRC-KI-0.70p_sq
303	LEU-COMP-THERM-025	lct025-002	RRC-KI-0.80p_sq
304	LEU-COMP-THERM-025	lct025-003	RRC-KI-1.00p_sq
305	LEU-COMP-THERM-025	lct025-004	RRC-KI-1.22p_sq
306	LEU-COMP-THERM-042	lct042-1	lct042-1
307	LEU-COMP-THERM-042	lct042-2	lct042-2
308	LEU-COMP-THERM-042	lct042-001	lct042-001
309	LEU-COMP-THERM-042	lct042-002	lct042-002
310	LEU-COMP-THERM-042	lct042-003	lct042-003
311	LEU-COMP-THERM-042	lct042-004	lct042-004
312	LEU-COMP-THERM-042	lct042-005	lct042-005
313	LEU-COMP-THERM-042	lct042-006	lct042-006
314	LEU-COMP-THERM-042	lct042-007	lct042-007
315	LEU-COMP-THERM-043	lct043-002	IPEN/MB-01
316	LEU-COMP-THERM-064	lct064-001	VVER_1.27p-01
317	LEU-COMP-THERM-064	lct064-002	VVER_1.27p-02
318	LEU-COMP-THERM-064	lct064-003	VVER_1.27p-03
319	LEU-COMP-THERM-064	lct064-004	VVER_1.27p-04
320	LEU-COMP-THERM-064	lct064-005	VVER_1.27p-05
321	LEU-COMP-THERM-064	lct064-006	VVER_1.27p-06
322	LEU-COMP-THERM-064	lct064-007	VVER_1.27p-07
323	LEU-COMP-THERM-078	lct078-001	SNL-7uPCXp.855-01
324	LEU-COMP-THERM-078	lct078-002	SNL-7uPCXp.855-02
325	LEU-COMP-THERM-078	lct078-003	SNL-7uPCXp.855-03
326	LEU-COMP-THERM-078	lct078-004	SNL-7uPCXp.855-04
327	LEU-COMP-THERM-078	lct078-005	SNL-7uPCXp.855-05
328	LEU-COMP-THERM-078	lct078-006	SNL-7uPCXp.855-06
329	LEU-COMP-THERM-078	lct078-007	SNL-7uPCXp.855-07
330	LEU-COMP-THERM-078	lct078-008	SNL-7uPCXp.855-08
331	LEU-COMP-THERM-078	lct078-009	SNL-7uPCXp.855-09
332	LEU-COMP-THERM-078	lct078-010	SNL-7uPCXp.855-10
333	LEU-COMP-THERM-078	lct078-011	SNL-7uPCXp.855-11
334	LEU-COMP-THERM-078	lct078-012	SNL-7uPCXp.855-12
335	LEU-COMP-THERM-078	lct078-013	SNL-7uPCXp.855-13
336	LEU-COMP-THERM-078	lct078-014	SNL-7uPCXp.855-14
337	LEU-COMP-THERM-078	lct078-015	SNL-7uPCXp.855-15
338	LEU-COMP-THERM-080	lct080-001	SNL-7uPCXp.800-01
339	LEU-COMP-THERM-080	lct080-002	SNL-7uPCXp.800-02
340	LEU-COMP-THERM-080	lct080-003	SNL-7uPCXp.800-03
341	LEU-COMP-THERM-080	lct080-004	SNL-7uPCXp.800-04
342	LEU-COMP-THERM-080	lct080-005	SNL-7uPCXp.800-05
343	LEU-COMP-THERM-080	lct080-006	SNL-7uPCXp.800-06
344	LEU-COMP-THERM-080	lct080-007	SNL-7uPCXp.800-07
345	LEU-COMP-THERM-080	lct080-008	SNL-7uPCXp.800-08
346	LEU-COMP-THERM-080	lct080-009	SNL-7uPCXp.800-09
347	LEU-COMP-THERM-080	lct080-010	SNL-7uPCXp.800-10
348	LEU-COMP-THERM-080	lct080-011	SNL-7uPCXp.800-11
349	LEU-COMP-THERM-096	lct096-001	SNL-7uPCXp.800R-01
350	LEU-COMP-THERM-096	lct096-002	SNL-7uPCXp.800R-02
351	LEU-COMP-THERM-096	lct096-003	SNL-7uPCXp.800R-03
352	LEU-COMP-THERM-096	lct096-004	SNL-7uPCXp.800R-04
353	LEU-COMP-THERM-096	lct096-005	SNL-7uPCXp.800R-05
354	LEU-COMP-THERM-096	lct096-006	SNL-7uPCXp.800R-06
355	LEU-COMP-THERM-096	lct096-007	SNL-7uPCXp.800R-07
356	LEU-COMP-THERM-096	lct096-008	SNL-7uPCXp.800R-08
357	LEU-COMP-THERM-096	lct096-009	SNL-7uPCXp.800R-09
358	LEU-COMP-THERM-096	lct096-010	SNL-7uPCXp.800R-10
359	LEU-COMP-THERM-096	lct096-011	SNL-7uPCXp.800R-11
360	LEU-COMP-THERM-096	lct096-012	SNL-7uPCXp.800R-12
361	LEU-COMP-THERM-096	lct096-013	SNL-7uPCXp.800R-13
362	LEU-COMP-THERM-096	lct096-014	SNL-7uPCXp.800R-14

363	LEU-COMP-THERM-096	lct096-015	SNL-7uPCXp.800R-15
364	LEU-COMP-THERM-096	lct096-016	SNL-7uPCXp.800R-16
365	LEU-COMP-THERM-096	lct096-017	SNL-7uPCXp.800R-17
366	LEU-COMP-THERM-096	lct096-018	SNL-7uPCXp.800R-18
367	LEU-COMP-THERM-096	lct096-019	SNL-7uPCXp.800R-19
368	LEU-SOL-THERM-001	lst001-001	SHEBA-II
369	LEU-SOL-THERM-002	lst002-001	ORNL-UO2F2-1
370	LEU-SOL-THERM-002	lst002-002	ORNL-UO2F2-2
371	LEU-SOL-THERM-002	lst002-003	ORNL-UO2F2-3
372	LEU-SOL-THERM-004	lst004-001	STACY-1
373	LEU-SOL-THERM-004	lst004-002	STACY-29
374	LEU-SOL-THERM-004	lst004-003	STACY-33
375	LEU-SOL-THERM-004	lst004-004	STACY-34
376	LEU-SOL-THERM-004	lst004-005	STACY-46
377	LEU-SOL-THERM-004	lst004-006	STACY-51
378	LEU-SOL-THERM-004	lst004-007	STACY-54
379	LEU-SOL-THERM-007	lst007-001	STACY-14
380	LEU-SOL-THERM-007	lst007-002	STACY-30
381	LEU-SOL-THERM-007	lst007-003	STACY-32
382	LEU-SOL-THERM-007	lst007-004	STACY-36
383	LEU-SOL-THERM-007	lst007-005	STACY-49
384	LEU-SOL-THERM-010	lst010-83	STACY-83
385	LEU-SOL-THERM-010	lst010-85	STACY-85
386	LEU-SOL-THERM-010	lst010-86	STACY-86
387	LEU-SOL-THERM-010	lst010-88	STACY-88
388	LEU-SOL-THERM-011	lst011-001	STACY-460
389	LEU-SOL-THERM-011	lst011-002	STACY-461
390	LEU-SOL-THERM-011	lst011-003	STACY-464
391	LEU-SOL-THERM-011	lst011-004	STACY-470
392	LEU-SOL-THERM-011	lst011-005	STACY-471
393	LEU-SOL-THERM-011	lst011-006	STACY-485
394	LEU-SOL-THERM-011	lst011-007	STACY-486
395	LEU-SOL-THERM-011	lst011-008	STACY-459
396	LEU-SOL-THERM-011	lst011-009	STACY-462
397	LEU-SOL-THERM-011	lst011-010	STACY-463
398	LEU-SOL-THERM-011	lst011-011	STACY-469
399	LEU-SOL-THERM-011	lst011-012	STACY-472
400	LEU-SOL-THERM-011	lst011-013	STACY-484
401	LEU-SOL-THERM-012	lst012-001	TRACY-203c
402	LEU-SOL-THERM-012	lst012-002	TRACY-203t
403	LEU-SOL-THERM-016	lst016-001	STACY-105
404	LEU-SOL-THERM-016	lst016-002	STACY-113
405	LEU-SOL-THERM-016	lst016-003	STACY-125
406	LEU-SOL-THERM-016	lst016-004	STACY-129
407	LEU-SOL-THERM-016	lst016-005	STACY-131
408	LEU-SOL-THERM-016	lst016-006	STACY-140
409	LEU-SOL-THERM-016	lst016-007	STACY-196
410	LEU-SOL-THERM-017	lst017-001	STACY-104
411	LEU-SOL-THERM-017	lst017-002	STACY-122
412	LEU-SOL-THERM-017	lst017-003	STACY-123
413	LEU-SOL-THERM-017	lst017-004	STACY-126
414	LEU-SOL-THERM-017	lst017-005	STACY-130
415	LEU-SOL-THERM-017	lst017-006	STACY-147
416	LEU-SOL-THERM-018	lst018-001	STACY-133
417	LEU-SOL-THERM-018	lst018-002	STACY-142
418	LEU-SOL-THERM-018	lst018-003	STACY-143
419	LEU-SOL-THERM-018	lst018-004	STACY-144
420	LEU-SOL-THERM-018	lst018-005	STACY-145
421	LEU-SOL-THERM-018	lst018-006	STACY-146
422	LEU-SOL-THERM-019	lst019-001	STACY-149
423	LEU-SOL-THERM-019	lst019-002	STACY-150

424	LEU-SOL-THERM-019	lst019-003	STACY-151
425	LEU-SOL-THERM-019	lst019-004	STACY-152
426	LEU-SOL-THERM-019	lst019-005	STACY-153
427	LEU-SOL-THERM-019	lst019-006	STACY-183
428	LEU-SOL-THERM-020	lst020-216	STACY-216
429	LEU-SOL-THERM-020	lst020-217	STACY-217
430	LEU-SOL-THERM-020	lst020-220	STACY-220
431	LEU-SOL-THERM-020	lst020-226	STACY-226
432	LEU-SOL-THERM-021	lst021-215	STACY-215
433	LEU-SOL-THERM-021	lst021-218	STACY-218
434	LEU-SOL-THERM-021	lst021-221	STACY-221
435	LEU-SOL-THERM-021	lst021-223	STACY-223
436	HEU-SOL-THERM-009	hst009-001	ORNL_S1
437	HEU-SOL-THERM-009	hst009-002	ORNL_S2
438	HEU-SOL-THERM-009	hst009-003	ORNL_S3
439	HEU-SOL-THERM-009	hst009-004	ORNL_S4
440	HEU-SOL-THERM-013	hst013-001	ORNL_T1
441	HEU-SOL-THERM-013	hst013-002	ORNL_T2
442	HEU-SOL-THERM-013	hst013-003	ORNL_T3
443	HEU-SOL-THERM-013	hst013-004	ORNL_T4
444	HEU-SOL-THERM-032	hst032	ORNL_T5
445	HEU-SOL-THERM-001	hst001-001	R01
446	HEU-SOL-THERM-001	hst001-002	R02
447	HEU-SOL-THERM-001	hst001-003	R03
448	HEU-SOL-THERM-001	hst001-004	R04
449	HEU-SOL-THERM-001	hst001-005	R05
450	HEU-SOL-THERM-001	hst001-006	R06
451	HEU-SOL-THERM-001	hst001-007	R07
452	HEU-SOL-THERM-001	hst001-008	R08
453	HEU-SOL-THERM-001	hst001-009	R09
454	HEU-SOL-THERM-001	hst001-010	R10
455	HEU-SOL-THERM-042	hst042-001	ORNL_C1
456	HEU-SOL-THERM-042	hst042-002	ORNL_C2
457	HEU-SOL-THERM-042	hst042-003	ORNL_C3
458	HEU-SOL-THERM-042	hst042-004	ORNL_C4
459	HEU-SOL-THERM-042	hst042-005	ORNL_C5
460	HEU-SOL-THERM-042	hst042-006	ORNL_C6
461	HEU-SOL-THERM-042	hst042-007	ORNL_C7
462	HEU-SOL-THERM-042	hst042-008	ORNL_C8
463	HEU-SOL-THERM-043	hst043-001	ORNL_LS1
464	HEU-SOL-THERM-043	hst043-002	ORNL_LS2
465	HEU-SOL-THERM-043	hst043-003	ORNL_LS3
466	HEU-SOL-THERM-010	hst010-001	ORNL_S10T0
467	HEU-SOL-THERM-011	hst011-001	ORNL_S17.1
468	HEU-SOL-THERM-011	hst011-002	ORNL_S17.2
469	HEU-SOL-THERM-012	hst012	ORNL_S91
470	HEU-SOL-THERM-048	hst048-001	ORNL_UO2F2-03
471	HEU-SOL-THERM-048	hst048-002	ORNL_UO2F2-04
472	HEU-SOL-THERM-048	hst048-003	ORNL_UO2F2-05
473	HEU-SOL-THERM-048	hst048-004	ORNL_UO2F2-06
474	HEU-SOL-THERM-048	hst048-005	ORNL_UO2F2-07
475	HEU-SOL-THERM-048	hst048-006	ORNL_UO2F2-08
476	HEU-SOL-THERM-048	hst048-007	ORNL_UO2F2-09
477	HEU-SOL-THERM-048	hst048-008	ORNL_UO2F2-10
478	HEU-SOL-THERM-048	hst048-009	ORNL_UO2F2-11
479	HEU-SOL-THERM-048	hst048-010	ORNL_UO2F2-12Cd
480	HEU-SOL-THERM-048	hst048-011	ORNL_UO2F2-15
481	HEU-SOL-THERM-048	hst048-012	ORNL_UO2F2-16
482	HEU-SOL-THERM-048	hst048-013	ORNL_UO2F2-17
483	HEU-SOL-THERM-048	hst048-014	ORNL_UO2F2-18
484	HEU-SOL-THERM-048	hst048-015	ORNL_UO2F2-19

485	HEU-SOL-THERM-048	hst048-016	ORNL_UO2F2-20
486	HEU-SOL-THERM-048	hst048-017	ORNL_UO2F2-21
487	HEU-SOL-THERM-048	hst048-018	ORNL_UO2F2-22Cd
488	HEU-SOL-THERM-048	hst048-019	ORNL_UO2F2-23Cd
489	HEU-SOL-THERM-048	hst048-020	ORNL_UO2F2-24Cd
490	HEU-SOL-THERM-049	hst049-001	PNL-001Cd
491	HEU-SOL-THERM-049	hst049-002	PNL-002Cd
492	HEU-SOL-THERM-049	hst049-003	PNL-003Cd
493	HEU-SOL-THERM-049	hst049-004	PNL-004Cd
494	HEU-SOL-THERM-049	hst049-005	PNL-005Cd
495	HEU-SOL-THERM-049	hst049-006	PNL-006Cd
496	HEU-SOL-THERM-049	hst049-007	PNL-007Cd
497	HEU-SOL-THERM-049	hst049-008	PNL-008Cd
498	HEU-SOL-THERM-049	hst049-009	PNL-009Cd
499	HEU-SOL-THERM-049	hst049-010	PNL-010Cd
500	HEU-SOL-THERM-049	hst049-011	PNL-011Cd
501	HEU-SOL-THERM-049	hst049-012	PNL-012Cd
502	HEU-SOL-THERM-049	hst049-013	PNL-012Cd
503	HEU-SOL-THERM-049	hst049-014	PNL-014Cd
504	HEU-SOL-THERM-049	hst049-015	PNL-015Cd
505	HEU-SOL-THERM-049	hst049-016	PNL-016Cd
506	HEU-SOL-THERM-049	hst049-017	PNL-017Cd
507	HEU-SOL-THERM-049	hst049-018	PNL-018Cd
508	HEU-SOL-THERM-049	hst049-019	PNL-019Cd
509	HEU-SOL-THERM-049	hst049-020	PNL-020Cd
510	HEU-SOL-THERM-050	hst050-001	ORNL_UO2F2-01
511	HEU-SOL-THERM-050	hst050-002	ORNL_UO2F2-03
512	HEU-SOL-THERM-050	hst050-003	ORNL_UO2F2-03
513	HEU-SOL-THERM-050	hst050-004	ORNL_UO2F2-04
514	HEU-SOL-THERM-050	hst050-005	ORNL_UO2F2-05
515	HEU-SOL-THERM-050	hst050-006	ORNL_UO2F2-06
516	HEU-SOL-THERM-050	hst050-007	ORNL_UO2F2-07
517	HEU-SOL-THERM-050	hst050-008	ORNL_UO2F2-08
518	HEU-SOL-THERM-050	hst050-009	ORNL_UO2F2-09
519	HEU-SOL-THERM-050	hst050-010	ORNL_UO2F2-10
520	HEU-SOL-THERM-050	hst050-011	ORNL_UO2F2-11
521	HEU-SOL-THERM-004	hst004-001	LANL-D2O-01
522	HEU-SOL-THERM-004	hst004-002	LANL-D2O-02
523	HEU-SOL-THERM-004	hst004-003	LANL-D2O-03
524	HEU-SOL-THERM-004	hst004-004	LANL-D2O-04
525	HEU-SOL-THERM-004	hst004-005	LANL-D2O-05
526	HEU-SOL-THERM-004	hst004-006	LANL-D2O-06
527	HEU-SOL-THERM-020	hst020-001	LANL_UO2F2_07
528	HEU-SOL-THERM-020	hst020-002	LANL_UO2F2_08
529	HEU-SOL-THERM-020	hst020-003	LANL_UO2F2_09
530	HEU-SOL-THERM-020	hst020-004	LANL_UO2F2_10
531	HEU-SOL-THERM-020	hst020-005	LANL_UO2F2_11
532	IEU-SOL-THERM-005	ist005	ORNL_IST_UO2F2
533	HEU-COMP-THERM-002	hct002-19	NRX-A_19
534	HEU-COMP-THERM-002	hct002-18	NRX-A_18
535	HEU-COMP-THERM-002	hct002-11	NRX-A_11
536	HEU-COMP-THERM-002	hct002-23	NRX-A_23
537	HEU-COMP-THERM-002	hct002-03	NRX-A_03
538	HEU-SOL-THERM-026	hst026-001	R1_Concrete
539	HEU-COMP-INTER-003	hci003-002	Comet-UH3.2
540	HEU-COMP-INTER-003	hci003-003	Comet-UH3.3
541	HEU-COMP-INTER-003	hci003-005	Comet-UH3.5
542	HEU-COMP-INTER-004	hci004	HISS_U235
543	HEU-MET-INTER-006	hmi006-001	Zeus-1/Gr
544	HEU-MET-INTER-006	hmi006-002	Zeus-2/Gr
545	HEU-MET-INTER-006	hmi006-003	Zeus-3/Gr

546	HEU-MET-INTER-006	hmi006-004	Zeus-4/Gr
547	HEU-MET-FAST-075	hmf075	ZPPR-20/C
548	IEU-MET-FAST-012	imf012	ZPR-3/41
549	IEU-COMP-FAST-004	icf004	ZPR-3/12
550	IEU-MET-FAST-020	imf020-001s	FR0_T0/1E-S
551	IEU-MET-FAST-020	imf020-002s	FR0_T1-S
552	IEU-MET-FAST-020	imf020-003s	FR0_T2-S
553	IEU-MET-FAST-020	imf020-004s	FR0_T3-S
554	IEU-MET-FAST-020	imf020-005s	FR0_T4a-S
555	IEU-MET-FAST-020	imf020-006s	FR0_T5-S
556	IEU-MET-FAST-020	imf020-007s	FR0_T6a-S
557	IEU-MET-FAST-021	imf021-001s	FR0_4-S
558	IEU-MET-FAST-022	imf022-001	FR0_3X-S
559	IEU-MET-FAST-022	imf022-002	FR0_5-S
560	IEU-MET-FAST-022	imf022-003	FR0_6A-S
561	IEU-MET-FAST-022	imf022-004	FR0_7-S
562	IEU-MET-FAST-022	imf022-005	FR0_8-S
563	IEU-MET-FAST-022	imf022-006	FR0_9-S
564	IEU-MET-FAST-022	imf022-007	FR0_10-S
565	HEU-MET-FAST-018	hmf018	VNIIEF_sphere
566	HEU-MET-FAST-019	hmf019	hmf019
567	HEU-MET-FAST-051	hmf051-01	ORCEF-01
568	HEU-MET-FAST-051	hmf051-02	ORCEF-02
569	HEU-MET-FAST-051	hmf051-03	ORCEF-03
570	HEU-MET-FAST-051	hmf051-15	ORCEF-15
571	HEU-MET-FAST-051	hmf051-16	ORCEF-16
572	HEU-MET-FAST-051	hmf051-17	ORCEF-17
573	HEU-MET-FAST-080	hmf080	Caliban
574	HEU-MET-FAST-100	hmf100-1	ORSphere-1
575	HEU-MET-FAST-100	hmf100-1s	ORSphere-1s
576	HEU-MET-FAST-100	hmf100-2	ORSphere-2
577	HEU-MET-FAST-100	hmf100-2s	ORSphere-2s
578	PU-SOL-THERM-001	pst001-1	PNL
579	PU-SOL-THERM-001	pst001-2	PNL
580	PU-SOL-THERM-001	pst001-3	PNL
581	PU-SOL-THERM-001	pst001-4	PNL
582	PU-SOL-THERM-001	pst001-5	PNL
583	PU-SOL-THERM-001	pst001-6	PNL
584	PU-SOL-THERM-003	pst003-001	P11-1
585	PU-SOL-THERM-003	pst003-002	P11-2
586	PU-SOL-THERM-003	pst003-003	P11-3
587	PU-SOL-THERM-003	pst003-004	P11-4
588	PU-SOL-THERM-003	pst003-005	P11-5
589	PU-SOL-THERM-003	pst003-006	P11-6
590	PU-SOL-THERM-003	pst003-007	P11-7
591	PU-SOL-THERM-003	pst003-008	P11-8
592	PU-SOL-THERM-004	pst004-01	PNL
593	PU-SOL-THERM-004	pst004-02	PNL
594	PU-SOL-THERM-004	pst004-03	PNL
595	PU-SOL-THERM-004	pst004-04	PNL
596	PU-SOL-THERM-004	pst004-05	PNL
597	PU-SOL-THERM-004	pst004-06	PNL
598	PU-SOL-THERM-004	pst004-07	PNL
599	PU-SOL-THERM-004	pst004-08	PNL
600	PU-SOL-THERM-004	pst004-09	PNL
601	PU-SOL-THERM-004	pst004-10	PNL
602	PU-SOL-THERM-004	pst004-11	PNL
603	PU-SOL-THERM-004	pst004-12	PNL
604	PU-SOL-THERM-004	pst004-13	PNL
605	PU-SOL-THERM-005	pst005-1	PNL
606	PU-SOL-THERM-005	pst005-2	PNL

