INL Adjustment Results Based on ENDF/B-VII and COMMARA 2.0

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Calculation Data

- **Cross Section Used: ENDF/B-VII data**
- **Covariance Used: COMMARA 2.0**
- **20 experiments have been used with MCNP solutions for all of them.**
- **Sensitivity coefficients calculated in S_4P_1 with ERANOS and ENDF/B-VII data**
- **Isotopes considered: U235, U238, Pu239, Pu240, Pu241, Fe56, Cr52, Ni58, O16, Na23, B10**
- **Reaction considered: Capture, Fission, Nu, Elastic, Inelastic, χ**
- **409 variables were selected using the following criteria on uncertainty produced by a single cross section: 0.01% for Keff, 0.1% for spectral indices, and 0.1% for sodium void.**
- **With respect to last time, beside adding the χ variables, an error has been corrected (misplaced C/E), and the new experiment and calculational covariance have been used.**

Experimental Cov. Matrix (from M. Ishikawa)

No.	Core		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Jezebel - Pu239	keff	0.2																			
2		F28/F25	0	1.1																		
3		F37/F25	0	0.32	0.9																	
4		F49/F25	0	0.23	0.23	1.4																
5	Jezebel - Pu240	keff	0	0	0	0	0.2															
6	Flattop	keff	0	0	0	0	0	0.3														
7		F28/F25	0	0	0	0	0	0	1.1													
8		F37/F25	0	0	0	0	0	0	0.23	1.4												
9	ZPR6-7	keff	0	0	0	0	0	0	0	0	0.23											
10		F28/F25	0	0	0	0	0	0	0	0	0	3										
11		F49/F25	0	0	0	0	0	0	0	0	0	0.23	2.1									
12		C28/F25	0	0	0	0	0	0	0	0	0	0.23	0.32	2.4								
13	ZPR6-7 Pu240	keff	0	0	0	0	0	0	0	0	0.13	0	0	0	0.22							
14	ZPPR-9	keff	0	0	0	0	0	0	0	0	0.31	0	0	0	0.3	0.117						
15		F28/F25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.7					
16		F49/F25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.23	2				
17		C28/F25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.23	0.32	1.9			
18		Central Na void	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.9		
19		Large Na void	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.41	1.9	
20	Joyo	keff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.18

Calculational Cov. Matrix (corr. from M. Ishikawa)

No.	Core		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1		keff	0.02																			
2	Jezebel - Pu239	F28/F25	0	0.9																		
3		F37/F25	0	0.5	0.3																	
4		F49/F25	0	0.5	0.5	0.3																
5	Jezebel - Pu240	keff	0	0	0	0	0.02															
6	Flattop	keff	0	0	0	0	0	0.04														
7		F28/F25	0	0	0	0	0	0	1.5													
8		F37/F25	0	0	0	0	0	0	0.5	0.3												
9	ZPR6-7	keff	0	0	0	0	0	0	0	0	0.01											
10		F28/F25	0	0	0	0	0	0	0	0	0	1.5										
11		F49/F25	0	0	0	0	0	0	0	0	0	0.5	1.4									
12		C28/F25	0	0	0	0	0	0	0	0	0	0.5	0.5	1.2								
13	ZPR6-7 Pu240	keff	0	0	0	0	0	0	0	0	0	0	0	0	0.02							
14	ZPPR-9	keff	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01						
15		F28/F25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1					
16		F49/F25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0.7				
17		C28/F25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0.5	0.6			
18		Central Na void	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.5		
19		Large Na void	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.3	
20	Joyo	keff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02

C/E Before and After Adjustment Normalized χ^2=0.50

Experiment	old C/E ± σ	new C/E ± σ	Experiment	old C/E ± σ	new C/E ± σ
JEZEBEL_Pu239 Keff	0.9999 ± 0.002	0.9999 ± 0.002	ZPR6-7 Pu239 F49/F25	0.96380± 0.025	0.9659 ± 0.006
JEZEBEL_Pu239 F28/F25	0.9770 ± 0.014	0.9929 ± 0.011	ZPR6-7 Pu239 C28/F25	1.0098 ± 0.027	1.0076 ± 0.009
JEZEBEL_Pu239 F37/F25	0.9870 ± 0.014	0.9987 ± 0.008	ZPR6-7 Pu240 Keff	0.9994 ± 0.002	0.9997 ± 0.001
JEZEBEL_Pu239 F49/F25	0.9753 ± 0.009	0.9837 ± 0.005	ZPPR9 Keff	0.9992 ± 0.001	1.0002 ± 0.001
JEZEBEL_Pu240 Keff	0.9998 ± 0.002	1.0000 ± 0.002	ZPPR9 F28/F25	0.9710 ± 0.029	0.9828 ± 0.018
FLATTOP Keff	1.0010 ± 0.003	1.0008 ± 0.002	ZPPR9 F49/F25	0.9808± 0.021	0.9865 ± 0.006
FLATTOP F28/F25	0.9822 ± 0.019	0.9964 ± 0.009	ZPPR9 C28/F25	1.0093 ± 0.020	1.0072 ± 0.009
FLATTOP F37/F25	0.9956 ± 0.014	1.0067± 0.007	ZPPR9 Na Void Step 3	1.0192± 0.077	1.0257 ± 0.036
ZPR6-7 Pu239 Keff	1.0004 ± 0.002	1.0008 ± 0.001	ZPPR9 Na Void Step 5	0.9732 ± 0.075	0.9816 ± 0.045
ZPR6-7 Pu239 F28/F25	1.0045 ± 0.035	1.0158 ± 0.016	JOYO Keff	0.9975 ± 0.002	0.9998 ± 0.002