607	PU-SOL-THERM-005	pst005-3	PNL
608	PU-SOL-THERM-005	pst005-4	PNL
609	PU-SOL-THERM-005	pst005-5	PNL
610	PU-SOL-THERM-005	pst005-6	PNL
611	PU-SOL-THERM-005	pst005-7	PNL
612	PU-SOL-THERM-005	pst005-8	PNL
613	PU-SOL-THERM-005	pst005-9	PNL
614	PU-SOL-THERM-006	pst006-1	PNL
615	PU-SOL-THERM-006	pst006-2	PNL
616	PU-SOL-THERM-006	pst006-3	PNL
617	PU-SOL-THERM-007	pst007-02	PNL
618	PU-SOL-THERM-007	pst007-03	PNL
619	PU-SOL-THERM-007	pst007-05	PNL
620	PU-SOL-THERM-007	pst007-06	PNL
621	PU-SOL-THERM-007	pst007-07	PNL
622	PU-SOL-THERM-007	pst007-08	PNL
623	PU-SOL-THERM-007	pst007-09	PNL
624	PU-SOL-THERM-007	pst007-10	PNL
625	PU-SOL-THERM-009	pst009-1a	PNL
626	PU-SOL-THERM-009	pst009-2a	PNL
627	PU-SOL-THERM-009	pst009-3a	PNL-48R-3a
628	PU-SOL-THERM-011	pst011-165	PNL-16R-5
629	PU-SOL-THERM-011	pst011-181	PNL-18R-1
630	PU-SOL-THERM-011	pst011-186	PNL-18R-6
631	PU-SOL-THERM-012	pst012-05	PNL
632	PU-SOL-THERM-012	pst012-06	PNL
633	PU-SOL-THERM-012	pst012-07	PNL
634	PU-SOL-THERM-012	pst012-13	PNL
635	PU-SOL-THERM-018	pst018-001	PNL-11-1
636	PU-SOL-THERM-018	pst018-002	PNL-11-2
637	PU-SOL-THERM-018	pst018-003	PNL-11-3
638	PU-SOL-THERM-018	pst018-004	PNL-11-4
639	PU-SOL-THERM-018	pst018-005	PNL-11-5
640	PU-SOL-THERM-018	pst018-006	PNL-11-6
641	PU-SOL-THERM-018	pst018-007	PNL-11-7
642	PU-SOL-THERM-018	pst018-008	PNL-11-8
643	PU-SOL-THERM-018	pst018-009	PNL-11-9
644	PU-SOL-THERM-021	pst021-001	PNL-11(15.2)-01
645	PU-SOL-THERM-021	pst021-003	PNL-11(15.2)-03
646	PU-SOL-THERM-034	pst034-001	PNL-10-Gd-01
647	U233-SOL-INTER-001	usi001	Falstaff-1.1
648	U233-SOL-THERM-001	ust001-001	U3ORNL-S1
649	U233-SOL-THERM-001	ust001-002	U3ORNL-S2
650	U233-SOL-THERM-001	ust001-003	U3ORNL-S3
651	U233-SOL-THERM-001	ust001-004	U3ORNL-S4
652	U233-SOL-THERM-001	ust001-005	U3ORNL-S5
653	U233-SOL-THERM-005	ust005-1	U3ORNL-37
654	U233-SOL-THERM-005	ust005-2	U3ORNL-39
655	U233-SOL-THERM-008	ust008	U3ORNL-11
656	U233-SOL-THERM-012	ust012-001	ORCEF-1
657	U233-SOL-THERM-012	ust012-002	ORCEF-2
658	U233-SOL-THERM-012	ust012-003	ORCEF-3
659	U233-SOL-THERM-012	ust012-004	ORCEF-4
660	U233-SOL-THERM-012	ust012-005	ORCEF-5
661	U233-SOL-THERM-012	ust012-006	ORCEF-6
662	U233-SOL-THERM-012	ust012-007	ORCEF-7
663	U233-SOL-THERM-012	ust012-008	ORCEF-8
664	PU-MET-FAST-008	pmf008	Thor
665	HEU-MET-FAST-085	hmf085-005	Comet-Th_2in
666	HEU-COMP-THERM-015	hct015-11	SB-1
667	HEU-COMP-THERM-015	hct015-15	SB-5

668	U233-COMP-THERM-001	uct001-020	SB-2
669	U233-COMP-THERM-001	uct001-025	SB-2h
670	U233-COMP-THERM-001	uct001-030	SB-3
671	U233-COMP-THERM-001	uct001-040	SB-4
672	U233-COMP-THERM-001	uct001-060	SB-6
673	U233-COMP-THERM-001	uct001-070	SB-7
674	U233-COMP-THERM-004	uct004-001	ETA-II
675	IEU-COMP-FAST-002	icf002	KBR-18
676	IEU-COMP-INTER-001	ici001-019	KBR-19
677	IEU-COMP-INTER-001	ici001-020	KBR-20
678	IEU-COMP-THERM-005	ict005	KBR-21
679	HEU-MET-FAST-068	hmf068	KBR-22
680	HEU-MET-INTER-008	hmi008	KBR-23
681	HEU-COMP-THERM-011	hct011-001	RRC-KI-21x21-001
682	HEU-COMP-THERM-011	hct011-002	RRC-KI-21x21-002
683	HEU-COMP-THERM-011	hct011-003	RRC-KI-21x21-003
684	HEU-COMP-THERM-012	hct012-001	RRC-KI-18x18-001
685	HEU-COMP-THERM-012	hct012-002	RRC-KI-18x18-002
686	HEU-COMP-THERM-013	hct013-001	RRC-KI-14x14-001
687	HEU-COMP-THERM-013	hct013-002	RRC-KI-14x14-002
688	HEU-COMP-THERM-014	hct014-001	RRC-KI-10x10-001
689	HEU-COMP-THERM-014	hct014-002	RRC-KI-10x10-002
690	HEU-COMP-THERM-016	hct016-001	IGR-Graphite-1
691	HEU-COMP-THERM-016	hct016-002	IGR-Graphite-2
692	HEU-COMP-THERM-016	hct016-003	IGR-Graphite-3
693	HEU-COMP-THERM-016	hct016-004	IGR-Graphite-4
694	HEU-COMP-THERM-016	hct016-005	IGR-Graphite-5
695	HEU-COMP-THERM-016	hct016-006	IGR-Graphite-6
696	HEU-COMP-THERM-018	hct018-001	ETA-I
697	HEU-COMP-THERM-021	hct021-001	TUPE-001(15/1)
698	HEU-COMP-THERM-021	hct021-002	TUPE-002(15/1)
699	HEU-COMP-THERM-021	hct021-003	TUPE-003(15/1)
700	HEU-COMP-THERM-021	hct021-004	TUPE-004(25/1)
701	HEU-COMP-THERM-021	hct021-005	TUPE-005(25/1)
702	HEU-COMP-THERM-021	hct021-006	TUPE-006
703	HEU-COMP-THERM-021	hct021-007	TUPE-007
704	HEU-COMP-THERM-021	hct021-008	TUPE-008
705	HEU-COMP-THERM-021	hct021-009	TUPE-009
706	HEU-COMP-THERM-021	hct021-010	TUPE-010
707	HEU-COMP-THERM-021	hct021-011	TUPE-011
708	HEU-COMP-THERM-021	hct021-012	TUPE-012
709	HEU-COMP-THERM-021	hct021-013	TUPE-013
710	HEU-COMP-THERM-021	hct021-014	TUPE-014_Cb070
711	HEU-COMP-THERM-021	hct021-015	TUPE-015_Cb070
712	HEU-COMP-THERM-021	hct021-016	TUPE-016_Cb070
713	HEU-COMP-THERM-021	hct021-017	TUPE-017_Cb070
714	HEU-COMP-THERM-021	hct021-018	TUPE-018_Cb070
715	HEU-COMP-THERM-021	hct021-019	TUPE-019_Cb070
716	HEU-COMP-THERM-021	hct021-020	TUPE-020_Cb070
717	HEU-COMP-THERM-021	hct021-021	TUPE-021_Cb070
718	HEU-COMP-THERM-021	hct021-022	TUPE-022_Cb070
719	HEU-COMP-THERM-021	hct021-023	TUPE-023_Cb322
720	HEU-COMP-THERM-021	hct021-024	TUPE-024_Cb322
721	HEU-COMP-THERM-021	hct021-025	TUPE-025_Cb322
722	HEU-COMP-THERM-021	hct021-026	TUPE-026_Cb322
723	HEU-COMP-THERM-021	hct021-027	TUPE-027_Cb322
724	HEU-COMP-THERM-021	hct021-028	TUPE-028_Cb322
725	HEU-COMP-THERM-021	hct021-029	TUPE-029_Cb322
726	HEU-COMP-THERM-021	hct021-030	TUPE-030_Cb322
727	HEU-COMP-THERM-021	hct021-031	TUPE-031_Cb322
728	HEU-COMP-THERM-021	hct021-032	TUPE-032_Cb586

729	HEU-COMP-THERM-021	hct021-033	TUPE-033_Cb586
730	HEU-COMP-THERM-021	hct021-034	TUPE-034_Cb586
731	HEU-COMP-THERM-021	hct021-035	TUPE-035_Cb586
732	HEU-COMP-THERM-021	hct021-036	TUPE-036_Cb586
733	HEU-COMP-THERM-021	hct021-037	TUPE-037_Cb586
734	HEU-COMP-THERM-021	hct021-038	TUPE-038_Cb586
735	HEU-COMP-THERM-021	hct021-039	TUPE-039_Cb586
736	HEU-COMP-THERM-021	hct021-040	TUPE-040_Cb586
737	HEU-COMP-THERM-021	hct021-041	TUPE-041_Cb586
738	HEU-COMP-THERM-021	hct021-042	TUPE-042_Cb586
739	HEU-COMP-THERM-021	hct021-043	TUPE-043_Cb586
740	HEU-COMP-THERM-021	hct021-044	TUPE-044_Cb823
741	HEU-COMP-THERM-021	hct021-045	TUPE-045_Cb823
742	HEU-COMP-THERM-021	hct021-046	TUPE-046_Cb823
743	HEU-COMP-THERM-021	hct021-047	TUPE-047_Cb823
744	HEU-COMP-THERM-021	hct021-048	TUPE-048_Cb823
745	HEU-COMP-THERM-021	hct021-049	TUPE-049_Cb823
746	HEU-COMP-THERM-021	hct021-050	TUPE-050_Cb823
747	HEU-COMP-THERM-021	hct021-051	TUPE-051_Cb823
748	HEU-COMP-THERM-021	hct021-052	TUPE-052_Cb823
749	HEU-COMP-THERM-021	hct021-053	TUPE-053_Cb823
750	HEU-COMP-THERM-021	hct021-054	TUPE-054
751	HEU-COMP-THERM-021	hct021-055	TUPE-055
752	HEU-COMP-THERM-021	hct021-056	TUPE-056
753	HEU-COMP-THERM-021	hct021-057	TUPE-057
754	HEU-COMP-THERM-021	hct021-058	TUPE-058
755	HEU-COMP-THERM-021	hct021-059	TUPE-059
756	HEU-COMP-THERM-021	hct021-060	TUPE-060
757	HEU-COMP-THERM-021	hct021-061	TUPE-061
758	HEU-COMP-THERM-021	hct021-062	TUPE-062
759	HEU-COMP-THERM-021	hct021-094	TUPE-094(25/1)
760	HEU-COMP-THERM-021	hct021-095	TUPE-095(25/1)
761	HEU-COMP-THERM-021	hct021-096	TUPE-096(25/1)
762	HEU-COMP-THERM-021	hct021-097	TUPE-097(25/1)
763	HEU-COMP-THERM-021	hct021-098	TUPE-098(25/1)
764	HEU-COMP-THERM-021	hct021-099	TUPE-099(25/1)
765	HEU-COMP-THERM-021	hct021-100	TUPE-100(25/1)
766	IEU-MET-FAST-013	imf013	ZPR-9/1
767	IEU-MET-FAST-014	imf014-002	ZPR-9/2
768	IEU-MET-FAST-014	imf014-003	ZPR-9/3
769	HEU-MET-FAST-060	hmf060-004	ZPR-9/4
770	HEU-MET-FAST-067	hmf067-005	ZPR-9/5
771	HEU-MET-FAST-067	hmf067-006	ZPR-9/6
772	HEU-MET-FAST-070	hmf070-007	ZPR-9/7
773	HEU-MET-FAST-070	hmf070-008	ZPR-9/8
774	HEU-MET-FAST-070	hmf070-009	ZPR-9/9
775	HEU-MET-FAST-003	hmf003-008	Topsy-W_1.9in
776	HEU-MET-FAST-003	hmf003-009	Topsy-W_2.9in
777	HEU-MET-FAST-003	hmf003-010	Topsy-W_4.5in
778	HEU-MET-FAST-003	hmf003-011	Topsy-W_6.5in
779	HEU-MET-FAST-003	hmf003-012	Topsy-Ni
780	HEU-MET-FAST-004	hmf004	hmf004
781	HEU-MET-FAST-049	hmf049-001	KFBN2-1cm
782	HEU-MET-FAST-049	hmf049-002	KFBN2-3cm
783	HEU-MET-FAST-049	hmf049-003	KFBN2-8cm
784	HEU-MET-FAST-050	hmf050	KFBN2-f1
785	HEU-MET-FAST-052	hmf052	KFBN2-f2
786	HEU-MET-MIXED-017	hmm017	KFBN2-f3
787	HEU-MET-FAST-084	hmf084-14	Comet-W_1.0in
788	HEU-MET-FAST-084	hmf084-25	Comet-W_0.5in
789	HEU-MET-FAST-085	hmf085-006	Comet-W_2.0in

790	PU-MET-FAST-005	pmf005	Planet-Pu/W1.8in
791	U233-MET-FAST-002	umf002-001	umf002-001
792	U233-MET-FAST-002	umf002-002	umf002-002
793	U233-MET-FAST-003	umf003-001	umf003-1
794	U233-MET-FAST-003	umf003-002	umf003-2
795	U233-MET-FAST-004	umf004-001	Planet-U3/W_1in
796	U233-MET-FAST-004	umf004-002	Planet-U3/W_2in
797	U233-MET-FAST-005	umf005-001	umf005-001
798	U233-MET-FAST-005	umf005-002	umf005-002
799	PU-MET-FAST-009	pmf009	LANL-pmf009
800	PU-MET-FAST-033	pmf033	ZPPR-21A
801	HEU-MET-FAST-061	hmf061	ZPPR-21F
802	HEU-COMP-INTER-005	hci005-016	KBR-16(Zr)
803	HEU-COMP-THERM-007	hct007-2	RRCt-2
804	IEU-COMP-THERM-002	ict002-001	IPPE-MATR_22.7C
805	IEU-COMP-THERM-002	ict002-003	IPPE-MATR_16.4C_Gd
806	IEU-COMP-THERM-002	ict002-005	IPPE-MATR_14.5C_Cd
807	IEU-COMP-THERM-003	ict003-001	TRIGA
808	IEU-COMP-THERM-003	ict003-002	TRIGA
809	IEU-COMP-THERM-009	ict009-001	PBF-1
810	IEU-COMP-THERM-009	ict009-002	PBF-2
811	MIX-MET-FAST-001	mmf001	LANL_mmf001
812	MIX-MET-FAST-003	mmf003	VNIITF-CTF_mmf003
813	MIX-MET-FAST-008	mmf008-007	ZEBRA-8H
814	MIX-MET-FAST-011	mmf011-b	ZPPR-21B
815	MIX-MET-FAST-011	mmf011-c	ZPPR-21C
816	MIX-MET-FAST-011	mmf011-d	ZPPR-21D
817	MIX-MET-FAST-011	mmf011-e	ZPPR-21E
818	HEU-COMP-MIXED-002	hcm002-001	hcm002-001
819	HEU-COMP-MIXED-002	hcm002-002	hcm002-002
820	HEU-COMP-MIXED-002	hcm002-003	hcm002-003
821	HEU-COMP-MIXED-002	hcm002-004	hcm002-004
822	HEU-COMP-MIXED-002	hcm002-005	hcm002-005
823	HEU-COMP-MIXED-002	hcm002-006	hcm002-006
824	HEU-COMP-MIXED-002	hcm002-007	hcm002-007
825	HEU-COMP-MIXED-002	hcm002-008	hcm002-008
826	HEU-COMP-MIXED-002	hcm002-009	hcm002-009
827	HEU-COMP-MIXED-002	hcm002-010	hcm002-010
828	HEU-COMP-MIXED-002	hcm002-011	hcm002-011
829	HEU-COMP-MIXED-002	hcm002-012	hcm002-012
830	HEU-COMP-MIXED-002	hcm002-013	hcm002-013
831	HEU-COMP-MIXED-002	hcm002-014	hcm002-014
832	HEU-COMP-MIXED-002	hcm002-015	hcm002-015
833	HEU-COMP-MIXED-002	hcm002-016	hcm002-016
834	HEU-COMP-MIXED-002	hcm002-017	hcm002-017
835	HEU-COMP-MIXED-002	hcm002-018	hcm002-018
836	HEU-COMP-MIXED-002	hcm002-019	hcm002-019
837	HEU-COMP-MIXED-002	hcm002-020	hcm002-020
838	HEU-COMP-MIXED-002	hcm002-021	hcm002-021
839	HEU-COMP-MIXED-002	hcm002-022	hcm002-022
840	HEU-COMP-MIXED-002	hcm002-023	hcm002-023
841	HEU-COMP-INTER-005	hci005-007	KBR-07(Ni)
842	HEU-COMP-INTER-005	hci005-009	KBR-09(SS)
843	HEU-COMP-INTER-005	hci005-010	KBR-10(Mo)
844	HEU-COMP-INTER-005	hci005-015	KBR-15(Cr)
845	PU-MET-FAST-015	pmf015	BR-1-3
846	PU-MET-FAST-025	pmf025	pmf025
847	PU-MET-FAST-026	pmf026	pmf026
848	PU-MET-FAST-028	pmf028	pmf028
849	PU-MET-FAST-032	pmf032	pmf032
850	HEU-MET-FAST-020	hmf020	hmf020

851	HEU-MET-FAST-021	hmf021	VNIITF-CTF-SS-21
852	HEU-MET-FAST-022	hmf022	hmf022
853	HEU-MET-FAST-024	hmf024	VNIITF-CTF-SS-24
854	HEU-MET-FAST-026	hmf026-021	hmf026-c11
855	HEU-MET-FAST-087	hmf087	VNIITF-CTF-Fe
856	HEU-MET-FAST-088	hmf088-001	hmf088-001
857	HEU-MET-FAST-088	hmf088-002	hmf088-002
858	HEU-MET-INTER-001	hmi001	ZPR-9/34
859	HEU-MET-INTER-001	hmi001d	ZPR-9/34(detailed)
860	PU-COMP-INTER-001	pci001	pci001
861	PU-MET-INTER-002	pmi002	ZPR-6/10
862	PU-MET-INTER-003	pmi003-001s	ZPR-6/58(U)
863	PU-MET-INTER-004	pmi004-001s	ZPR-3/59(Pb)
864	MIX-COMP-FAST-001	mcf001	ZPR-6/7
865	MIX-COMP-FAST-002	mcf002-001	ZPR-6/7(Pu-240)
866	MIX-COMP-FAST-005	mcf005	ZPR-9/31
867	MIX-COMP-FAST-005	mcf005-s	ZPR-9/31
868	MIX-COMP-FAST-006	mcf006-s	ZPPR-2
869	MIX-COMP-THERM-002	mct002-001	PNL-PRCF-30
870	MIX-COMP-THERM-002	mct002-002	PNL-PRCF-31
871	MIX-COMP-THERM-002	mct002-003	PNL-PRCF-32
872	MIX-COMP-THERM-002	mct002-004	PNL-PRCF-33
873	MIX-COMP-THERM-002	mct002-005	PNL-PRCF-34
874	MIX-COMP-THERM-002	mct002-006	PNL-PRCF-35
875	LEU-MET-THERM-001	lmt001	RB-Vinca(1)
876	LEU-MET-THERM-002	lmt002-001	RB-Vinca(2-01)
877	LEU-MET-THERM-002	lmt002-002	RB-Vinca(2-02)
878	LEU-MET-THERM-002	lmt002-003	RB-Vinca(2-03)
879	LEU-MET-THERM-002	lmt002-011	RB-Vinca(2-11)
880	LEU-MET-THERM-002	lmt002-012	RB-Vinca(2-12)
881	LEU-MET-THERM-003	lmt003-001	ZED-2_1
882	LEU-MET-THERM-003	lmt003-002	ZED-2_2
883	LEU-MET-THERM-003	lmt003-003	ZED-2_3
884	LEU-MET-THERM-015	lmt015-001	RB-Vinca-01
885	LEU-MET-THERM-015	lmt015-002	RB-Vinca-02
886	LEU-MET-THERM-015	lmt015-003	RB-Vinca-03
887	LEU-MET-THERM-015	lmt015-004	RB-Vinca-04
888	LEU-MET-THERM-015	lmt015-005	RB-Vinca-05
889	LEU-MET-THERM-015	lmt015-006	RB-Vinca-06
890	LEU-MET-THERM-015	lmt015-007	RB-Vinca-07
891	LEU-MET-THERM-015	lmt015-008	RB-Vinca-08
892	LEU-MET-THERM-015	lmt015-009	RB-Vinca-09
893	LEU-MET-THERM-015	lmt015-010	RB-Vinca-10
894	LEU-MET-THERM-015	lmt015-011	RB-Vinca-11
895	LEU-MET-THERM-015	lmt015-012	RB-Vinca-12
896	LEU-MET-THERM-015	lmt015-013	RB-Vinca-13
897	LEU-MET-THERM-015	lmt015-014	RB-Vinca-14
898	LEU-MET-THERM-015	lmt015-015	RB-Vinca-15
899	LEU-MET-THERM-015	lmt015-016	RB-Vinca-16
900	LEU-MET-THERM-015	lmt015-017	RB-Vinca-17
901	LEU-MET-THERM-015	lmt015-018	RB-Vinca-18
902	LEU-MET-THERM-015	lmt015-019	RB-Vinca-19
903	LEU-MET-THERM-015	lmt015-020	RB-Vinca-20
904	LEU-MET-THERM-015	lmt015-021	RB-Vinca-21
905	LEU-MET-THERM-015	lmt015-022	RB-Vinca-22
906	LEU-MET-THERM-004	lmt004-001	ORCEF-1
907	LEU-MET-THERM-004	lmt004-002	ORCEF-2
908	LEU-MET-THERM-004	lmt004-003	ORCEF-3
909	LEU-MET-THERM-004	lmt004-004	ORCEF-4
910	LEU-MET-THERM-004	lmt004-005	ORCEF-5
911	LEU-MET-THERM-004	lmt004-006	ORCEF-6

912	LEU-MET-THERM-004	lmt004-007	ORCEF-7
913	LEU-MET-THERM-004	lmt004-008	ORCEF-8
914	LEU-MET-THERM-006	lmt006-001d	Bugey-28
915	LEU-MET-THERM-006	lmt006-002d	Bugey-27
916	LEU-MET-THERM-006	lmt006-003d	Bugey-26
917	LEU-MET-THERM-006	lmt006-004d	Bugey-10
918	LEU-MET-THERM-006	lmt006-005d	Bugey-09
919	LEU-MET-THERM-006	lmt006-006d	Bugey-13
920	LEU-MET-THERM-006	lmt006-007d	Bugey-07
921	LEU-MET-THERM-006	lmt006-008d	Bugey-06
922	LEU-MET-THERM-006	lmt006-009d	Bugey-05
923	LEU-MET-THERM-006	lmt006-010d	Bugey-12
924	LEU-MET-THERM-006	lmt006-011d	Bugey-04
925	LEU-MET-THERM-006	lmt006-012d	Bugey-16
926	LEU-MET-THERM-006	lmt006-013d	Bugey-14
927	LEU-MET-THERM-006	lmt006-014d	Bugey-20
928	LEU-MET-THERM-006	lmt006-015d	Bugey-19
929	LEU-MET-THERM-006	lmt006-016d	Bugey-18
930	LEU-MET-THERM-006	lmt006-017d	Bugey-24
931	LEU-MET-THERM-006	lmt006-018d	Bugey-23
932	LEU-MET-THERM-006	lmt006-019d	Bugey-51
933	LEU-MET-THERM-006	lmt006-020d	Bugey-50
934	LEU-MET-THERM-006	lmt006-021d	Bugey-49
935	LEU-MET-THERM-006	lmt006-022d	Bugey-46
936	LEU-MET-THERM-006	lmt006-023d	Bugey-45
937	LEU-MET-THERM-006	lmt006-024d	Bugey-44
938	LEU-MET-THERM-006	lmt006-025d	Bugey-33
939	LEU-MET-THERM-006	lmt006-026d	Bugey-32
940	LEU-MET-THERM-006	lmt006-027d	Bugey-31
941	LEU-MET-THERM-006	lmt006-028d	Bugey-30
942	LEU-MET-THERM-006	lmt006-029d	Bugey-42
943	LEU-MET-THERM-006	lmt006-030d	Bugey-43
944	LEU-MET-THERM-007	lmt007-001	ORNL_196-1602
945	LEU-MET-THERM-007	lmt007-002	ORNL_180-1440
946	LEU-MET-THERM-007	lmt007-003	ORNL_161-0907
947	LEU-MET-THERM-007	lmt007-004	ORNL_149-0955
948	LEU-MET-THERM-007	lmt007-005	ORNL_171-1400
949	LEU-MET-THERM-007	lmt007-006	ORNL_245-1115
950	HEU-MET-THERM-010	hmt010-001s	Planet_Gd_7.5mil
951	HEU-MET-THERM-010	hmt010-002s	Planet_Gd_15.mil
952	HEU-MET-THERM-011	hmt011-001	Valduc_02I
953	HEU-MET-THERM-011	hmt011-002	Valduc_02J
954	HEU-MET-THERM-011	hmt011-003	Valduc_01I
955	HEU-MET-THERM-011	hmt011-004	Valduc_01K
956	HEU-MET-THERM-011	hmt011-005	Valduc_03E
957	HEU-MET-THERM-011	hmt011-006	Valduc_04A
958	HEU-MET-THERM-011	hmt011-007	Valduc_04B
959	HEU-MET-THERM-011	hmt011-008	Valduc_04C
960	HEU-MET-THERM-011	hmt011-009	Valduc_04D
961	HEU-MET-THERM-011	hmt011-010	Valduc_06B
962	HEU-MET-THERM-011	hmt011-011	Valduc_07B
963	HEU-MET-THERM-011	hmt011-012	Valduc_07D
964	HEU-MET-THERM-011	hmt011-013	Valduc_08B
965	HEU-MET-THERM-011	hmt011-014	Valduc_09C
966	HEU-MET-THERM-011	hmt011-015	Valduc_10A
967	HEU-MET-THERM-011	hmt011-016	Valduc_11A
968	HEU-MET-THERM-011	hmt011-017	Valduc_11B
969	HEU-MET-THERM-011	hmt011-018	Valduc_12B
970	HEU-MET-THERM-011	hmt011-019	Valduc_13A
971	HEU-MET-THERM-011	hmt011-020	Valduc_14A
972	HEU-MET-THERM-011	hmt011-021	Valduc_15B

973	HEU-MET-THERM-011	hmt011-022	Valduc_16D
974	HEU-MET-THERM-011	hmt011-023	Valduc_17D
975	HEU-MET-THERM-011	hmt011-024	Valduc_17E
976	HEU-MET-THERM-011	hmt011-025	Valduc_18C
977	HEU-MET-THERM-011	hmt011-026	Valduc_18E
978	HEU-MET-THERM-011	hmt011-027	Valduc_19A
979	HEU-MET-THERM-011	hmt011-028	Valduc_19B
980	HEU-MET-THERM-011	hmt011-029	Valduc_19C
981	HEU-MET-THERM-011	hmt011-030	Valduc_19E
982	HEU-MET-THERM-011	hmt011-031	Valduc_20C
983	HEU-MET-THERM-011	hmt011-032	Valduc_20D
984	HEU-MET-THERM-011	hmt011-033	Valduc_20E
985	HEU-MET-THERM-011	hmt011-034	Valduc_21B
986	HEU-MET-THERM-011	hmt011-035	Valduc_22G
987	HEU-MET-THERM-011	hmt011-036	Valduc_22H
988	HEU-MET-THERM-011	hmt011-037	Valduc_23C
989	HEU-MET-THERM-011	hmt011-038	Valduc_24B
990	HEU-MET-THERM-011	hmt011-039	Valduc_24D
991	HEU-MET-THERM-011	hmt011-040	Valduc_25D
992	HEU-MET-THERM-011	hmt011-041	Valduc_26B
993	HEU-MET-THERM-011	hmt011-042	Valduc_27B
994	HEU-MET-THERM-011	hmt011-043	Valduc_27C
995	HEU-MET-THERM-012	hmt012-001s	hmt012-001s
996	HEU-MET-THERM-013	hmt013-001	hmt013-001
997	HEU-MET-THERM-013	hmt013-002	hmt013-002
998	HEU-MET-THERM-014	hmt014-001s	Planet_SiO2_Poly
999	HEU-MET-THERM-015	hmt015	hmt015
1000	HEU-MET-THERM-031	hmt031-001s	Planet_Poly
1001	HEU-MET-FAST-072	hmf072-1	ZEUS_Fe/Cu-1
1002	HEU-MET-FAST-072	hmf072-3	ZEUS_Fe/Cu-3
1003	HEU-MET-FAST-073	hmf073	ZEUS/Cu

A.3 Results for the full suite of the criticality benchmarks at the IAEA

	Name	Benchmark value	ENDF/B-VII.1	JEFF-3.3	ENDF/B-VIII.0
1	Godiva	1.00000(0100)	0.99972(07)	1.00017(08)	1.00016(08)
2	Flattop-25	1.00000(0300)	1.00283(04)	1.00413(04)	1.00085(04)
3	Big Ten	1.00490(0080)	1.00428(05)	1.00481(09)	1.00419(08)
4	Big_Ten(d)	1.00450(0070)	1.00442(08)	1.00497(07)	1.00442(07)
5	Jezebel (v2)	1.00000(0110)	0.99986(06)	0.99920(06)	0.99985(06)
6	Jezebel-240	1.00000(0200)	1.00005(06)	1.00130(06)	1.00144(06)
7	Flattop-Pu	1.00000(0300)	1.00097(08)	1.00347(08)	0.99962(08)
8	Jezebel-23	1.00000(0100)	0.99985(06)	1.00114(06)	1.00026(06)
9	Flattop-23	1.00000(0140)	0.99869(18)	1.00322(17)	0.99998(17)
10	Jezebel-1d	0.99999(0129)	1.00067(02)	1.00009(08)	1.00045(08)
11	Jezebel-2d	1.00016(0129)	1.00132(08)	1.00065(08)	1.00097(08)
12	Jezebel-3d	1.00020(0129)	1.00086(08)	1.00018(08)	1.00072(08)
13	Jezebel-4d	1.00128(0129)	1.00205(08)	1.00119(08)	1.00178(08)
14	Russian Pu bare	1.00000(0210)	0.99853(08)	0.99771(08)	0.99797(09)
15	Topsy-1	1.00000(0300)	1.00154(23)	1.00324(17)	0.99961(17)
16	Topsy-2	1.00000(0300)	1.00216(07)	1.00337(12)	1.00029(13)
17	Topsy-3	1.00000(0300)	1.00034(20)	1.00207(16)	0.99824(16)
18	Topsy-4	1.00000(0300)	0.99979(18)	1.00131(17)	0.99771(18)
19	Topsy-5	1.00000(0300)	0.99982(13)	1.00135(16)	0.99820(16)
20	Topsy-6	1.00000(0300)	1.00151(17)	1.00268(16)	0.99946(17)
21	Jemima-1d	0.99880(0090)	1.00018(12)	1.00004(09)	0.99912(09)
22	Jemima-2d	0.99880(0090)	1.00073(12)	1.00020(09)	0.99929(09)
23	Jemima-3d	0.99900(0030)	1.00079(12)	0.99952(09)	0.99827(09)
24	Jemima-4d	0.99900(0030)	1.00122(12)	1.00032(09)	0.99945(09)
25	Jemima-1	0.99890(0090)	1.00039(09)	1.00006(08)	0.99918(09)
26	Jemima-2	0.99970(0090)	1.00067(09)	1.00035(09)	0.99933(09)
27	Jemima-3	0.99930(0030)	1.00123(09)	1.00014(05)	0.99886(05)
28	Jemima-4	1.00020(0030)	1.00145(09)	1.00045(06)	0.99942(06)
29	LANL-pmf010	1.00000(0180)	0.99957(09)	1.00032(09)	0.99775(09)
30	LANL-pmf011	1.00000(0100)	1.00023(11)	1.00011(10)	1.00070(10)
31	IPPE-pmf012	1.00090(0210)	1.00505(14)	1.00797(14)	1.00443(14)
32	Rocky_Flats-pmf16	0.99740(0420)	1.01580(17)	1.01634(17)	1.01852(17)
33	Rocky_Flats-pmf16	1.00000(0380)	1.00417(18)	1.00431(18)	1.00680(18)
34	Rocky_Flats-pmf16	1.00000(0330)	1.00242(17)	1.00268(17)	1.00510(17)
35	Rocky_Flats-pmf16	1.00000(0300)	1.00118(17)	1.00127(17)	1.00457(18)
36	Rocky_Flats-pmf16	1.00000(0340)	1.00088(17)	1.00144(18)	1.00424(19)
37	Rocky_Flats-pmf16	1.00000(0320)	1.00393(18)	1.00412(18)	1.00659(17)
38	pmf018	1.00000(0300)	0.99941(09)	0.99830(09)	0.99793(09)
39	pmf019	0.99920(0150)	1.00082(10)	1.00005(09)	0.99958(09)
40	pmf020	0.99930(0170)	0.99817(13)	0.99918(13)	0.99643(13)
41	pmf021-1	1.00000(0260)	1.00463(09)	1.00407(09)	1.00368(09)
42	pmf021-2	1.00000(0260)	0.99330(09)	0.99302(09)	0.99256(09)
43	pmf023	1.00000(0220)	0.99990(09)	0.99931(09)	0.99927(09)
44	pmf024	1.00000(0220)	1.00198(09)	1.00151(09)	1.00133(09)
45	pmf027d	1.00000(0220)	1.00340(15)	1.00417(16)	1.00343(15)
46	pmf029	1.00000(0200)	0.99552(11)	0.99565(12)	0.99603(11)
47	VNIIEF_Pu9(a,88%)	1.00000(0210)	1.00469(14)	1.00552(14)	1.00513(14)
48	pmf041	1.00000(0160)	1.00509(17)	1.00818(16)	1.00431(16)
49	pmf044-Be/PE	0.99770(0210)	1.00015(10)	1.00010(10)	1.00039(10)
50	pmf044-Gr./PE	0.99800(0220)	0.99553(10)	0.99462(10)	0.99762(10)
51	pmf044-Al/PE	0.99770(0210)	0.99499(10)	0.99422(10)	0.99455(10)
52	pmf044-Fe/PE	0.99780(0260)	0.99568(10)	0.99564(10)	0.99599(10)
53	pmf044-Mo/PE	0.99770(0240)	0.99489(10)	0.99453(10)	0.99486(10)
54	LLNL_Pu_Buttons-1	1.00000(0300)	1.00141(09)	1.00169(09)	1.00153(09)
55	LLNL_Pu_Buttons-2	1.00000(0300)	0.99596(09)	0.99629(09)	0.99610(09)
56	LLNL_Pu_Buttons-3	1.00000(0300)	0.99602(09)	0.99684(09)	0.99620(09)
57	LLNL_Pu_Buttons-4	1.00000(0300)	0.99716(10)	0.99851(10)	0.99760(10)
58	LLNL_Pu_Buttons-5	1.00000(0300)	0.99845(09)	0.99860(09)	0.99848(09)
59	ZPR-3/53	0.97570(0230)	0.98189(20)	0.98215(19)	0.97986(20)
60	BFS-35-1(Case 1)	0.97360(0710)	0.96577(07)	0.97224(07)	0.97090(07)
61	BFS-35-2(Case 2)	1.00500(0570)	0.99363(07)	1.00003(07)	0.99872(07)
62	BFS-35-3(Case 3)	0.99590(0590)	0.98566(07)	0.99247(07)	0.99083(07)
63	BFS-31-4(Case 9)	1.01880(0720)	1.00624(08)	1.01418(07)	1.00970(07)
64	BFS-31-5(Case 10)	0.97320(0640)	0.96899(05)	0.97623(07)	0.97220(07)

65	BFS-42(Case 11)	1.01530(0740)	1.01100(05)	1.01579(08)	1.01327(08)
66	BFS-49/1A	1.00050(0210)	0.99502(11)	1.00145(11)	0.99613(11)
67	ZPR-6/6A	0.99390(0230)	0.99283(36)	0.99731(16)	0.99190(15)
68	Comet-Cu/2in	0.99980(0290)	0.99998(09)	1.00122(09)	0.99453(08)
69	Comet-Cu/4in	0.99970(0310)	1.00425(09)	1.00505(09)	0.99699(09)
70	Comet-Fe/4in	0.99950(0460)	0.99614(09)	0.99461(09)	0.99883(09)
71	Comet-NiCuZn/2in	0.99960(0290)	0.99990(09)	1.00264(09)	0.99506(09)
72	Comet-UH3.1	1.00000(0570)	1.00489(11)	1.01125(14)	1.00664(14)
73	Comet-UH3.4	1.00000(0550)	1.00417(14)	1.00986(14)	1.00845(14)
74	Comet-UH3.6	1.00000(0470)	0.99567(15)	1.00172(13)	0.99844(15)
75	Comet-UH3.7	1.00000(0500)	0.99712(16)	1.00288(15)	1.00005(14)
76	Pajarito	1.00000(0300)	0.99884(08)	0.99637(08)	0.99601(08)
77	Topsy-U_2.0in	1.00000(0500)	0.99496(07)	0.99562(12)	0.99275(12)
78	Topsy-U_3.0in	1.00000(0500)	0.99455(07)	0.99512(12)	0.99224(11)
79	Topsy-U_4.0in	1.00000(0500)	0.99926(07)	1.00007(12)	0.99701(11)
80	Topsy-U_5.0in	1.00000(0300)	0.99725(26)	0.99824(12)	0.99488(12)
81	Topsy-U_7.0in	1.00000(0300)	1.00149(13)	1.00300(12)	0.99918(12)
82	Topsy-U_8.0in	1.00000(0300)	1.00160(13)	1.00313(12)	0.99965(12)
83	Topsy-U_11.in	1.00000(0300)	1.00196(13)	1.00371(12)	1.00050(12)
84	hmf007-01	0.99500(0240)	0.99293(09)	0.99286(09)	0.99297(09)
85	hmf007-02	0.99640(0140)	0.99867(09)	0.99743(09)	0.99875(09)
86	hmf007-03	0.99900(0130)	1.00009(10)	0.99937(09)	1.00027(09)
87	hmf007-04	0.99480(0130)	0.99844(10)	0.99716(09)	0.99859(09)
88	hmf007-05	0.99780(0180)	1.00028(10)	0.99921(10)	1.00074(10)
89	hmf007-06	1.00060(0130)	1.00559(10)	1.00511(10)	1.00587(11)
90	hmf007-07	0.99740(0140)	1.00161(10)	1.00078(10)	1.00239(10)
91	hmf007-08	0.99730(0130)	0.99949(10)	0.99855(10)	1.00029(10)
92	hmf007-09	0.99950(0560)	1.00327(10)	1.00283(10)	1.00404(10)
93	hmf007-10	0.99810(0120)	0.99919(11)	0.99985(11)	0.99987(11)
94	hmf007-11	0.99580(0130)	0.99763(12)	0.99963(12)	0.99844(12)
95	hmf007-12	0.99320(0120)	0.99274(12)	0.99504(11)	0.99385(12)
96	hmf007-13	0.99900(0120)	1.00005(12)	1.00073(12)	0.99912(12)
97	hmf007-14	0.99640(0120)	0.99677(12)	0.99904(12)	0.99744(12)
98	hmf007-15	0.99590(0120)	0.99663(12)	0.99733(12)	0.99621(12)
99	hmf007-16	0.99690(0120)	0.99749(12)	0.99808(12)	0.99667(12)
100	hmf007-17	0.99530(0120)	0.99587(13)	0.99782(13)	0.99515(13)
101	hmf007-18	0.99720(0120)	0.99836(13)	1.00031(12)	0.99759(12)
102	hmf007-19	0.99560(0150)	0.99681(09)	0.99669(09)	0.99692(08)
103	hmf007-20	0.99500(0170)	0.99826(10)	0.99770(10)	0.99852(10)
104	hmf007-21	0.99560(0180)	0.99901(10)	0.99821(10)	0.99912(10)
105	hmf007-22	0.99630(0190)	0.99947(10)	0.99915(10)	1.00001(10)
106	hmf007-23	0.99620(0262)	0.99924(11)	0.99901(11)	0.99894(11)
107	hmf007-24	0.99700(0180)	0.99969(11)	0.99937(11)	0.99960(11)
108	hmf007-25	0.99590(0180)	0.99847(11)	0.99850(11)	0.99792(11)
109	hmf007-26	0.99660(0170)	0.99885(11)	0.99836(11)	0.99832(11)
110	hmf007-35	1.00030(0180)	1.00225(12)	1.00095(11)	1.00086(11)
111	hmf007-36	0.99990(0070)	1.00329(12)	1.00243(11)	1.00260(11)
112	hmf007-37	0.99880(0080)	1.00151(11)	1.00146(12)	1.00151(11)
113	hmf007-38	1.00000(0080)	1.00275(12)	1.00285(12)	1.00303(11)
114	hmf007-39	1.00180(0140)	1.00495(12)	1.00505(11)	1.00513(11)
115	hmf007-40	1.00130(0080)	1.00605(11)	1.00576(12)	1.00595(11)
116	hmf007-41	0.99940(0090)	1.00080(12)	1.00197(11)	1.00061(12)
117	hmf007-42	1.00160(0090)	1.00278(12)	1.00410(12)	1.00287(12)
118	hmf007-43	0.99980(0080)	1.00064(13)	1.00300(13)	0.99970(12)
119	VNIITF-CTF-bare	0.99890(0160)	0.99578(11)	0.99594(11)	0.99555(11)
120	VNIITF-CTF-009-1	0.99920(0150)	0.99768(09)	0.99622(09)	0.99622(09)
121	VNIITF-CTF-009-2	0.99920(0150)	0.99664(09)	0.99497(09)	0.99526(09)
122	VNIITF-CTF-011	0.99890(0150)	0.99879(11)	0.99796(11)	0.99754(11)
123	VNIITF-CTF-012	0.99920(0180)	0.99822(08)	0.99826(09)	0.99799(09)
124	VNIITF-CTF-SS-13	0.99900(0150)	0.99736(11)	0.99583(11)	0.99873(11)
125	VNIITF-CTF-DU	0.99890(0170)	0.99788(09)	0.99821(08)	0.99536(09)
126	VNIITF-CTF-UnrCy1	0.99960(0170)	0.99443(12)	0.99445(12)	0.99481(13)
127	VNIITF-CTF-UnrCy2	0.99950(0130)	0.99828(13)	0.99838(12)	0.99880(12)
128	TU1-3.93in	1.00000(0160)	1.00423(09)	1.00476(09)	1.00178(09)
129	TU1-3.52in	1.00000(0270)	1.00462(07)	1.00543(09)	1.00229(09)
130	TU1-1.742in	1.00000(0170)	1.00024(09)	1.00080(09)	0.99828(09)
131	TU1-0.683in	1.00000(0170)	1.00087(06)	1.00155(09)	0.99988(09)
132	ZPR-3/23	0.99550(0280)	0.99809(08)	0.99898(09)	0.99723(08)

133	VNIIEF-CTF-3	1.00000(0170)	1.00242(09)	1.00126(09)	0.99992(09)
134	VNIIEF-CTF-4	1.00000(0300)	1.00752(09)	1.00532(09)	1.00524(09)
135	VNIIEF-CTF-5	1.00000(0210)	1.00185(11)	1.00002(12)	1.00107(11)
136	VNIIEF-CTF-5s	1.00000(0230)	1.00180(09)	0.99981(09)	1.00104(09)
137	VNIIEF-CTF-6	1.00000(0230)	0.99608(11)	0.99371(11)	0.99402(11)
138	VNIIEF-CTF-6s	1.00000(0230)	0.99637(09)	0.99380(09)	0.99405(09)
139	ZPR-6/9(U9)	0.99540(0240)	0.99538(09)	0.99745(09)	0.99558(09)
140	ZPR-3/6F	0.99560(0150)	0.99907(09)	0.99998(08)	0.99734(09)
141	ZPR-3/11	0.99740(0160)	0.99634(08)	0.99694(07)	0.99548(07)
142	PNL_2.032p-1	0.99980(0310)	0.99946(12)	0.99990(12)	0.99984(12)
143	PNL_2.032p-2	0.99980(0310)	0.99888(12)	0.99901(12)	0.99888(12)
144	PNL_2.032p-3	0.99980(0310)	0.99853(12)	0.99842(12)	0.99870(12)
145	PNL_2.032p-4	0.99980(0310)	0.99899(12)	0.99915(12)	0.99923(12)
146	PNL_2.032p-5	0.99980(0310)	0.99697(12)	0.99655(12)	0.99711(12)
147	PNL_2.032p-6	0.99980(0310)	0.99895(11)	0.99879(12)	0.99934(12)
148	PNL_2.032p-7	0.99980(0310)	0.99833(11)	0.99775(12)	0.99841(12)
149	PNL_2.032p-8	0.99980(0310)	0.99730(12)	0.99694(12)	0.99760(12)
150	PNL_2.54p-1	0.99970(0200)	0.99826(14)	0.99893(14)	0.99863(14)
151	PNL_2.54p-2	0.99970(0200)	0.99971(14)	0.99987(14)	0.99980(14)
152	PNL_2.54p-3	0.99970(0200)	0.99930(14)	0.99916(13)	0.99941(14)
153	PNL_2.54p-4	0.99970(0200)	0.99890(13)	0.99823(13)	0.99900(13)
154	PNL_2.54p-5	0.99970(0200)	0.99721(13)	0.99652(13)	0.99757(13)
155	PNL_1.64p-1	1.00000(0390)	0.99017(08)	0.99077(12)	0.99010(08)
156	PNL_1.64p-2	1.00000(0390)	0.99027(08)	0.99132(12)	0.99004(08)
157	PNL_1.64p-3	1.00000(0390)	0.99091(08)	0.99215(12)	0.99065(08)
158	PNL_1.64p-4	1.00000(0390)	0.99106(08)	0.99202(12)	0.99067(08)
159	PNL_1.64p-5	1.00000(0390)	0.99093(08)	0.99173(12)	0.99069(08)
160	PNL_1.64p-6	1.00000(0390)	0.98811(08)	0.98864(11)	0.98796(08)
161	PNL_1.64p-7	1.00000(0390)	0.99032(08)	0.99153(12)	0.99045(08)
162	PNL_1.64p-8	1.00000(0390)	0.99246(11)	0.99289(12)	0.99231(12)
163	PNL_1.64p-9	1.00000(0390)	0.98559(12)	0.98563(12)	0.98569(12)
164	PNL_1.64p-14	1.00000(0390)	0.98788(12)	0.98787(12)	0.98794(11)
165	PNL_1.64p-15	1.00000(0390)	0.98847(12)	0.98818(12)	0.98808(11)
166	PNL_1.64p-16	1.00000(0390)	0.98808(12)	0.98758(11)	0.98780(11)
167	PNL_1.64p-17	1.00000(0390)	0.98746(12)	0.98728(12)	0.98741(12)
168	PNL_1.64p-18	1.00000(0390)	0.98728(11)	0.98693(11)	0.98728(11)
169	PNL_1.64p-19	1.00000(0390)	0.98785(12)	0.98792(11)	0.98805(11)
170	PNL_1.64p-20	1.00000(0390)	0.98862(12)	0.98895(12)	0.98837(11)
171	PNL_1.64p-20	1.00000(0390)	0.98681(12)	0.98690(11)	0.98675(12)
172	PNL_1.64p-22	1.00000(0390)	0.99798(11)	0.99767(12)	0.99753(12)
173	PNL_2.398p_Gd0	1.00000(0230)	1.00259(08)	1.00317(08)	1.00249(08)
174	PNL_2.398p_Gd0.06	1.00000(0210)	0.99982(11)	1.00111(11)	0.99928(11)
175	PNL_2.398p_Gd0.43	1.00000(0290)	0.99884(11)	1.00288(11)	0.99904(11)
176	PNL_2.398p_Gd0.48	1.00000(0250)	0.99741(11)	1.00150(10)	0.99778(11)
177	PNL_1.801p_Gd0	1.00000(0470)	1.00500(08)	1.00609(08)	1.00302(08)
178	PNL_1.801p_Gd0.12	1.00000(0420)	1.00501(11)	1.00766(11)	1.00305(11)
179	PNL_1.801p_Gd0.40	1.00000(0430)	1.00150(11)	1.00549(11)	0.99920(11)
180	PNL_1.801p_Gd0.90	1.00000(0210)	1.00143(11)	1.00749(11)	0.99990(11)
181	PNL_1.801p_Gd1.24	1.00000(0400)	1.00194(10)	1.00870(11)	1.00046(11)
182	PNL_1.801p_Gd1.44	1.00000(0280)	1.00114(11)	1.00789(10)	0.99987(11)
183	PNL_1.801p_Gd1.48	1.00000(0430)	1.00175(10)	1.00877(11)	1.00044(11)
184	PNL_1.598p_Gd0	1.00000(0660)	1.00633(07)	1.00873(07)	1.00370(07)
185	PNL_1.598p_Gd0.12	1.00000(0640)	1.01220(10)	1.01540(11)	1.00926(11)
186	TCA-1.50U-01	1.00000(0200)	1.00027(14)	1.00105(14)	0.99923(13)
187	TCA-1.50U-02	1.00000(0200)	1.00062(13)	1.00160(14)	0.99979(14)
188	TCA-1.50U-03	1.00000(0200)	1.00030(13)	1.00150(14)	0.99948(13)
189	TCA-1.83U-04	1.00000(0200)	1.00015(12)	1.00068(13)	0.99950(13)
190	TCA-1.83U-05	1.00000(0200)	0.99974(12)	1.00080(13)	0.99911(13)
191	TCA-1.83U-06	1.00000(0200)	1.00030(13)	1.00116(14)	0.99972(13)
192	TCA-1.83U-07	1.00000(0200)	0.99997(14)	1.00132(14)	0.99950(14)
193	TCA-1.83U-08	1.00000(0200)	1.00004(14)	1.00104(13)	0.99935(14)
194	TCA-2.48U-09	1.00000(0200)	0.99996(13)	1.00090(13)	0.99959(13)
195	TCA-2.48U-10	1.00000(0200)	0.99959(13)	1.00027(13)	0.99983(13)
196	TCA-2.48U-11	1.00000(0200)	0.99973(13)	1.00063(13)	0.99991(13)
197	TCA-2.48U-12	1.00000(0200)	0.99958(13)	1.00060(14)	0.99954(13)
198	TCA-2.48U-13	1.00000(0200)	0.99946(13)	1.00042(13)	0.99905(13)
199	TCA-3.00U-14	1.00000(0200)	1.00000(13)	1.00021(12)	0.99975(13)
200	TCA-3.00U-15	1.00000(0200)	0.99965(13)	1.00028(12)	0.99935(13)

201	TCA-3.00U-16	1.00000(0200)	0.99941(13)	1.00037(13)	0.99961(12)
202	TCA-3.00U-17	1.00000(0200)	0.99951(13)	1.00030(13)	0.99946(13)
203	TCA-3.00U-18	1.00000(0200)	0.99928(14)	1.00007(13)	0.99929(12)
204	Valduc-sq-1.26p	1.00000(0140)	0.99750(08)	0.99837(08)	0.99665(08)
205	Valduc-sq-1.60p	1.00000(0080)	0.99876(08)	0.99956(08)	0.99893(08)
206	Valduc-sq-2.10p	1.00000(0070)	0.99763(07)	0.99762(07)	0.99790(07)
207	Valduc-sq-2.52p	1.00000(0080)	0.99800(06)	0.99698(06)	0.99858(06)
208	Valduc-tr-1.35p	1.00000(0140)	0.99706(12)	0.99835(12)	0.99576(11)
209	Valduc-tr-1.72p	1.00000(0080)	0.99890(11)	0.99968(11)	0.99885(11)
210	Valduc-tr-2.26p	1.00000(0070)	0.99841(10)	0.99843(10)	0.99869(10)
211	Valduc-tr-1.35p	1.00000(0140)	0.99822(11)	0.99923(12)	0.99728(12)
212	Valduc-tr-1.72p	1.00000(0080)	0.99814(11)	0.99928(11)	0.99809(11)
213	Valduc-tr-2.26p	1.00000(0070)	0.99846(10)	0.99875(10)	0.99871(10)
214	BW-XI-1	1.00070(0120)	1.00056(09)	1.00220(10)	1.00048(09)
215	BW-XI-2	1.00070(0120)	1.00067(09)	1.00193(09)	1.00084(09)
216	BW-XI-3	1.00070(0120)	1.00118(09)	1.00260(09)	1.00142(09)
217	BW-XI-4	1.00070(0120)	1.00076(09)	1.00198(09)	1.00051(09)
218	BW-XI-5	1.00070(0120)	1.00057(09)	1.00147(09)	1.00035(09)
219	BW-XI-6	1.00070(0120)	1.00093(09)	1.00179(09)	1.00057(09)
220	BW-XI-7	1.00070(0120)	1.00030(09)	1.00131(09)	0.99987(09)
221	BW-XI-8	1.00070(0120)	0.99995(10)	1.00082(10)	0.99927(09)
222	BW-XI-9	1.00070(0120)	1.00028(09)	1.00133(09)	0.99970(10)
223	BW-XI-10	1.00070(0120)	1.00047(09)	1.00163(09)	1.00026(09)
224	BW-XI-11	1.00070(0120)	1.00139(09)	1.00275(10)	1.00129(09)
225	BW-XI-12	1.00070(0120)	1.00085(09)	1.00198(09)	1.00100(09)
226	BW-XI-13	1.00070(0120)	1.00083(09)	1.00204(09)	1.00106(09)
227	BW-XI-14	1.00070(0120)	1.00045(09)	1.00179(10)	1.00090(09)
228	BW-XI-15	1.00070(0120)	1.00044(09)	1.00177(09)	1.00060(09)
229	PNL_2.54p_SSnoB	1.00000(0210)	0.99911(10)	0.99866(11)	0.99917(10)
230	PNL_2.54p_SSnoB	1.00000(0210)	0.99910(10)	0.99846(11)	0.99884(11)
231	PNL_2.54p_SSnoB	1.00000(0210)	0.99842(11)	0.99767(10)	0.99860(11)
232	PNL_2.54p_SSnoB	1.00000(0210)	0.99903(11)	0.99862(10)	0.99899(10)
233	PNL_2.54p_SS1.6B	1.00000(0210)	0.99972(11)	0.99948(10)	0.99953(10)
234	PNL_2.54p_SS1.6B	1.00000(0210)	0.99876(10)	0.99893(11)	0.99885(10)
235	PNL_2.54p_SS1.6B	1.00000(0210)	0.99977(10)	0.99956(11)	0.99960(11)
236	PNL_2.54p_SS1.6B	1.00000(0210)	0.99896(10)	0.99878(11)	0.99862(10)
237	PNL_2.54p_CuNoCd	1.00000(0210)	0.99882(10)	0.99852(10)	0.99890(11)
238	PNL_2.54p_CuNoCd	1.00000(0210)	0.99890(11)	0.99869(10)	0.99910(11)
239	PNL_2.54p_CuNoCd	1.00000(0210)	0.99928(11)	0.99880(10)	0.99928(10)
240	PNL_2.54p_Cu1.0Cd	1.00000(0210)	0.99960(11)	0.99947(11)	0.99967(10)
241	PNL_2.54p_Cd	1.00000(0210)	0.99897(10)	0.99867(11)	0.99877(10)
242	PNL_2.54p_Cd	1.00000(0210)	0.99990(11)	0.99965(11)	0.99961(11)
243	PNL_2.54p_Cd	1.00000(0210)	0.99850(11)	0.99846(11)	0.99865(10)
244	PNL_2.54p_Cd	1.00000(0210)	0.99972(11)	0.99916(11)	0.99962(10)
245	PNL_2.54p_Cd	1.00000(0210)	0.99905(11)	0.99883(10)	0.99860(11)
246	PNL_2.54p_Cd	1.00000(0210)	0.99955(11)	0.99928(10)	0.99949(10)
247	PNL_2.54p_Cd	1.00000(0210)	0.99925(10)	0.99890(10)	0.99891(10)
248	PNL_2.54p_Cd	1.00000(0210)	1.00001(11)	0.99978(10)	0.99989(10)
249	PNL_2.54p_Al	1.00000(0210)	0.99866(10)	0.99840(10)	0.99895(11)
250	PNL_2.54p_Al	1.00000(0210)	0.99904(11)	0.99858(10)	0.99919(11)
251	PNL_2.54p_Zr	1.00000(0210)	0.99781(54)	0.99911(53)	0.99848(49)
252	lct009-27	1.00000(0210)	0.99992(52)	0.99807(53)	0.99883(49)
253	PNL_2.54p_Pb-1	1.00000(0210)	1.00479(14)	1.00850(13)	1.00504(13)
254	PNL_2.54p_Pb-2	1.00000(0210)	1.00527(13)	1.00835(14)	1.00518(14)
255	PNL_2.54p_Pb-3	1.00000(0210)	1.00425(13)	1.00631(13)	1.00435(14)
256	PNL_2.54p_Pb-4	1.00000(0210)	0.99691(13)	0.99644(13)	0.99660(13)
257	PNL_2.54p_DU-1	1.00000(0210)	0.99952(13)	1.00015(13)	0.99906(13)
258	PNL_2.54p_DU-2	1.00000(0210)	1.00019(13)	1.00024(13)	1.00000(13)
259	PNL_2.54p_DU-3	1.00000(0210)	1.00134(13)	1.00113(13)	1.00096(12)
260	PNL_2.54p_DU-4	1.00000(0210)	0.99801(13)	0.99717(13)	0.99772(13)
261	PNL_2.54p_SS-1	1.00000(0210)	0.99984(13)	1.00067(14)	1.00022(13)
262	PNL_2.54p_SS-2	1.00000(0210)	0.99998(13)	1.00083(14)	0.99996(14)
263	PNL_2.54p_SS-3	1.00000(0210)	1.00035(13)	1.00087(13)	1.00049(13)
264	PNL_2.54p_SS-4	1.00000(0210)	0.99982(14)	0.99997(14)	0.99966(14)
265	PNL_2.54p_SS-5	1.00000(0210)	0.99778(13)	0.99696(13)	0.99786(13)
266	PNL_1.892p_SS-6	1.00000(0280)	1.00203(14)	1.00256(14)	1.00113(13)
267	PNL_1.892p_SS-7	1.00000(0280)	1.00254(14)	1.00296(14)	1.00167(14)
268	PNL_1.892p_SS-8	1.00000(0280)	1.00351(14)	1.00366(15)	1.00207(14)

269	PNL_1.892p_SS-9	1.00000(0280)	1.00245(14)	1.00273(14)	1.00170(15)
270	PNL_1.892p_SS-10	1.00000(0280)	1.00253(14)	1.00260(14)	1.00134(15)
271	PNL_1.892p_SS-11	1.00000(0280)	1.00225(14)	1.00243(14)	1.00108(14)
272	PNL_1.892p_Pb-5	1.00000(0280)	1.00387(13)	1.00655(13)	1.00272(14)
273	PNL_1.892p_Pb-6	1.00000(0280)	1.00413(13)	1.00656(14)	1.00298(14)
274	PNL_1.892p_Pb-7	1.00000(0280)	1.00377(15)	1.00534(14)	1.00260(14)
275	PNL_1.892p_Pb-8	1.00000(0280)	1.00208(14)	1.00265(14)	1.00103(14)
276	PNL_1.892p_DU-5	1.00000(0280)	1.00032(14)	1.00080(14)	0.99871(14)
277	PNL_1.892p_DU-6	1.00000(0280)	1.00171(14)	1.00231(13)	1.00051(14)
278	PNL_1.892p_DU-7	1.00000(0280)	1.00237(14)	1.00261(13)	1.00083(13)
279	PNL_1.892p_DU-8	1.00000(0280)	1.00249(13)	1.00285(14)	1.00110(13)
280	PNL_1.892p_DU-9	1.00000(0280)	1.00264(13)	1.00304(13)	1.00127(13)
281	PNL_1.892p_DU-10	1.00000(0280)	1.00274(14)	1.00301(14)	1.00134(13)
282	PNL_1.892p_DU-11	1.00000(0280)	1.00101(14)	1.00098(14)	0.99998(14)
283	BW_CX-10-II(2)	1.00090(0320)	0.99839(10)	1.00007(09)	0.99822(10)
284	BW_CX-10-IIIA(3)	1.00090(0320)	0.99791(09)	0.99852(09)	0.99802(10)
285	BW_CX-10-IIIB(4)	1.00090(0320)	0.99845(09)	0.99894(10)	0.99843(09)
286	BW_CX-10-IIIC(5)	1.00090(0320)	0.99834(09)	0.99863(10)	0.99804(10)
287	BW_CX-10-IIID(6)	1.00090(0320)	0.99816(10)	0.99876(09)	0.99816(09)
288	BW_CX-10-IIIE(7)	1.00090(0320)	0.99827(09)	0.99889(10)	0.99813(10)
289	BW_CX-10-IIIF(8)	1.00090(0320)	0.99838(10)	0.99885(10)	0.99858(10)
290	BW_CX-10-IIIG(9)	1.00090(0320)	0.99810(10)	0.99878(10)	0.99832(10)
291	BW_CX-10-IX(15)	1.00100(0180)	0.99632(09)	0.99339(09)	0.99650(09)
292	RRC-KI-0.70p(22)	1.00000(0470)	1.00252(11)	1.00357(11)	1.00182(11)
293	RRC-KI-0.80p(22)	1.00000(0460)	1.00720(11)	1.00751(12)	1.00699(11)
294	RRC-KI-1.00p(22)	1.00000(0360)	1.00751(12)	1.00736(12)	1.00777(11)
295	RRC-KI-1.22p(22)	1.00000(0370)	1.00799(11)	1.00826(10)	1.00856(11)
296	RRC-KI-1.40p(22)	1.00000(0380)	1.00328(10)	1.00350(10)	1.00398(10)
297	RRC-KI-1.83p(22)	1.00000(0460)	1.00144(09)	1.00078(09)	1.00192(09)
298	RRC-KI-1.85p(22)	1.00000(0460)	1.00386(09)	1.00310(09)	1.00425(09)
299	RRC-KI-0.62p(24)	1.00000(0540)	1.00123(12)	1.00203(11)	0.99998(11)
300	RRC-KI-0.88p(24)	1.00000(0400)	1.00882(11)	1.00806(11)	1.00885(11)
301	RRC-KI-0.70p(25)	1.00000(0410)	0.98826(11)	0.98890(11)	0.98792(11)
302	RRC-KI-0.80p(25)	1.00000(0440)	0.99583(11)	0.99588(11)	0.99591(11)
303	RRC-KI-1.00p(25)	1.00000(0470)	1.00040(10)	1.00032(11)	1.00112(11)
304	RRC-KI-1.22p(25)	1.00000(0520)	1.00250(10)	1.00245(10)	1.00331(10)
305	PNL_2.286p_B0	0.99980(0470)	0.99785(10)	0.99836(10)	0.99753(10)
306	PNL_2.286p_B.2307	1.00010(0540)	0.99929(10)	1.00026(10)	0.99861(10)
307	PNL_2.286p_B.4514	0.99990(0510)	0.99900(11)	1.00003(11)	0.99834(10)
308	PNL_2.286p_B.6053	1.00000(0430)	1.00118(10)	1.00267(10)	1.00075(10)
309	PNL_2.286p_Cd0.42	1.00020(0480)	0.99979(10)	0.99957(10)	0.99981(11)
310	PNL_2.286p_Cd1.06	1.00010(0450)	1.00093(10)	0.99993(10)	1.00081(10)
311	PNL_2.286p_Gd.072	0.99980(0470)	0.99585(10)	0.99715(10)	0.99581(11)
312	PNL_2.286p_Gd.145	0.99980(0520)	0.99409(10)	0.99626(10)	0.99400(11)
313	PNL_2.286p_Gd.213	0.99980(0470)	0.99254(11)	0.99491(10)	0.99250(10)
314	PNL_2.794p_B0	1.00040(0450)	0.99753(10)	0.99725(10)	0.99773(10)
315	PNL_2.794p_B.158	1.00020(0450)	0.99798(10)	0.99774(10)	0.99827(10)
316	PNL_2.794p_B.38	1.00000(0490)	0.99624(10)	0.99594(10)	0.99658(10)
317	PNL_2.794p_Gd.054	0.99980(0500)	0.99516(10)	0.99511(10)	0.99537(10)
318	PNL_2.794p_Gd.116	1.00010(0470)	0.99295(10)	0.99340(10)	0.99354(10)
319	PNL_3.302p_B0	0.99970(0440)	0.99779(09)	0.99614(09)	0.99824(09)
320	PNL_3.302p_B.0643	1.00000(0490)	0.99841(09)	0.99693(09)	0.99875(09)
321	PNL_3.302p_B.2154	1.00000(0470)	0.99826(09)	0.99642(09)	0.99867(09)
322	PNL_3.302p_B.1507	0.99990(0470)	0.99883(09)	0.99713(09)	0.99904(09)
323	PNL_3.302p_Gd.025	1.00020(0460)	0.99808(09)	0.99656(09)	0.99828(09)
324	PNL_3.302p_Gd.044	1.00010(0460)	0.99560(09)	0.99442(09)	0.99632(09)
325	TCA_B0.070	1.00000(0180)	1.00010(10)	1.00115(10)	0.99928(10)
326	TCA_B0.1477	1.00000(0190)	0.99902(10)	1.00025(10)	0.99864(10)
327	TCA_Gd0.0645	1.00000(0220)	0.99503(11)	0.99702(10)	0.99496(11)
328	lct042-1	1.00000(0160)	0.99814(12)	0.99869(12)	0.99787(12)
329	lct042-2	1.00000(0160)	0.99799(13)	0.99886(13)	0.99752(12)
330	PNL_1.68p-1	1.00000(0160)	0.99828(10)	0.99883(10)	0.99773(10)
331	PNL_1.68p-2	1.00000(0160)	0.99803(10)	0.99910(10)	0.99754(10)
332	PNL_1.68p-3	1.00000(0160)	0.99905(10)	1.00019(10)	0.99816(10)
333	PNL_1.68p-4	1.00000(0170)	0.99844(10)	0.99966(10)	0.99780(10)
334	PNL_1.68p-5	1.00000(0330)	0.99940(10)	1.00053(10)	0.99873(10)
335	PNL_1.68p-6	1.00000(0160)	0.99928(10)	1.00013(10)	0.99889(10)
336	PNL_2.54p-7	1.00000(0180)	0.99776(10)	0.99863(10)	0.99717(09)

337	IPEN/MB-01	1.00040(0100)	1.00080(11)	1.00091(11)	1.00053(11)
338	Valduc_hxGd0.60	1.00030(0230)	0.99220(12)	0.99707(11)	0.99161(11)
339	Valduc_hxGd0.43	1.00030(0360)	0.99194(11)	0.99609(10)	0.99226(11)
340	Valduc_hxGd0.171	1.00030(0340)	1.00050(17)	1.00101(12)	1.00025(26)
341	Valduc_cyGd0.60	1.00030(0230)	0.99610(11)	1.00103(11)	0.99557(11)
342	Valduc_cyGd0.44	1.00030(0360)	0.99084(11)	0.99454(11)	0.99111(10)
343	Valduc_cyGd0.182	1.00030(0340)	0.98960(10)	0.99040(10)	0.99020(10)
344	VVER_1.27p-01	1.00090(0280)	1.01598(13)	1.01854(13)	1.01506(13)
345	VVER_1.27p-02	1.00090(0280)	1.00690(13)	1.00963(14)	1.00665(13)
346	VVER_1.27p-03	1.00090(0280)	1.00750(13)	1.00988(13)	1.00732(13)
347	VVER_1.27p-04	1.00090(0280)	1.00696(13)	1.00895(14)	1.00673(13)
348	VVER_1.27p-05	1.00090(0280)	1.00673(12)	1.00901(12)	1.00652(13)
349	VVER_1.27p-06	1.00090(0280)	1.00667(13)	1.00867(13)	1.00608(13)
350	VVER_1.27p-07	1.00090(0280)	1.00640(13)	1.00850(13)	1.00652(13)
351	SNL-7uPCXp.855-01	0.99950(0100)	0.99820(12)	0.99898(12)	0.99680(12)
352	SNL-7uPCXp.855-02	0.99990(0100)	0.99831(12)	0.99957(12)	0.99739(12)
353	SNL-7uPCXp.855-03	0.99900(0100)	0.99755(12)	0.99848(12)	0.99650(12)
354	SNL-7uPCXp.855-04	0.99860(0100)	0.99716(12)	0.99832(12)	0.99598(12)
355	SNL-7uPCXp.855-05	0.99800(0100)	0.99667(12)	0.99772(11)	0.99549(12)
356	SNL-7uPCXp.855-06	0.99740(0100)	0.99610(11)	0.99705(12)	0.99488(12)
357	SNL-7uPCXp.855-07	0.99940(0100)	0.99771(12)	0.99899(12)	0.99694(11)
358	SNL-7uPCXp.855-08	0.99870(0100)	0.99721(12)	0.99830(12)	0.99615(12)
359	SNL-7uPCXp.855-09	0.99780(0100)	0.99626(12)	0.99727(12)	0.99510(12)
360	SNL-7uPCXp.855-10	0.99690(0100)	0.99532(12)	0.99636(12)	0.99412(12)
361	SNL-7uPCXp.855-11	0.99940(0100)	0.99788(12)	0.99878(12)	0.99677(12)
362	SNL-7uPCXp.855-12	0.99930(0100)	0.99797(12)	0.99885(12)	0.99697(12)
363	SNL-7uPCXp.855-13	0.99930(0100)	0.99787(12)	0.99866(12)	0.99676(11)
364	SNL-7uPCXp.855-14	0.99910(0100)	0.99769(12)	0.99859(12)	0.99671(12)
365	SNL-7uPCXp.855-15	0.99960(0100)	0.99856(12)	0.99949(12)	0.99761(11)
366	SNL-7uPCXp.800-01	0.99760(0100)	0.99587(12)	0.99703(11)	0.99414(12)
367	SNL-7uPCXp.800-02	0.99820(0100)	0.99651(11)	0.99752(12)	0.99492(12)
368	SNL-7uPCXp.800-03	0.99840(0100)	0.99674(11)	0.99786(12)	0.99514(12)
369	SNL-7uPCXp.800-04	0.99810(0100)	0.99629(12)	0.99748(12)	0.99493(12)
370	SNL-7uPCXp.800-05	0.99790(0100)	0.99590(11)	0.99720(11)	0.99460(11)
371	SNL-7uPCXp.800-06	0.99750(0100)	0.99540(12)	0.99681(11)	0.99415(12)
372	SNL-7uPCXp.800-07	0.99930(0100)	0.99774(12)	0.99875(12)	0.99622(11)
373	SNL-7uPCXp.800-08	0.99870(0100)	0.99703(11)	0.99829(12)	0.99576(11)
374	SNL-7uPCXp.800-09	0.99820(0100)	0.99651(11)	0.99776(12)	0.99467(12)
375	SNL-7uPCXp.800-10	0.99720(0100)	0.99585(12)	0.99676(12)	0.99417(11)
376	SNL-7uPCXp.800-11	0.99840(0100)	0.99740(12)	0.99851(12)	0.99589(12)
377	SNL-7uPCXp.800R-0	0.99985(0095)	0.99868(15)	1.00000(15)	0.99704(15)
378	SNL-7uPCXp.800R-0	0.99994(0095)	0.99898(16)	1.00026(16)	0.99711(15)
379	SNL-7uPCXp.800R-0	0.99988(0093)	0.99976(15)	1.00105(15)	0.99796(16)
380	SNL-7uPCXp.800R-0	0.99985(0095)	0.99837(15)	1.00010(15)	0.99634(15)
381	SNL-7uPCXp.800R-0	0.99987(0095)	0.99899(15)	1.00023(15)	0.99689(15)
382	SNL-7uPCXp.800R-0	0.99981(0092)	0.99862(15)	1.00004(15)	0.99647(14)
383	SNL-7uPCXp.800R-0	0.99986(0092)	0.99832(15)	0.99995(15)	0.99631(16)
384	SNL-7uPCXp.800R-0	0.99987(0092)	0.99812(15)	0.99929(15)	0.99620(15)
385	SNL-7uPCXp.800R-0	0.99994(0092)	0.99818(16)	0.99944(14)	0.99674(16)
386	SNL-7uPCXp.800R-1	0.99988(0092)	0.99788(14)	0.99871(15)	0.99613(15)
387	SNL-7uPCXp.800R-1	0.99997(0096)	0.99841(15)	0.99953(16)	0.99682(15)
388	SNL-7uPCXp.800R-1	1.00000(0096)	0.99824(15)	0.99968(15)	0.99689(15)
389	SNL-7uPCXp.800R-1	0.99999(0096)	0.99855(15)	0.99941(15)	0.99764(14)
390	SNL-7uPCXp.800R-1	0.99993(0096)	0.99815(15)	0.99870(15)	0.99718(16)
391	SNL-7uPCXp.800R-1	0.99991(0096)	0.99832(16)	0.99830(15)	0.99754(14)
392	SNL-7uPCXp.800R-1	0.99993(0096)	0.99876(15)	1.00001(15)	0.99745(15)
393	SNL-7uPCXp.800R-1	0.99991(0096)	0.99878(16)	1.00001(15)	0.99779(16)
394	SNL-7uPCXp.800R-1	0.99991(0096)	0.99905(15)	0.99945(16)	0.99793(15)
395	SNL-7uPCXp.800R-1	0.99987(0096)	0.99868(15)	0.99823(15)	0.99812(15)
396	Sheba-II	0.99910(0290)	1.01158(15)	1.01270(14)	1.01162(15)
397	ORNL-UO2F2-1	1.00380(0400)	0.99989(08)	0.99909(08)	0.99960(08)
398	ORNL-UO2F2-2	1.00240(0370)	0.99580(09)	0.99561(09)	0.99583(09)
399	ORNL-UO2F2-3	1.00240(0440)	1.00068(08)	0.99996(08)	1.00076(09)
400	Stacey-1	0.99940(0080)	1.00057(09)	1.00038(09)	1.00075(09)
401	Stacey-29	0.99990(0090)	1.00157(09)	1.00145(09)	1.00191(09)
402	Stacey-33	0.99990(0900)	0.99985(09)	0.99929(09)	0.99989(09)
403	Stacey-34	0.99990(0100)	1.00204(08)	1.00134(08)	1.00210(08)
404	Stacey-46	0.99990(0100)	1.00195(08)	1.00133(08)	1.00188(08)

405	Stacey-51	0.99940(0110)	1.00115(08)	1.00040(08)	1.00109(08)
406	Stacey-54	0.99960(0110)	1.00121(08)	1.00037(07)	1.00126(08)
407	STACY-14	0.99610(0090)	0.99479(10)	0.99516(10)	0.99528(10)
408	STACY-30	0.99730(0090)	0.99719(10)	0.99728(10)	0.99761(09)
409	STACY-32	0.99850(0100)	0.99632(09)	0.99584(09)	0.99607(09)
410	STACY-36	0.99880(0110)	0.99889(09)	0.99838(09)	0.99888(09)
411	STACY-49	0.99830(0110)	0.99729(08)	0.99716(08)	0.99732(08)
412	STACY-83	0.99990(0150)	0.99777(12)	0.99724(12)	0.99789(11)
413	STACY-85	0.99990(0140)	1.00128(12)	1.00056(12)	1.00156(12)
414	STACY-86	1.00000(0140)	1.00144(12)	1.00070(11)	1.00115(11)
415	STACY-88	1.00010(0140)	1.00178(12)	1.00058(11)	1.00195(12)
416	STACY-460R	0.99990(0100)	1.00357(09)	1.00341(10)	1.00374(11)
417	STACY-461R	1.00000(0100)	1.00408(08)	1.00386(11)	1.00402(10)
418	STACY-464R	1.00000(0090)	1.00331(08)	1.00283(10)	1.00355(10)
419	STACY-470R	0.99980(0090)	1.00284(08)	1.00222(09)	1.00292(10)
420	STACY-471R	0.99980(0110)	1.00217(07)	1.00107(10)	1.00208(10)
421	STACY-485R	1.00000(0110)	1.00333(07)	1.00229(09)	1.00276(09)
422	STACY-486R	0.99990(0100)	1.00348(07)	1.00235(09)	1.00305(09)
423	STACY-459	0.99670(0100)	1.00013(09)	0.99985(11)	1.00002(12)
424	STACY-462	0.99740(0100)	1.00104(09)	1.00071(11)	1.00087(11)
425	STACY-463	0.99800(0090)	1.00040(08)	1.00024(11)	1.00071(11)
426	STACY-469	0.99840(0090)	1.00041(08)	0.99978(10)	1.00028(10)
427	STACY-472	0.99850(0110)	1.00028(07)	0.99935(10)	1.00010(10)
428	STACY-484	0.99870(0100)	1.00133(08)	1.00050(09)	1.00102(10)
429	TRACY-203c	1.00460(0150)	1.00717(06)	1.00752(06)	1.00752(06)
430	TRACY-203t	1.02820(0150)	1.03049(06)	1.03074(06)	1.03072(06)
431	STACY-105	0.99960(0130)	1.00492(11)	1.00522(11)	1.00541(11)
432	STACY-113	0.99990(0130)	1.00479(11)	1.00541(10)	1.00553(10)
433	STACY-125	0.99940(0140)	1.00412(10)	1.00467(10)	1.00469(10)
434	STACY-129	0.99960(0140)	1.00373(10)	1.00387(10)	1.00386(10)
435	STACY-131	0.99950(0140)	1.00318(10)	1.00304(10)	1.00333(10)
436	STACY-140	0.99920(0150)	1.00167(10)	1.00157(09)	1.00184(09)
437	STACY-196	0.99940(0150)	1.00268(09)	1.00275(09)	1.00300(09)
438	STACY-104	0.99810(0130)	1.00206(11)	1.00314(11)	1.00263(11)
439	STACY-122	0.99860(0130)	1.00237(11)	1.00327(11)	1.00287(11)
440	STACY-123	0.99890(0140)	1.00020(10)	1.00120(11)	1.00111(10)
441	STACY-126	0.99920(0140)	1.00136(10)	1.00183(10)	1.00184(10)
442	STACY-130	0.99870(0150)	1.00117(10)	1.00111(10)	1.00134(10)
443	STACY-147	0.99960(0150)	1.00085(09)	1.00117(10)	1.00110(10)
444	STACY-133(Concr.)	0.99920(0100)	1.00144(12)	1.00129(12)	1.00169(12)
445	STACY-142(Concr.)	0.99960(0100)	1.00129(21)	1.00115(11)	1.00132(12)
446	STACY-143(Concr.)	0.99960(0100)	1.00189(13)	1.00185(12)	1.00167(13)
447	STACY-144(Concr.)	0.99970(0100)	1.00187(12)	1.00172(13)	1.00243(12)
448	STACY-145(Concr.)	0.99920(0100)	1.00200(12)	1.00177(12)	1.00208(12)
449	STACY-146(Concr.)	0.99960(0100)	1.00154(12)	1.00160(13)	1.00142(12)
450	STACY-183(PE)	0.99940(0090)	1.00227(12)	1.00269(12)	1.00264(12)
451	STACY-149(PE)	0.99970(0090)	1.00308(12)	1.00241(12)	1.00313(12)
452	STACY-150(PE)	0.99950(0090)	1.00296(13)	1.00304(12)	1.00332(12)
453	STACY-151(PE)	0.99990(0090)	1.00297(12)	1.00280(12)	1.00322(12)
454	STACY-152(PE)	0.99960(0090)	1.00310(13)	1.00296(12)	1.00346(12)
455	STACY-153(PE)	0.99980(0090)	1.00136(12)	1.00142(12)	1.00173(12)
456	STACY-216R	0.99950(0100)	0.99998(08)	0.99925(09)	0.99975(08)
457	STACY-217R	0.99960(0100)	0.99947(08)	0.99872(08)	0.99948(08)
458	STACY-220R	0.99970(0120)	0.99904(07)	0.99770(07)	0.99874(07)
459	STACY-226R	0.99980(0120)	1.00010(07)	0.99866(07)	0.99975(07)
460	STACY-215	0.99830(0090)	0.99783(09)	0.99738(09)	0.99766(09)
461	STACY-218	0.99850(0100)	0.99827(08)	0.99775(08)	0.99801(08)
462	STACY-221	0.99890(0110)	0.99742(08)	0.99666(08)	0.99704(08)
463	STACY-223	0.99930(0120)	0.99942(07)	0.99835(07)	0.99907(07)
464	ORNL S1	0.99900(0430)	1.00226(22)	1.00268(15)	1.00134(14)
465	ORNL S2	1.00000(0390)	1.00233(21)	1.00324(16)	1.00214(15)
466	ORNL S3	1.00000(0360)	1.00207(22)	1.00204(14)	1.00208(16)
467	ORNL S4	0.99860(0350)	0.99618(22)	0.99677(14)	0.99738(14)
468	ORNL T1	1.00120(0260)	0.99857(11)	0.99811(09)	0.99819(08)
469	ORNL T2	1.00070(0360)	0.99788(40)	0.99713(09)	0.99755(09)
470	ORNL T3	1.00090(0360)	0.99401(13)	0.99357(10)	0.99421(10)
471	ORNL T4	1.00030(0360)	0.99599(13)	0.99522(11)	0.99590(10)
472	ORNL T5	1.00150(0260)	0.99962(08)	0.99747(07)	0.99846(08)

473	Rocky_Flats-01	1.00040(0600)	0.99812(11)	0.99997(11)	0.99845(11)
474	Rocky_Flats-02	1.00210(0720)	0.99578(11)	0.99813(12)	0.99494(11)
475	Rocky_Flats-03	1.00030(0350)	1.00164(11)	1.00350(11)	1.00180(11)
476	Rocky_Flats-04	1.00080(0530)	0.99820(11)	1.00069(11)	0.99719(12)
477	Rocky_Flats-05	1.00010(0490)	0.99875(09)	1.00026(09)	0.99899(09)
478	Rocky_Flats-06	1.00020(0460)	1.00190(10)	1.00346(10)	1.00222(10)
479	Rocky_Flats-07	1.00080(0400)	0.99773(11)	0.99976(11)	0.99796(11)
480	Rocky_Flats-08	0.99980(0380)	0.99803(11)	0.99990(11)	0.99805(11)
481	Rocky_Flats-09	1.00080(0540)	0.99408(11)	0.99656(11)	0.99316(11)
482	Rocky_Flats-10	0.99930(0540)	0.99257(09)	0.99379(10)	0.99254(10)
483	ORNL C1	0.99570(0390)	0.99657(08)	0.99543(11)	0.99593(11)
484	ORNL C2	0.99650(0360)	0.99661(08)	0.99528(11)	0.99591(11)
485	ORNL C3	0.99940(0280)	1.00085(07)	0.99868(09)	1.00036(09)
486	ORNL C4	1.00000(0340)	1.00235(06)	1.00015(08)	1.00149(08)
487	ORNL C5	1.00000(0340)	1.00005(06)	0.99717(08)	0.99886(08)
488	ORNL C6	1.00000(0370)	1.00063(07)	0.99838(10)	0.99994(08)
489	ORNL C7	1.00000(0360)	1.00183(06)	0.99917(08)	1.00071(07)
490	ORNL C8	1.00000(0350)	1.00210(04)	0.99904(06)	1.00068(06)
491	ORNL_LS1	0.99860(0310)	0.99480(14)	0.99688(15)	0.99500(15)
492	ORNL_LS2	0.99950(0260)	1.00538(09)	1.00552(09)	1.00525(09)
493	ORNL_LS3	0.99900(0250)	1.00092(08)	1.00027(08)	1.00065(08)
494	ORNL_S10T0	1.00000(0290)	1.00142(13)	1.00140(13)	1.00257(13)
495	ORNL_S17.1	1.00000(0230)	1.00460(14)	1.00500(15)	1.00541(14)
496	ORNL_S17.2	1.00000(0230)	1.00093(15)	1.00107(14)	1.00135(15)
497	ORNL_S91	0.99990(0580)	1.00107(10)	1.00036(10)	1.00102(10)
498	IPPE-070g/l-Gd-1	1.00000(0280)	0.99615(15)	0.99645(15)	0.99689(14)
499	IPPE-070g/l-Gd-2	1.00000(0520)	1.01198(14)	1.01285(15)	1.01293(15)
500	IPPE-070g/l-Gd-3	1.00000(0870)	1.02030(13)	1.02140(13)	1.02161(14)
501	IPPE-100g/l-Gd-1	1.00000(0320)	0.99885(16)	1.00016(16)	1.00004(16)
502	IPPE-100g/l-Gd-2	1.00000(0340)	0.99130(16)	0.99226(15)	0.99261(15)
503	IPPE-100g/l-Gd-3	1.00000(0680)	1.00800(16)	1.00994(16)	1.00908(15)
504	IPPE-100g/l-Gd-4	1.00000(0690)	1.01427(15)	1.01616(15)	1.01571(14)
505	IPPE-100g/l-Gd-5	1.00000(0890)	1.01011(13)	1.01276(13)	1.01157(14)
506	IPPE-150g/l-Gd-1	1.00000(0360)	0.99213(17)	0.99277(16)	0.99254(16)
507	IPPE-150g/l-Gd-2	1.00000(0690)	1.00752(16)	1.00953(15)	1.00847(15)
508	IPPE-150g/l-Gd-3	1.00000(0790)	1.02501(15)	1.02863(15)	1.02659(14)
509	IPPE-200g/l-Gd-1	1.00000(0280)	0.99295(16)	0.99377(17)	0.99370(17)
510	IPPE-200g/l-Gd-2	1.00000(0400)	0.98141(17)	0.98316(17)	0.98208(17)
511	IPPE-200g/l-Gd-3	1.00000(0360)	0.98179(17)	0.98238(16)	0.98274(17)
512	IPPE-200g/l-Gd-4	1.00000(0470)	0.99762(16)	0.99951(16)	0.99869(15)
513	IPPE-200g/l-Gd-5	1.00000(0580)	1.00699(16)	1.01006(15)	1.00863(14)
514	IPPE-200g/l-Gd-6	1.00000(0550)	1.00058(17)	1.00473(16)	1.00194(16)
515	IPPE-200g/l-Gd-7	1.00000(0570)	1.00470(16)	1.00836(16)	1.00616(15)
516	IPPE-200g/l-Gd-8	1.00000(0670)	0.99926(15)	1.00472(16)	1.00107(15)
517	IPPE-300g/l-Gd-1	1.00000(0340)	0.99132(17)	0.99246(17)	0.99197(18)
518	IPPE-300g/l-Gd-2	1.00000(0460)	0.98826(18)	0.98956(17)	0.98805(17)
519	IPPE-300g/l-Gd-3	1.00000(0420)	0.98973(16)	0.99077(17)	0.99008(17)
520	IPPE-300g/l-Gd-4	1.00000(0440)	0.99778(16)	1.00067(16)	0.99908(16)
521	IPPE-300g/l-Gd-5	1.00000(0460)	0.99020(17)	0.99386(18)	0.99069(17)
522	IPPE-300g/l-Gd-6	1.00000(0450)	0.98994(16)	0.99346(17)	0.99142(16)
523	IPPE-300g/l-Gd-7	1.00000(0580)	1.00633(15)	1.01135(16)	1.00787(15)
524	IPPE-300g/l-Gd-8	1.00000(0560)	1.00590(16)	1.01189(16)	1.00715(15)
525	IPPE-300g/l-Gd-9	1.00000(0560)	1.00333(16)	1.00824(16)	1.00455(16)
526	IPPE-300g/l-Gd-10	1.00000(0570)	1.01840(16)	1.02558(15)	1.01989(15)
527	IPPE-300g/l-Gd-11	1.00000(0590)	1.02076(14)	1.02774(15)	1.02294(14)
528	IPPE-300g/l-Gd-12	1.00000(0650)	1.01410(14)	1.02252(14)	1.01637(13)
529	IPPE-400g/l-Gd-1	1.00000(0410)	0.99731(14)	0.99850(14)	0.99719(14)
530	IPPE-400g/l-Gd-2	1.00000(0410)	0.99923(13)	1.00238(14)	0.99945(14)
531	IPPE-400g/l-Gd-3	1.00000(0670)	0.99479(13)	0.99964(13)	0.99579(13)
532	IPPE-051g/l-Gd-01	1.00020(0250)	1.00093(12)	1.00157(11)	1.00150(11)
533	IPPE-051g/l-Gd-02	1.00070(0250)	1.00028(12)	1.00071(11)	1.00075(11)
534	IPPE-051g/l-Gd-03	1.00020(0640)	0.99520(11)	0.99603(11)	0.99629(11)
535	IPPE-053g/l-Gd-04	1.00030(0270)	1.00073(11)	1.00165(12)	1.00151(12)
536	IPPE-077g/l-Gd-05	1.00130(0300)	1.00309(13)	1.00394(13)	1.00425(12)
537	IPPE-049g/l-Gd-06	1.00020(0670)	1.00841(10)	1.00870(10)	1.00896(10)
538	IPPE-068g/l-Gd-07	1.00090(0730)	1.01260(10)	1.01373(11)	1.01327(10)
539	IPPE-070g/l-Gd-08	1.00000(0670)	1.00984(11)	1.01095(10)	1.01085(10)
540	IPPE-095g/l-Gd-09	1.00020(0650)	1.00382(11)	1.00555(11)	1.00509(11)

541	IPPE-142g/l-Gd-10	1.00030(0430)	1.00802(11)	1.01152(11)	1.00961(11)
542	IPPE-142g/l-Gd-11	1.00020(0450)	1.00715(11)	1.01046(11)	1.00866(11)
543	IPPE-185g/l-Gd-12	1.00020(0450)	1.00589(11)	1.01061(11)	1.00730(11)
544	IPPE-189g/l-Gd-13	1.00090(0470)	1.01386(11)	1.01868(10)	1.01532(10)
545	IPPE-273g/l-Gd-14	1.00080(0530)	1.00514(10)	1.01076(11)	1.00642(11)
546	IPPE-268g/l-Gd-15	1.00020(0580)	0.99904(11)	1.00450(11)	1.00056(11)
547	IPPE-400g/l-Gd-16	1.00000(0490)	1.00919(11)	1.01613(11)	1.01049(11)
548	IPPE-393g/l-Gd-17	1.00000(0550)	1.00107(11)	1.00794(11)	1.00270(11)
549	IPPE-395g/l-Gd-18	1.00000(0610)	0.99886(11)	1.00502(11)	1.00000(11)
550	ORNL_UO2F2-03*	0.97740(0960)	0.99942(10)	0.99739(09)	0.99906(09)
551	ORNL_UO2F2-04*	0.98830(0690)	0.99770(09)	0.99530(09)	0.99741(09)
552	ORNL_UO2F2-05	0.98490(0920)	0.99709(10)	0.99493(10)	0.99650(09)
553	ORNL_UO2F2-06	1.00120(0480)	0.99815(14)	0.99715(13)	0.99774(13)
554	ORNL_UO2F2-07	1.00320(0400)	0.99800(09)	0.99762(10)	0.99753(09)
555	ORNL_UO2F2-08	1.00270(0400)	0.99803(10)	0.99758(09)	0.99738(10)
556	ORNL_UO2F2-09	1.00280(0400)	0.99760(09)	0.99750(10)	0.99733(09)
557	ORNL_UO2F2-10	1.00270(0400)	0.99705(10)	0.99690(09)	0.99651(09)
558	ORNL_UO2F2-11Cd*	0.98160(0910)	0.98851(10)	0.98956(10)	0.98671(10)
559	ORNL_UO2F2-12Cd	0.99560(0890)	0.98743(10)	0.98820(10)	0.98498(10)
560	ORNL_UO2F2-15*	0.97320(0960)	1.01350(10)	1.01209(10)	1.01282(10)
561	ORNL_UO2F2-16*	0.98090(0760)	1.01049(10)	1.00956(10)	1.00991(10)
562	ORNL_UO2F2-17*	0.98490(0640)	1.00671(10)	1.00606(10)	1.00595(09)
563	ORNL_UO2F2-18*	0.98910(0560)	1.00457(10)	1.00491(10)	1.00390(10)
564	ORNL_UO2F2-19*	0.98830(0580)	1.00116(10)	1.00165(10)	1.00007(10)
565	ORNL_UO2F2-20Cd*	0.97250(0960)	0.99961(10)	1.00083(10)	0.99772(10)
566	ORNL_UO2F2-21Cd*	0.98320(0770)	0.98767(10)	0.98884(10)	0.98580(10)
567	ORNL_UO2F2-22Cd	0.99160(0910)	0.98930(10)	0.99055(10)	0.98711(10)
568	ORNL_UO2F2-23Cd	0.99620(0600)	0.99397(10)	0.99597(10)	0.99194(10)
569	ORNL_UO2F2-24Cd	0.99890(0480)	0.99710(11)	0.99887(10)	0.99481(10)
570	PNL-001	1.00120(0260)	0.99900(13)	0.99941(14)	0.99840(13)
571	PNL-002Cd	1.00120(0290)	0.99064(15)	0.99234(15)	0.98947(14)
572	PNL-003	1.00120(0260)	0.99808(14)	0.99781(14)	0.99834(13)
573	PNL-004	1.00120(0250)	0.99919(13)	0.99818(13)	0.99994(13)
574	PNL-005	1.00120(0250)	1.00139(13)	0.99961(13)	1.00287(13)
575	PNL-006	1.00120(0250)	1.00508(13)	1.00365(13)	1.00626(12)
576	PNL-007	1.00120(0240)	1.00551(13)	1.00444(13)	1.00699(13)
577	PNL-008	1.00120(0240)	1.00386(13)	1.00274(13)	1.00560(13)
578	PNL-009	1.00120(0200)	0.99857(14)	0.99940(14)	0.99786(14)
579	PNL-010Cd	1.00120(0240)	0.98880(15)	0.99077(14)	0.98756(14)
580	PNL-011Cd	1.00120(0220)	0.99272(14)	0.99407(14)	0.99234(14)
581	PNL-012Cd	1.00120(0210)	0.99581(14)	0.99628(14)	0.99550(14)
582	PNL-013Cd	1.00120(0210)	0.99646(14)	0.99701(14)	0.99739(14)
583	PNL-014Cd	1.00120(0200)	0.99775(14)	0.99796(13)	0.99878(13)
584	PNL-015Cd	1.00120(0210)	0.99992(13)	1.00020(13)	1.00130(13)
585	PNL-016Cd	1.00120(0200)	0.99855(13)	0.99864(13)	0.99989(13)
586	PNL-017Cd	1.00120(0210)	0.99847(13)	0.99798(13)	0.99950(13)
587	PNL-019	1.00120(0200)	1.00005(13)	0.99877(13)	1.00170(13)
588	PNL-020	1.00120(0200)	1.00085(13)	0.99960(12)	1.00280(12)
589	PNL-021	1.00120(0190)	0.99932(12)	0.99769(12)	1.00114(12)
590	ORNL_UO2F2-01	0.99530(0860)	1.00675(15)	1.00966(15)	1.00581(15)
591	ORNL_UO2F2-02	0.99870(0830)	1.00260(15)	1.00531(15)	1.00116(15)
592	ORNL_UO2F2-03(L5)	0.99840(0790)	1.00436(14)	1.00801(15)	1.00263(15)
593	ORNL_UO2F2-04(L6)	0.99870(0840)	1.00434(15)	1.00684(15)	1.00275(15)
594	ORNL_UO2F2-05	0.99850(0850)	1.00067(16)	1.00294(16)	1.00021(16)
595	ORNL_UO2F2-06	0.99850(0810)	1.00924(15)	1.01170(15)	1.00775(15)
596	ORNL_UO2F2-07	0.99780(0780)	0.99811(15)	1.00158(14)	0.99591(15)
597	ORNL_UO2F2-08	0.99750(0840)	0.99761(15)	1.00053(14)	0.99626(15)
598	ORNL_UO2F2-09	0.99660(0820)	0.99711(14)	1.00035(14)	0.99492(15)
599	ORNL_UO2F2-10	0.99600(0900)	0.98016(14)	0.98262(15)	0.97816(15)
600	ORNL_UO2F2-11	0.99640(0890)	0.99106(14)	0.99316(15)	0.98999(15)
601	LANL-D2O-01	1.00000(0650)	0.98605(13)	0.99484(12)	0.99015(13)
602	LANL-D2O-02	1.00000(0710)	0.98140(13)	0.98934(13)	0.98409(13)
603	LANL-D2O-03	1.00000(0780)	0.98803(13)	0.99555(12)	0.99048(13)
604	LANL-D2O-04	1.00000(0920)	0.99092(13)	0.99720(13)	0.99232(13)
605	LANL-D2O-05	1.00000(1040)	0.98937(13)	0.99491(13)	0.99080(14)
606	LANL-D2O-06	1.00000(1170)	0.98630(14)	0.99102(14)	0.98819(14)
607	LANL_UO2F2_1	0.99660(1160)	0.99052(15)	0.99947(16)	0.99418(15)
608	LANL_UO2F2_2	0.99560(0930)	0.99601(16)	1.00340(17)	0.99939(16)

609	LANL_UO2F2_3	0.99570(0790)	1.00513(16)	1.00977(16)	1.00786(17)
610	LANL_UO2F2_4	0.99550(0780)	1.00491(17)	1.00959(15)	1.00706(16)
611	LANL_UO2F2_5	0.99590(0770)	1.01446(16)	1.01518(15)	1.01388(16)
612	ORNL-IEU-UF2O2	1.00410(0650)	0.99927(08)	0.99863(08)	0.99908(08)
613	NRX-A_19	1.00200(0430)	1.01314(17)	1.01190(17)	1.01404(17)
614	NRX-A_18	1.00200(0430)	1.01591(18)	1.01470(18)	1.01596(18)
615	NRX-A_11	1.00110(0530)	1.01502(17)	1.01398(17)	1.01525(17)
616	NRX-A_23	1.00080(0850)	1.01420(18)	1.01405(18)	1.01537(17)
617	NRX-A_03	1.00110(0690)	1.01620(18)	1.01535(17)	1.01723(17)
618	R1_Concrete	0.99880(0840)	0.99435(06)	0.99360(17)	0.99387(16)
619	Comet-UH3.2	1.00000(0610)	1.00790(14)	1.01452(15)	1.01048(14)
620	Comet-UH3.3	1.00000(0560)	1.00258(15)	1.00891(14)	1.00543(14)
621	Comet-UH3.5	1.00000(0470)	0.99742(15)	1.00251(15)	1.00045(15)
622	HISS_U235	1.00000(0400)	1.01159(09)	1.02281(09)	1.01531(09)
623	ZEUS/Gr-1	0.99770(0080)	0.99284(11)	0.99627(11)	0.99612(11)
624	ZEUS/Gr-2	1.00010(0080)	0.99697(11)	0.99925(10)	1.00069(11)
625	ZEUS/Gr-3	1.00150(0090)	0.99942(11)	0.99890(10)	1.00231(11)
626	ZEUS/Gr-4	1.00160(0080)	1.00729(10)	1.00113(10)	1.00597(10)
627	ZPPR-20/C	0.99850(0270)	1.00435(14)	0.99382(15)	1.00487(14)
628	ZPR-3/41	1.00070(0270)	1.00294(08)	1.00422(11)	1.00151(11)
629	ZPR-3/12	0.99780(0150)	1.00009(07)	0.99898(07)	0.99823(07)
630	FR0_T0/1E-S	1.00200(0132)	1.00996(11)	1.00543(10)	1.00304(10)
631	FR0_T1-S	1.00410(0130)	1.01254(10)	1.00886(10)	1.00434(10)
632	FR0_T2-S	1.00400(0129)	1.01316(10)	1.00919(10)	1.00421(10)
633	FR0_T3-S	1.00530(0130)	1.01471(10)	1.01069(11)	1.00519(10)
634	FR0_T4a-S	1.00670(0130)	1.01553(10)	1.01192(10)	1.00622(11)
635	FR0_T5-S	1.00650(0133)	1.01500(10)	1.01118(10)	1.00566(10)
636	FR0_T6a-S	1.01040(0136)	1.01797(11)	1.01437(10)	1.00945(10)
637	mFR0-4-S	1.00839(0145)	1.01341(06)	1.01134(09)	1.01037(09)
638	FR0_3X-S	1.00077(0137)	1.00766(06)	1.00288(10)	1.00334(10)
639	FR0_5-S	0.99325(0115)	0.99371(07)	0.99579(12)	0.99507(11)
640	FR0_6A-S	0.98748(0115)	0.98215(07)	0.98639(11)	0.98451(11)
641	FR0_7-S	0.98629(0236)	0.98557(07)	0.98828(11)	0.98689(11)
642	FR0_8-S	0.99775(0127)	1.00108(06)	0.99849(10)	0.99944(11)
643	FR0_9-S	1.00121(0207)	1.00285(06)	1.00064(10)	1.00275(10)
644	FR0_10-S	0.99758(0196)	1.00190(07)	1.00180(10)	1.00034(11)
645	VNIIEF_Sphere	1.00000(0140)	0.99999(09)	1.00037(08)	1.00003(09)
646	VNIITF-CTF-019	1.00000(0200)	1.00697(09)	1.00654(09)	1.00686(09)
647	ORCEF-01	0.99710(0050)	0.99520(09)	0.99503(09)	0.99553(09)
648	ORCEF-02	0.99680(0050)	0.99540(09)	0.99524(09)	0.99560(09)
649	ORCEF-03	0.99740(0050)	0.99482(09)	0.99484(09)	0.99532(09)
650	ORCEF-15	0.99980(0010)	0.99805(09)	0.99796(09)	0.99822(09)
651	ORCEF-16	0.99810(0010)	0.99635(09)	0.99610(08)	0.99661(09)
652	ORCEF-17	0.99690(0010)	0.99551(09)	0.99538(09)	0.99557(09)
653	Caliban	1.00000(0120)	1.00952(17)	1.00930(09)	1.00980(08)
654	ORSphere-1	1.00260(0070)	1.00384(02)	1.00413(05)	1.00398(05)
655	ORSphere-1s	1.00310(0070)	1.00486(08)	1.00504(09)	1.00494(09)
656	ORSphere-2	0.99660(0070)	0.99818(02)	0.99848(06)	0.99842(05)
657	ORSphere-2s	0.99660(0070)	0.99886(09)	0.99895(08)	0.99882(09)
658	PNL-1(11.5)2210	1.00000(0500)	1.00459(33)	0.99931(33)	0.99945(34)
659	PNL-1(11.5)2170	1.00000(0500)	1.00719(33)	1.00141(33)	1.00311(34)
660	PNL-1(11.5)2165	1.00000(0500)	1.00943(30)	1.00453(31)	1.00531(31)
661	PNL-1(11.5)2164	1.00000(0500)	1.00382(31)	0.99909(29)	0.99983(33)
662	PNL-1(11.5)2163	1.00000(0500)	1.00749(28)	1.00264(33)	1.00453(33)
663	PNL-1(11.5)2218	1.00000(0500)	1.00920(28)	1.00670(29)	1.00688(31)
664	P11-1	1.00000(0470)	1.00281(13)	0.99767(13)	0.99694(12)
665	P11-2	1.00000(0470)	1.00978(14)	1.00918(13)	1.00923(13)
666	P11-3	1.00000(0470)	1.01250(14)	1.01170(13)	1.01227(13)
667	P11-4	1.00000(0470)	1.01190(13)	1.01120(13)	1.01188(13)
668	P11-5	1.00000(0470)	1.01323(14)	1.01216(13)	1.01290(14)
669	P11-6	1.00000(0470)	1.01349(13)	1.01228(13)	1.01357(14)
670	P11-7	1.00000(0470)	1.00700(12)	1.00197(13)	1.00096(13)
671	P11-8	1.00000(0470)	1.00551(14)	1.00105(13)	0.99999(13)
672	PNL-11(14)-01	1.00000(0470)	1.00400(29)	0.99962(27)	0.99761(30)
673	PNL-11(14)-02	1.00000(0470)	0.99873(26)	0.99391(27)	0.99295(29)
674	PNL-11(14)-03	1.00000(0470)	1.00076(25)	0.99678(28)	0.99488(30)
675	PNL-11(14)-04	1.00000(0470)	0.99877(29)	0.99368(26)	0.99201(29)
676	PNL-11(14)-05	1.00000(0470)	0.99980(17)	0.99479(30)	0.99354(28)

677	PNL-11(14)-06	1.00000(0470)	1.00144(24)	0.99692(28)	0.99524(31)
678	PNL-11(14)-07	1.00000(0470)	1.00556(17)	1.00110(28)	0.99948(29)
679	PNL-11(14)-08	1.00000(0470)	1.00175(25)	0.99643(28)	0.99527(29)
680	PNL-11(14)-09	1.00000(0470)	1.00054(26)	0.99609(30)	0.99443(32)
681	PNL-11(14)-10	1.00000(0470)	1.00162(28)	0.99773(30)	0.99582(26)
682	PNL-11(14)-11	1.00000(0470)	1.00065(27)	0.99613(29)	0.99484(31)
683	PNL-11(14)-12	1.00000(0470)	1.00269(30)	0.99821(29)	0.99710(27)
684	PNL-11(14)-13	1.00000(0470)	1.00007(28)	0.99577(29)	0.99463(28)
685	PNL-11(14R)-1	1.00000(0470)	1.00184(26)	0.99770(25)	0.99579(31)
686	PNL-11(14R)-2	1.00000(0470)	1.00227(28)	0.99850(31)	0.99710(30)
687	PNL-11(14R)-3	1.00000(0470)	1.00331(29)	0.99844(29)	0.99716(26)
688	PNL-11(14R)-4	1.00000(0470)	1.00465(27)	0.99997(28)	0.99943(30)
689	PNL-11(14R)-5	1.00000(0470)	1.00563(25)	1.00148(30)	0.99990(30)
690	PNL-11(14R)-6	1.00000(0470)	1.00492(29)	1.00098(29)	0.99937(30)
691	PNL-11(14R)-7	1.00000(0470)	1.00356(33)	0.99929(27)	0.99867(28)
692	PNL-11(14R)-8	1.00000(0470)	0.99935(26)	0.99420(27)	0.99360(28)
693	PNL-11(14R)-9	1.00000(0470)	1.00165(27)	0.99737(30)	0.99627(29)
694	PNL-11(15R)-1	1.00000(0350)	1.00033(28)	0.99590(27)	0.99422(28)
695	PNL-11(15R)-2	1.00000(0350)	1.00157(23)	0.99663(26)	0.99571(31)
696	PNL-11(15R)-3	1.00000(0350)	1.00055(26)	0.99676(27)	0.99550(28)
697	PNL-1(11.5)2185	1.00000(0470)	1.00919(15)	1.00582(14)	1.00689(14)
698	PNL-1(11.5)2187	1.00000(0470)	1.00329(15)	1.00011(15)	1.00136(15)
699	PNL-1(11.5)2197	1.00000(0470)	1.00941(15)	1.00411(15)	1.00492(15)
700	PNL-1(11.5)2201	1.00000(0470)	1.00315(14)	0.99783(15)	0.99920(14)
701	PNL-1(11.5)2202	1.00000(0470)	1.00511(14)	1.00002(15)	1.00102(14)
702	PNL-1(11.5)2203	1.00000(0470)	0.99896(15)	0.99340(14)	0.99461(14)
703	PNL-1(11.5)2205	1.00000(0470)	0.99694(14)	0.99207(15)	0.99342(15)
704	PNL-1(11.5)2206	1.00000(0470)	1.00108(15)	0.99578(15)	0.99664(15)
705	PNL-48R-1a	1.00000(0330)	1.01553(08)	1.01008(08)	1.00913(08)
706	PNL-48R-2a	1.00000(0330)	1.02028(06)	1.01462(06)	1.01387(07)
707	PNL-48R-3a	1.00000(0330)	1.01920(06)	1.01361(06)	1.01299(05)
708	PNL-16R-5	1.00000(0520)	1.00615(14)	1.00230(13)	0.99987(12)
709	PNL-18R-1	1.00000(0520)	0.99416(11)	0.99021(11)	0.98762(11)
710	PNL-18R-6	1.00000(0520)	1.00017(11)	0.99651(12)	0.99359(12)
711	Valduc-05	1.00000(0580)	1.00969(10)	1.00498(10)	1.00420(10)
712	Valduc-06	1.00000(0070)	1.00687(29)	1.00401(27)	1.00554(28)
713	Valduc-07	1.00000(0130)	1.00611(32)	1.00209(30)	1.00323(26)
714	Valduc-13	1.00000(0580)	1.00975(10)	1.00478(10)	1.00402(10)
715	PNL-11-9	1.00000(0340)	1.00932(15)	1.00888(15)	1.01003(16)
716	PNL-11-9	1.00000(0340)	1.01260(15)	1.01154(15)	1.01298(15)
717	PNL-11-9	1.00000(0340)	1.01015(15)	1.00871(14)	1.00991(15)
718	PNL-11-9	1.00000(0340)	1.00821(14)	1.00705(14)	1.00746(14)
719	PNL-11-9	1.00000(0340)	1.00731(14)	1.00591(14)	1.00603(14)
720	PNL-11-9	1.00000(0340)	1.00543(14)	1.00391(14)	1.00406(14)
721	PNL-11-9	1.00000(0340)	1.00456(13)	1.00280(13)	1.00304(13)
722	PNL-11-9	1.00000(0340)	1.00435(12)	1.00205(13)	1.00220(13)
723	PNL-11-9	1.00000(0340)	1.00232(10)	1.00052(10)	0.99995(10)
724	PNL-11(15.2)-01	1.00000(0320)	1.00490(13)	1.00104(13)	0.99877(13)
725	PNL-11(15.2)-03	1.00000(0650)	1.00457(15)	1.00207(14)	1.00086(14)
726	PNL-10-Gd-01	1.00000(0620)	1.00008(13)	0.99576(13)	0.99678(13)
727	Falstaff-1.1	1.00000(0830)	0.98551(15)	0.98526(16)	0.98206(15)
728	U3ORNL-S1	1.00000(0310)	1.00139(13)	1.00257(12)	0.99938(12)
729	U3ORNL-S2	1.00050(0330)	1.00137(14)	1.00240(12)	0.99951(14)
730	U3ORNL-CS	1.00060(0330)	1.00169(13)	1.00257(14)	0.99953(13)
731	U3ORNL-S4	0.99980(0330)	1.00078(13)	1.00189(14)	0.99942(13)
732	U3ORNL-S5	0.99990(0330)	1.00009(14)	1.00097(13)	0.99844(14)
733	U3ORNL-37	1.00000(0400)	1.00205(19)	1.00114(19)	0.99991(18)
734	U3ORNL-39	1.00000(0490)	1.00537(16)	1.00522(19)	1.00272(18)
735	U3ORNL-11	1.00060(0290)	1.00180(12)	1.00180(12)	1.00000(12)
736	ORCEF-1	1.00000(0280)	1.00076(17)	0.99889(16)	0.99877(17)
737	ORCEF-2	1.00000(0250)	1.00000(16)	0.99826(17)	0.99817(16)
738	ORCEF-3	1.00000(0230)	1.00952(17)	1.00821(17)	1.00756(17)
739	ORCEF-4	1.00000(0150)	1.00294(16)	1.00156(17)	1.00079(17)
740	ORCEF-5	1.00000(0710)	1.00496(16)	1.00383(16)	1.00269(16)
741	ORCEF-6	1.00000(0100)	1.00569(15)	1.00525(15)	1.00388(16)
742	ORCEF-7	1.00000(0380)	1.00169(14)	1.00201(14)	0.99992(14)
743	ORCEF-8	1.00000(0480)	0.99906(14)	0.99901(14)	0.99689(14)
744	Thor	1.00000(0060)	0.99758(14)	0.99680(14)	0.99768(14)

745	Comet-Th/2in	0.99950(0240)	1.00044(09)	1.00020(09)	1.00029(09)
746	SB-1	1.00060(0270)	0.99949(09)	1.00624(10)	0.99649(10)
747	SB-5	1.00150(0280)	0.99860(09)	1.00387(09)	0.99686(09)
748	SB-2	1.00150(0250)	1.00205(11)	1.00726(11)	0.99900(11)
749	SB-2+h	1.00000(0240)	1.00216(10)	1.00339(10)	1.00048(11)
750	SB-3	1.00070(0250)	1.00031(09)	1.00458(08)	0.99801(09)
751	SB-4	1.00150(0260)	0.99998(08)	1.00550(09)	0.99761(08)
752	SB-6	0.99950(0270)	1.00192(11)	1.00646(10)	0.99827(10)
753	SB-7	1.00040(0280)	0.99954(10)	1.00451(10)	0.99592(10)
754	ETA-II	1.00170(0180)	0.99775(11)	0.99875(11)	0.99865(11)
755	KBR-18(Th-U/PE)	0.96900(0516)	0.98115(06)	0.97142(06)	0.97886(06)
756	KBR-19(Th-U/PE)	0.98000(0300)	0.97963(40)	0.97749(40)	0.98158(41)
757	KBR-20(Th-U/PE)	1.01400(0600)	1.01858(52)	1.02090(51)	1.01620(51)
758	KBR-21(Th-U/PE)	0.96400(1200)	0.93716(56)	0.94009(56)	0.93772(53)
759	KBR-22(Th-U/PE)	1.00010(0410)	0.99432(54)	0.98731(51)	0.99206(52)
760	KBR-23(Th-U/PE)	1.00080(0360)	1.00405(59)	1.00697(61)	1.00414(60)
761	RRC-KI-21x21-001	0.99880(0420)	0.98791(14)	0.99073(14)	0.98869(15)
762	RRC-KI-21x21-002	0.99880(0420)	0.99027(15)	0.99232(14)	0.99098(14)
763	RRC-KI-21x21-003	0.99880(0420)	0.99192(14)	0.99300(13)	0.99270(14)
764	RRC-KI-18x18-001	0.99870(0320)	0.98812(15)	0.99014(15)	0.98897(15)
765	RRC-KI-18x18-002	0.99870(0340)	0.98971(14)	0.99069(14)	0.99088(13)
766	RRC-KI-14x14-001	0.99880(0420)	0.99099(14)	0.99296(15)	0.99186(14)
767	RRC-KI-14x14-002	0.99880(0430)	0.99264(13)	0.99263(14)	0.99363(13)
768	RRC-KI-10x10-001	0.99860(0480)	0.99802(14)	0.99867(14)	0.99872(14)
769	RRC-KI-10x10-001	0.99860(0490)	0.99883(14)	0.99818(13)	0.99936(13)
770	IGR-Graphite-1	1.00000(1100)	1.01096(18)	1.00288(16)	1.00938(15)
771	IGR-Graphite-2	1.00000(1100)	1.00398(16)	0.99878(16)	1.00561(16)
772	IGR-Graphite-3	1.00000(1100)	1.00534(16)	( )	1.00663(16)
773	IGR-Graphite-4	1.00000(1100)	1.00886(16)	( )	1.01054(16)
774	ETA-I	0.99950(0200)	0.99427(11)	0.99642(11)	0.99439(10)
775	TUPE-001(15/1)	1.00080(0290)	0.99918(25)	0.99957(26)	0.99861(24)
776	TUPE-002(15/1)	1.00040(0240)	0.99673(27)	0.99671(25)	0.99562(25)
777	TUPE-003(15/1)	1.00080(0240)	1.00658(24)	1.00693(24)	1.00707(24)
778	TUPE-004(25/1)	1.00230(0160)	1.00750(20)	1.00760(20)	1.00785(20)
779	TUPE-005(25/1)	1.00150(0140)	1.00753(19)	1.00737(20)	1.00785(19)
780	TUPE-006(15/1)	1.00380(0290)	1.00116(29)	1.00195(28)	0.99983(27)
781	TUPE-007(15/1)	1.00330(0290)	0.99973(26)	0.99979(26)	0.99785(26)
782	TUPE-008(15/1)	1.00220(0290)	0.99974(25)	1.00045(25)	0.99820(25)
783	TUPE-009(15/1)	1.00210(0290)	0.99891(26)	0.99973(26)	0.99788(27)
784	TUPE-010(15/1)	1.00180(0290)	0.99570(26)	0.99646(26)	0.99511(28)
785	TUPE-011(15/1)	1.00080(0290)	0.99520(26)	0.99562(27)	0.99420(26)
786	TUPE-012(15/1)	1.00080(0290)	0.99498(27)	0.99535(25)	0.99413(27)
787	TUPE-013(15/1)	1.00080(0290)	0.99516(26)	0.99566(28)	0.99462(27)
788	TUPE-014(15/1)	1.00410(0250)	1.00655(27)	1.00725(27)	1.00527(28)
789	TUPE-015_Cb823	1.00460(0250)	1.00478(25)	1.00595(11)	1.00447(11)
790	TUPE-016_Cb070	1.00360(0250)	1.00457(25)	1.00580(11)	1.00404(11)
791	TUPE-017_Cb070	1.00240(0250)	1.00558(25)	1.00624(11)	1.00499(11)
792	TUPE-018_Cb070	1.00210(0250)	1.00564(25)	1.00588(11)	1.00449(11)
793	TUPE-019_Cb070	1.00150(0250)	1.00496(25)	1.00577(11)	1.00454(11)
794	TUPE-020_Cb070	1.00160(0250)	1.00459(25)	1.00462(11)	1.00365(11)
795	TUPE-021_Cb070	1.00040(0250)	1.00415(25)	1.00438(11)	1.00314(10)
796	TUPE-022_Cb070	1.00140(0250)	1.00284(25)	1.00374(11)	1.00265(11)
797	TUPE-023_Cb322	1.00360(0240)	1.00536(08)	1.00677(11)	1.00439(11)
798	TUPE-024_Cb322	1.00400(0240)	1.00529(08)	1.00667(11)	1.00447(11)
799	TUPE-025_Cb322	1.00250(0240)	1.00689(08)	1.00805(11)	1.00589(11)
800	TUPE-026_Cb322	1.00250(0240)	1.00695(08)	1.00805(11)	1.00620(11)
801	TUPE-027_Cb322	1.00090(0240)	1.00773(08)	1.00846(11)	1.00686(11)
802	TUPE-028_Cb322	1.00110(0240)	1.00802(08)	1.00898(11)	1.00706(11)
803	TUPE-029_Cb322	1.00180(0240)	1.00767(08)	1.00853(11)	1.00686(11)
804	TUPE-030_Cb322	1.00110(0240)	1.00685(08)	1.00766(11)	1.00642(11)
805	TUPE-031_Cb322	1.00150(0240)	1.00625(08)	1.00687(11)	1.00556(10)
806	TUPE-032_Cb586	1.00260(0250)	1.00759(08)	1.00918(12)	1.00647(11)
807	TUPE-033_Cb586	1.00380(0250)	1.00769(08)	1.00934(11)	1.00670(11)
808	TUPE-034_Cb586	1.00350(0250)	1.00778(08)	1.00927(11)	1.00679(11)
809	TUPE-035_Cb586	1.00290(0250)	1.00775(08)	1.00960(11)	1.00703(11)
810	TUPE-036_Cb586	1.00370(0250)	1.00784(08)	1.00947(11)	1.00691(11)
811	TUPE-037_Cb586	1.00240(0250)	1.00892(08)	1.01022(11)	1.00785(11)
812	TUPE-038_Cb586	1.00280(0250)	1.00951(08)	1.01060(11)	1.00838(11)

813	TUPE-039_Cb586	1.00150(0250)	1.00864(08)	1.01008(11)	1.00787(11)
814	TUPE-040_Cb586	1.00180(0250)	1.00877(08)	1.01008(11)	1.00789(11)
815	TUPE-041_Cb586	1.00130(0250)	1.00839(08)	1.00957(11)	1.00772(11)
816	TUPE-042_Cb586	1.00010(0250)	1.00842(08)	1.00970(11)	1.00752(11)
817	TUPE-043_Cb586	1.00080(0250)	1.00809(08)	1.00913(11)	1.00714(11)
818	TUPE-044_Cb823	1.00350(0300)	1.01144(08)	1.01308(11)	1.01060(11)
819	TUPE-045_Cb823	1.00330(0300)	1.01061(25)	1.01243(11)	1.00985(11)
820	TUPE-046_Cb823	1.00260(0300)	1.01109(25)	1.01249(11)	1.00998(11)
821	TUPE-047_Cb823	1.00260(0300)	1.01013(25)	1.01208(11)	1.00954(12)
822	TUPE-048_Cb823	1.00210(0300)	1.01059(25)	1.01227(11)	1.00993(11)
823	TUPE-049_Cb823	1.00160(0300)	1.01067(26)	1.01230(11)	1.00975(11)
824	TUPE-050_Cb823	1.00150(0300)	1.01023(25)	1.01180(11)	1.00976(11)
825	TUPE-051_Cb823	1.00180(0300)	1.01004(25)	1.01202(11)	1.00973(11)
826	TUPE-052_Cb823	1.00080(0300)	1.01032(25)	1.01202(11)	1.00951(11)
827	TUPE-053_Cb823	1.00080(0300)	1.01065(25)	1.01180(11)	1.00950(11)
828	TUPE-054(15/1)	1.00460(0180)	1.00896(11)	1.00979(11)	1.00915(11)
829	TUPE-055(15/1)	1.00490(0180)	1.00892(11)	1.00933(11)	1.00908(11)
830	TUPE-056(15/1)	1.00400(0180)	1.00790(11)	1.00841(11)	1.00780(11)
831	TUPE-057(15/1)	1.00310(0180)	1.00760(11)	1.00839(11)	1.00796(11)
832	TUPE-058(15/1)	1.00280(0180)	1.00800(11)	1.00843(11)	1.00831(11)
833	TUPE-059(15/1)	1.00080(0180)	1.00703(15)	1.00731(11)	1.00710(11)
834	TUPE-060(15/1)	1.00080(0180)	1.00779(14)	1.00824(11)	1.00814(11)
835	TUPE-061(15/1)	1.00080(0180)	1.00778(14)	1.00818(11)	1.00815(10)
836	TUPE-062(15/1)	1.00120(0180)	1.00798(11)	1.00830(11)	1.00797(10)
837	TUPE-094(25/1)	1.00260(0160)	1.00521(21)	1.00587(08)	1.00597(09)
838	TUPE-095(25/1)	1.00210(0160)	1.00585(20)	1.00601(09)	1.00635(09)
839	TUPE-096(25/1)	1.00210(0160)	1.00603(20)	1.00640(09)	1.00665(09)
840	TUPE-097(25/1)	1.00190(0160)	1.00672(20)	1.00697(09)	1.00737(09)
841	TUPE-098(25/1)	1.00150(0160)	1.00727(20)	1.00771(09)	1.00790(09)
842	TUPE-099(25/1)	1.00100(0160)	1.00780(20)	1.00818(08)	1.00845(09)
843	TUPE-100(25/1)	1.00150(0160)	1.00817(20)	1.00792(08)	1.00844(09)
844	AZPR-9/1 (as built	1.00220(0110)	1.00429(08)	1.00198(08)	1.00366(07)
845	WZPR-9/2 (as built	1.00320(0101)	1.00441(07)	1.01037(07)	1.00445(07)
846	WZPR-9/3 (as built	1.00250(0102)	1.00528(16)	1.01496(07)	1.00494(07)
847	WZPR-9/4 (as built	1.00130(0114)	1.00864(17)	1.01454(18)	1.00790(18)
848	WZPR-9/5 (as built	1.00230(0112)	1.00602(19)	1.00817(18)	1.00727(18)
849	WZPR-9/6 (as built	1.00290(0120)	1.00434(17)	1.00679(18)	1.00308(18)
850	AZPR-9/7 (as built	1.00390(0122)	1.00861(19)	1.01380(18)	1.01014(19)
851	BZPR-9/8 (as built	1.00200(0125)	1.00184(19)	1.00562(18)	1.00207(19)
852	AZPR-9/9 (as built	1.00290(0120)	1.00594(19)	1.01055(19)	1.00732(19)
853	Topsy-W_1.9in	1.00000(0500)	1.00140(08)	1.00140(09)	1.00083(08)
854	Topsy-W_2.9in	1.00000(0500)	1.00176(08)	1.00153(08)	1.00110(08)
855	Topsy-W_4.5in	1.00000(0500)	1.00499(08)	1.00490(08)	1.00455(09)
856	Topsy-W_6.5in	1.00000(0500)	1.00884(08)	1.00951(08)	1.00910(08)
857	Topsy-Ni	1.00000(0500)	1.00862(08)	1.00526(08)	0.99944(08)
858	LANL_hmf004(s)	1.00200(0100)	1.00351(11)	1.00135(11)	1.00251(11)
859	FKBN2-1cm	0.99990(0160)	0.99791(14)	0.99780(14)	0.99818(15)
860	FKBN2-3cm	0.99940(0150)	0.99931(14)	0.99965(14)	0.99954(14)
861	FKBN2-8cm	0.99940(0160)	0.99846(14)	0.99900(14)	0.99835(14)
862	FKBN2-f1	0.99990(0120)	0.99803(15)	1.00026(16)	0.99872(17)
863	FKBN2-f2	0.99930(0110)	1.00486(17)	1.00491(16)	1.00326(16)
864	FKBN2-f3	1.00000(0094)	0.99550(20)	0.99563(20)	0.99306(21)
865	Comet-W1.0in	0.99940(0190)	0.99969(08)	1.00050(08)	0.99848(08)
866	Comet-W0.5in	0.99950(0200)	0.99805(08)	0.99857(08)	0.99726(08)
867	Comet-W/2in	0.99970(0290)	1.00604(09)	1.00658(09)	1.00347(09)
868	Planet-Pu/W1.8in	1.00000(0130)	1.00107(08)	1.00125(08)	0.99923(08)
869	Planet_U3U5_10kg	1.00000(0100)	1.00017(10)	1.00128(11)	1.00148(11)
870	Planet_U3U5_7.6kg	1.00000(0100)	0.99882(11)	1.00003(11)	1.00015(10)
871	Planet_U3U8_10kg	1.00000(0100)	0.99799(11)	1.00074(11)	0.99868(10)
872	Planet_U3U8_7.6kg	1.00000(0100)	0.99767(12)	1.00092(11)	0.99823(12)
873	Planet-U233/W1in	1.00000(0070)	0.99841(06)	1.00036(06)	0.99955(06)
874	Planet-U233/W2in	1.00000(0080)	0.99537(06)	0.99819(06)	0.99655(06)
875	Planet_U3Be_10kg	1.00000(0300)	0.99607(11)	0.99705(12)	0.99755(12)
876	Planet_U3Be_7.6kg	1.00000(0300)	0.99539(12)	0.99636(12)	0.99729(12)
877	LANL-pmf009	1.00000(0270)	0.99926(13)	0.99886(13)	0.99945(13)
878	ZPPR-21A	0.99670(0260)	0.99597(14)	0.99817(14)	0.99613(14)
879	ZPPR-21F	0.99980(0250)	1.00430(47)	1.00433(50)	1.00425(48)
880	KBR-16(Zr)	0.99700(1300)	0.93370(06)	0.94989(41)	0.96850(42)

881	hct007-2	1.00000(0410)	0.99599(19)	0.99554(16)	0.99916(16)
882	hcm003-1	1.00000(0001)	0.99793(36)	1.00269(36)	0.99541(38)
883	IPPE-MATR_22.7C	1.00140(0390)	0.99966(15)	0.99642(16)	1.00063(15)
884	IPPE-MATR_16.4C_G	1.00170(0440)	1.00400(10)	1.00138(10)	1.00468(10)
885	IPPE-MATR_14.5C_C	1.00140(0430)	0.99792(16)	0.99540(15)	0.99890(14)
886	TRIGA C132	1.00060(0560)	1.00393(12)	1.00954(09)	1.00483(15)
887	TRIGA C133	1.00460(0560)	1.00918(10)	1.01414(08)	1.00952(11)
888	PBF-1	1.00660(0600)	1.01284(07)	1.01443(23)	1.01207(24)
889	PBF-2	1.00650(0600)	1.01234(08)	1.01405(24)	1.01097(24)
890	LANL_mmf001	1.00000(0160)	0.99956(08)	0.99911(08)	0.99936(09)
891	VNIITF-CTF_mmf003	0.99930(0160)	1.00063(09)	1.00038(09)	1.00067(09)
892	ZEBRA-8H	1.03000(0240)	1.01896(06)	1.02624(07)	1.02317(07)
893	ZPPR-21B	0.98970(0230)	0.99062(50)	0.99269(13)	0.99047(14)
894	ZPPR-21C	0.99980(0230)	0.99705(15)	0.99756(14)	0.99677(13)
895	ZPPR-21D	1.00180(0240)	1.00124(15)	1.00138(14)	1.00173(14)
896	ZPPR-21E	1.00120(0240)	1.00329(13)	1.00315(14)	1.00303(14)
897	hcm002-001	1.00000(0850)	0.98697(14)	0.98502(15)	0.98656(14)
898	hcm002-002	1.00000(0880)	0.98755(14)	0.98511(13)	0.98781(13)
899	hcm002-003	1.00000(0930)	0.98551(15)	0.98557(15)	0.98924(14)
900	hcm002-004	1.00000(0870)	0.99338(16)	0.99292(15)	0.99258(14)
901	hcm002-005	1.00000(0890)	0.99212(15)	0.99221(16)	0.99153(15)
902	hcm002-006	1.00000(0930)	0.97056(15)	0.97482(14)	0.97602(14)
903	hcm002-007	1.00000(0860)	0.97209(14)	0.97505(14)	0.97672(14)
904	hcm002-008	1.00000(0680)	0.99329(15)	0.99115(15)	0.99124(15)
905	hcm002-009	1.00000(0760)	0.98961(14)	0.98720(15)	0.98792(14)
906	hcm002-010	1.00000(0810)	0.98111(15)	0.98287(15)	0.98267(14)
907	hcm002-011	1.00000(0880)	0.97758(15)	0.98021(14)	0.97952(15)
908	hcm002-012	1.00000(0780)	0.98853(16)	0.98825(16)	0.98798(15)
909	hcm002-013	1.00000(0830)	0.98414(15)	0.98437(16)	0.98346(15)
910	hcm002-014	1.00000(1120)	0.98277(16)	0.98388(15)	0.98375(15)
911	hcm002-015	1.00000(1110)	0.98281(14)	0.98247(13)	0.98336(14)
912	hcm002-016	1.00000(1080)	0.97784(14)	0.97978(14)	0.98138(13)
913	hcm002-017	1.00000(1120)	0.97928(15)	0.97994(14)	0.98164(14)
914	hcm002-018	1.00000(1110)	0.98560(15)	0.98546(14)	0.98473(15)
915	hcm002-019	1.00000(1070)	0.98978(14)	0.98905(15)	0.98842(14)
916	hcm002-020	1.00000(1080)	0.97703(15)	0.97897(14)	0.98080(14)
917	hcm002-021	1.00000(0920)	0.97951(14)	0.97740(14)	0.98011(13)
918	hcm002-022	1.00000(0900)	0.98652(14)	0.98460(14)	0.98619(14)
919	hcm002-023	1.00000(0930)	0.98718(14)	0.98455(14)	0.98776(13)
920	KBR-07(Ni)	1.03200(0400)	1.04203(07)	1.01237(17)	1.04985(17)
921	KBR-09(SS)	1.05000(0800)	1.09830(08)	1.10144(17)	1.08570(16)
922	KBR-10(Mo)	1.03000(0600)	1.05158(07)	1.05388(17)	1.04377(17)
923	KBR-15(Cr)	1.06400(1800)	1.18068(08)	1.18411(18)	1.18829(18)
924	BR-1-3	1.00440(0070)	1.00009(12)	1.00237(13)	1.00368(14)
925	pmf025	1.00000(0200)	0.99866(11)	0.99666(12)	0.99973(11)
926	pmf026	1.00000(0240)	0.99853(12)	0.99726(12)	1.00157(12)
927	pmf028	1.00000(0220)	0.99914(11)	0.99914(12)	1.00304(11)
928	pmf032	1.00000(0200)	0.99848(12)	0.99699(11)	1.00133(11)
929	VNIITF-CTF-020	1.00000(0300)	1.00060(09)	1.00087(10)	1.00042(09)
930	VNIITF-CTF-SS-21	1.00000(0240)	0.99724(17)	0.99644(17)	1.00002(16)
931	VNIITF-CTF-022	1.00000(0210)	0.99748(09)	0.99716(09)	0.99733(09)
932	VNIITF-CTF-SS-24	0.99900(0150)	0.99865(16)	0.99665(15)	0.99820(15)
933	Tinkertoy_2-c11	1.00000(0380)	1.00333(11)	1.00177(11)	1.00205(10)
934	VNIITF-CTF-Fe	0.99870(0130)	0.99820(09)	0.99790(09)	0.99990(09)
935	hmf088-1	0.99930(0080)	0.99714(11)	0.99559(11)	0.99811(10)
936	hmf088-2	0.99930(0070)	0.99673(11)	0.99469(11)	0.99667(12)
937	ZPR-9/34	0.99660(0260)	1.00064(14)	1.00908(15)	0.99776(15)
938	ZPR-9/34(d)	1.00060(0110)	1.00301(12)	1.01176(12)	1.00010(12)
939	HISS_Pu	1.00000(1100)	1.01170(11)	0.99819(11)	1.00746(10)
940	ZPR-6/10	0.98690(0260)	1.01466(40)	1.00251(14)	1.00367(13)
941	ZPR-3/58(U)	0.98420(0160)	0.98789(10)	0.98854(10)	0.98610(10)
942	ZPR-3/59(Pb)	0.98690(0260)	0.97482(11)	0.97381(11)	0.97195(11)
943	ZPR-6/7(s)	0.98660(0230)	0.98663(16)	0.99105(14)	0.98323(14)
944	ZPR-6/7(Pu240)	0.98740(0220)	0.98568(07)	0.99039(07)	0.98246(07)
945	ZPR-9/31	1.00070(0110)	0.99695(16)	1.00267(17)	0.99700(17)
946	ZPR-9/31	0.99130(0230)	0.98713(07)	0.99273(07)	0.98714(07)
947	ZPPR-2	0.98890(0210)	0.99125(07)	0.99533(07)	0.98819(07)
948	PNL-PRCF-30	1.00100(0590)	1.00028(10)	1.00081(11)	1.00024(10)

949	PNL-PRCF-31	1.00090(0450)	1.00193(11)	1.00315(10)	1.00118(11)
950	PNL-PRCF-32	1.00240(0290)	1.00229(10)	1.00077(10)	1.00060(10)
951	PNL-PRCF-33	1.00240(0210)	1.00612(11)	1.00590(10)	1.00514(10)
952	PNL-PRCF-34	1.00380(0220)	1.00350(10)	1.00144(10)	1.00187(10)
953	PNL-PRCF-35	1.00290(0240)	1.00585(09)	1.00398(10)	1.00471(10)
954	RB-Vinca(1)	0.99970(0570)	0.99865(11)	0.99654(11)	0.99653(10)
955	RB-Vinca(2-01)	1.00000(1410)	1.01358(14)	1.00577(14)	1.00604(14)
956	RB-Vinca(2-02)	1.00000(1410)	1.00706(13)	1.00107(13)	1.00112(14)
957	RB-Vinca(2-03)	1.00000(1410)	1.01282(14)	1.00602(13)	1.00627(14)
958	RB-Vinca(2-11)	1.00000(1410)	1.00064(13)	0.99984(14)	0.99911(13)
959	RB-Vinca(2-12)	1.00000(1410)	1.00914(12)	1.00588(12)	1.00543(12)
960	ZED-2_1	1.00000(0331)	0.99892(04)	0.99623(10)	0.99661(10)
961	ZED-2_2	1.00000(0328)	0.99855(10)	0.99671(10)	0.99709(09)
962	ZED-2_3	1.00000(0327)	0.99887(09)	0.99623(09)	0.99694(10)
963	RB-Vinca-01	1.00000(0510)	1.00131(12)	1.00167(11)	1.00087(12)
964	RB-Vinca-02	1.00000(0510)	0.99531(11)	0.99530(11)	0.99465(11)
965	RB-Vinca-03	1.00000(0510)	1.00266(12)	1.00277(12)	1.00215(12)
966	RB-Vinca-04	1.00000(0510)	1.00068(11)	1.00063(11)	1.00029(11)
967	RB-Vinca-05	1.00000(0510)	1.00064(11)	1.00030(12)	1.00008(11)
968	RB-Vinca-06	1.00000(0510)	1.00032(12)	1.00000(11)	0.99935(12)
969	RB-Vinca-07	1.00000(0510)	0.99989(12)	0.99971(12)	0.99913(12)
970	RB-Vinca-08	1.00000(0510)	1.00798(11)	1.00281(11)	1.00269(11)
971	RB-Vinca-09	1.00000(0510)	1.00798(12)	1.00306(11)	1.00268(11)
972	RB-Vinca-10	1.00000(0510)	1.00840(11)	1.00357(11)	1.00296(11)
973	RB-Vinca-11	1.00000(0510)	1.00834(11)	1.00326(11)	1.00300(11)
974	RB-Vinca-12	1.00000(0510)	1.00851(11)	1.00361(11)	1.00347(11)
975	RB-Vinca-13	1.00000(0510)	1.00816(12)	1.00291(11)	1.00298(11)
976	RB-Vinca-14	1.00000(0510)	1.00799(11)	1.00295(11)	1.00263(11)
977	RB-Vinca-15	1.00000(0510)	1.00796(12)	1.00172(12)	1.00149(11)
978	RB-Vinca-16	1.00000(0510)	1.00830(12)	1.00172(12)	1.00151(11)
979	RB-Vinca-17	1.00000(0510)	1.00806(11)	1.00155(11)	1.00134(12)
980	RB-Vinca-18	1.00000(0510)	1.00809(11)	1.00161(11)	1.00150(11)
981	RB-Vinca-19	1.00000(0510)	1.00773(12)	1.00124(12)	1.00101(11)
982	RB-Vinca-20	1.00000(0510)	1.00854(12)	1.00195(11)	1.00164(12)
983	RB-Vinca-21	1.00000(0510)	1.00806(12)	1.00169(12)	1.00161(12)
984	RB-Vinca-22	1.00000(0510)	1.00811(11)	1.00163(11)	1.00159(11)
985	ORCEF(1)	0.99980(0170)	0.99878(09)	0.99867(09)	0.99659(09)
986	ORCEF(2)	0.99780(0180)	0.99635(09)	0.99655(09)	0.99414(09)
987	ORCEF(3)	0.99930(0090)	0.99868(09)	0.99784(09)	0.99716(09)
988	ORCEF(4)	0.99720(0100)	0.99642(09)	0.99557(09)	0.99471(10)
989	ORCEF(5)	0.99830(0100)	0.99814(09)	0.99608(09)	0.99737(08)
990	ORCEF(6)	0.99700(0100)	0.99619(09)	0.99466(08)	0.99524(09)
991	ORCEF(7)	0.99840(0180)	0.99704(08)	0.99291(09)	0.99693(08)
992	ORCEF(8)	0.99680(0190)	0.99522(08)	0.99088(09)	0.99487(09)
993	Bugey-28	1.00000(0180)	0.99733(13)	0.99458(14)	0.99804(15)
994	Bugey-27	1.00000(0180)	0.99738(13)	0.99481(15)	0.99800(12)
995	Bugey-26	1.00000(0180)	0.99800(13)	0.99524(13)	0.99852(13)
996	Bugey-10	1.00000(0170)	1.00123(28)	0.99931(18)	1.00253(22)
997	Bugey-09	1.00000(0170)	1.00157(20)	0.99975(17)	1.00164(17)
998	Bugey-13	1.00000(0160)	1.00231(17)	0.99921(19)	1.00245(22)
999	Bugey-07	1.00000(0160)	1.00192(20)	0.99916(19)	1.00243(18)
1000	Bugey-06	1.00000(0160)	1.00197(17)	0.99962(16)	1.00232(18)
1001	Bugey-05	1.00000(0160)	1.00150(19)	1.00150(19)	1.00150(19)
1002	Bugey-12	1.00000(0160)	1.00222(20)	0.99982(17)	1.00272(18)
1003	Bugey-04	1.00000(0160)	1.00129(18)	0.99915(20)	1.00233(19)
1004	Bugey-16	1.00000(0170)	1.00272(19)	1.00008(19)	1.00353(18)
1005	Bugey-14	1.00000(0170)	1.00279(17)	1.00032(20)	1.00389(19)
1006	Bugey-20	1.00000(0190)	1.00400(17)	1.00029(18)	1.00498(19)
1007	Bugey-19	1.00000(0190)	1.00368(20)	1.00085(19)	1.00476(18)
1008	Bugey-18	1.00000(0190)	1.00401(19)	1.00055(20)	1.00467(20)
1009	Bugey-24	1.00000(0190)	1.00323(18)	0.99931(18)	1.00444(21)
1010	Bugey-23	1.00000(0190)	1.00302(20)	0.99906(21)	1.00461(19)
1011	Bugey-51	1.00000(0160)	0.99903(20)	0.99577(18)	0.99973(18)
1012	Bugey-50	1.00000(0160)	1.00186(18)	0.99859(20)	1.00229(19)
1013	Bugey-49	1.00000(0160)	1.00107(19)	0.99818(18)	1.00192(20)
1014	Bugey-46	1.00000(0160)	1.00169(19)	0.99853(19)	1.00204(18)
1015	Bugey-45	1.00000(0160)	1.00172(19)	0.99838(18)	1.00260(19)
1016	Bugey-44	1.00000(0160)	1.00162(19)	0.99847(19)	1.00217(17)

1017	Bugey-33	1.00000(0160)	1.00290(18)	0.99990(20)	1.00347(16)
1018	Bugey-32	1.00000(0160)	1.00324(18)	1.00032(18)	1.00394(17)
1019	Bugey-31	1.00000(0160)	1.00325(18)	1.00008(19)	1.00356(17)
1020	Bugey-30	1.00000(0160)	1.00362(18)	1.00054(19)	1.00457(20)
1021	Bugey-42	1.00000(0180)	1.00298(20)	0.99961(17)	1.00426(20)
1022	Bugey-43	1.00000(0180)	1.00286(12)	0.99943(13)	1.00385(12)
1023	ORNL_196-1602	0.99830(1140)	0.99955(11)	1.00104(11)	0.99802(11)
1024	ORNL_180-1440	0.99760(0680)	0.99843(11)	0.99971(11)	0.99778(11)
1025	ORNL_161-0907	0.99740(0310)	0.99699(11)	0.99770(11)	0.99648(11)
1026	ORNL_149-0955	0.99740(0060)	0.99572(11)	0.99607(11)	0.99583(11)
1027	ORNL_171-1400	0.9972 (280)	0.99409(10)	0.99364(10)	0.99458(10)
1028	ORNL_245-1115	0.9967 (530)	0.99048(09)	0.98808(09)	0.99086(09)
1029	Planet_Gd_15mil	1.00650(0700)	1.00869(12)	1.00904(12)	1.00993(12)
1030	Valduc_02I	1.00000(0096)	1.00231(12)	1.00222(17)	1.00249(17)
1031	Valduc_02J	1.00000(0096)	1.00088(17)	1.00099(16)	1.00092(16)
1032	Valduc_01I	1.00000(0054)	1.00510(16)	1.00498(16)	1.00564(16)
1033	Valduc_01K	1.00000(0054)	1.00399(17)	1.00385(16)	1.00447(16)
1034	Valduc_03E	1.00000(0051)	1.00666(15)	1.00600(14)	1.00778(15)
1035	Valduc_04A	1.00000(0060)	1.00593(15)	1.00419(14)	1.00666(14)
1036	Valduc_04B	1.00000(0060)	1.00600(15)	1.00410(14)	1.00716(14)
1037	Valduc_04C	1.00000(0060)	1.00678(14)	1.00448(14)	1.00758(14)
1038	Valduc_04D	1.00000(0060)	1.00677(14)	1.00486(14)	1.00796(14)
1039	Valduc_06B	1.00000(0051)	1.00435(16)	1.00416(16)	1.00554(15)
1040	Valduc_07B	1.00000(0051)	1.00537(16)	1.00521(15)	1.00669(15)
1041	Valduc_07D	1.00000(0051)	1.00466(16)	1.00469(15)	1.00511(15)
1042	Valduc_08B	1.00000(0051)	1.00572(16)	1.00545(16)	1.00629(14)
1043	Valduc_09C	1.00000(0051)	1.00644(15)	1.00562(15)	1.00730(15)
1044	Valduc_10A	1.00000(0051)	1.00619(15)	1.00527(15)	1.00710(14)
1045	Valduc_11A	1.00000(0051)	1.00589(14)	1.00473(14)	1.00706(15)
1046	Valduc_11B	1.00000(0051)	1.00284(15)	1.00126(15)	1.00370(14)
1047	Valduc_12B	1.00000(0051)	1.00488(15)	1.00456(15)	1.00603(16)
1048	Valduc_13A	1.00000(0051)	1.00478(16)	1.00432(16)	1.00558(16)
1049	Valduc_14A	1.00000(0051)	1.01154(15)	1.01107(16)	1.01254(15)
1050	Valduc_15B	1.00000(0051)	1.00571(16)	1.00484(15)	1.00661(15)
1051	Valduc_16D	1.00000(0054)	1.00429(16)	1.00434(16)	1.00485(17)
1052	Valduc_17D	1.00000(0060)	1.00587(16)	1.00535(14)	1.00702(15)
1053	Valduc_17E	1.00000(0060)	1.00624(15)	1.00534(15)	1.00724(15)
1054	Valduc_18C	1.00000(0070)	1.00659(14)	1.00491(15)	1.00769(14)
1055	Valduc_18E	1.00000(0070)	1.00553(15)	1.00409(15)	1.00654(14)
1056	Valduc_19A	1.00000(0079)	1.00493(14)	1.00250(14)	1.00602(14)
1057	Valduc_19B	1.00000(0079)	1.00558(14)	1.00337(13)	1.00691(14)
1058	Valduc_19C	1.00000(0079)	1.00627(14)	1.00375(14)	1.00770(14)
1059	Valduc_19E	1.00000(0079)	1.00649(14)	1.00412(13)	1.00795(13)
1060	Valduc_20C	1.00000(0051)	1.00547(16)	1.00528(16)	1.00619(16)
1061	Valduc_20D	1.00000(0051)	1.00573(16)	1.00538(15)	1.00631(15)
1062	Valduc_20E	1.00000(0051)	1.00607(15)	1.00528(15)	1.00654(15)
1063	Valduc_21B	1.00000(0051)	1.00253(16)	1.00214(14)	1.00309(16)
1064	Valduc_22G	1.00000(0169)	1.00204(18)	1.00202(16)	1.00188(16)
1065	Valduc_22H	1.00000(0169)	1.00166(16)	1.00130(17)	1.00166(17)
1066	Valduc_23C	1.00000(0050)	1.00364(16)	1.00328(16)	1.00411(17)
1067	Valduc_24B	1.00000(0060)	1.00246(16)	1.00117(15)	1.00353(15)
1068	Valduc_24D	1.00000(0060)	1.00033(16)	0.99922(16)	1.00054(16)
1069	Valduc_25D	1.00000(0084)	1.00146(15)	0.99854(15)	1.00247(15)
1070	Valduc_26B	1.00000(0097)	1.00309(14)	0.99911(14)	1.00453(14)
1071	Valduc_27B	1.00000(0060)	1.00174(15)	1.00013(15)	1.00227(15)
1072	Valduc_27C	1.00000(0060)	0.99888(16)	0.99798(16)	0.99971(16)
1073	Planet_Al_Poly	0.99710(0250)	1.00922(13)	1.00989(12)	1.00927(12)
1074	Planet_Fe-PE-1	1.00210(0220)	1.00733(15)	1.00812(13)	1.00929(15)
1075	Planet_Fe-PE-2	0.99830(0200)	1.00732(15)	1.00849(15)	1.00907(15)
1076	Planet_SiO2_Poly	0.99390(0150)	1.00777(13)	1.00846(12)	1.00727(13)
1077	hmt015	1.00060(0210)	1.00809(15)	1.00891(15)	1.00970(15)
1078	Planet_Poly	1.00370(0240)	1.00891(12)	1.00921(12)	1.00992(11)
1079	ZEUS_Fe/Cu-1	1.00000(0240)	1.00841(09)	1.00773(09)	1.00396(09)
1080	ZEUS_Fe/Cu-3	1.00280(0690)	1.01220(10)	1.01371(10)	1.01138(10)
1081	ZEUS/Cu-1	1.00040(0160)	1.00811(10)	1.00362(09)	0.99970(09)

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