Uncertainties Before and After Adjustment

Experiment	Unc. before adj	Unc. after adj	Experiment	Unc. before adj	Unc. after adj
JEZEBEL_Pu239 Keff (pcm)	± 636	± 164	ZPR6-7 Pu239 F49/F25 (%)	± 0.8	± 0.6
JEZEBEL_Pu239 F28/F25 (%)	± 3.7	± 1.1	ZPR6-7 Pu239 C28/F25 (%)	± 1.5	± 0.9
JEZEBEL_Pu239 F37/F25 (%)	± 2.4	± 0.8	ZPR6-7 Pu240 Keff (pcm)	± 971	± 134
JEZEBEL_Pu239 F49/F25 (%)	± 0.8	± 0.5	ZPPR9 Keff (pcm)	± 1191	± 121
JEZEBEL_Pu240 Keff (pcm)	± 656	± 181	ZPPR9 F28/F25 (%)	± 7.9	± 1.8
FLATTOP Keff (pcm)	± 764	± 222	ZPPR9 F49/F25 (%)	± 0.9	± 0.6
FLATTOP F28/F25 (%)	± 3.1	± 0.9	ZPPR9 C28/F25 (%)	± 1.5	± 0.9
FLATTOP F37/F25 (%)	± 2.0	± 0.7	ZPPR9 Na Void Step 3 (%)	± 7.6	± 3.6
ZPR6-7 Pu239 Keff (pcm)	± 968	± 131	ZPPR9 Na Void Step 5 (%)	± 9.7	± 4.5
ZPR6-7 Pu239 F28/F25 (%)	± 6.4	± 1.6	JOYO Keff (pcm)	± 863	± 185

Major Contributors to Improved C/E

JEZEBEL Keff

Cross Section	Contribution (pcm)
Pu239 σ^{fiss} gr. 5	78
Pu239 σ^{inel} gr. 6	-78
Pu239 σ^{inel} gr. 5	-69
Pu239 σ^{inel} gr. 4	-64
Pu239 σ^{fiss} gr. 4	64
Pu239 σ^{inel} gr. 7	-57
Pu239 σ^{fiss} gr. 6	49
Total	7

JEZEBEL F28/F25

Cross Section	Contribution (%)
Pu239 σ^{inel} gr. 5	0.4
Pu239 σ^{inel} gr. 4	0.4
Pu239 σ^{inel} gr. 3	0.3
Pu239 σ^{inel} gr. 6	0.2
Pu239 σ^{inel} gr. 7	0.1
Pu239 σ^{elas} gr. 8	0.1
Total	1.6

Major Contributors to Improved C/E

ZPR6/7 Keff

Cross Section	Contribution (pcm)
Pu239 σ^{capt} gr. 16	-34
Pu239 σ^{capt} gr. 17	-33
U238 σ^{inel} gr. 4	26
Pu239 σ^{capt} gr. 15	-24
U238 σ^{inel} gr. 4	23
Pu239 σ^{capt} gr. 14	-20
U238 ν gr. 5	-17
Pu239 σ^{fiss} gr. 7	16
Total	38

ZPPR9 Na Void Step 5

Cross Section	Contribution (%)
U238 σ^{inel} gr. 4	0.3
Pu239 σ^{cap} gr. 16	0.2
Pu239 σ^{cap} gr. 18	-0.2
U238 σ^{inel} gr. 5	0.2
U238 σ^{capt} gr. 20	-0.1
U238 σ^{capt} gr. 19	-0.1
Total	0.9

Major Contributors to Improved C/E

JOYO Keff

Cross Section	Contribution (pcm)
U235 σ^{cap} gr. 11	43
U235 σ^{cap} gr. 10	42
U235 σ^{cap} gr. 12	40
U235 σ^{cap} gr. 13	35
U235 σ^{cap} gr. 14	34
U235 σ^{cap} gr. 9	32
U235 σ^{cap} gr. 15	31
Total	230

Major Cross Section Adjustments

U238

Cross Sect.	Adjus. %	Stand. Deviat. %	
		Initial	Adj.
σ^{inel} gr. 3	-2.1	20.1	8.1
σ^{inel} gr. 4	-2.0	19.4	5.4
σ^{inel} gr. 5	-1.7	20.6	8.4
σ^{inel} gr. 6	-1.7	16.9	7.3

U235

Param.	Adjus. %	Stand. Deviat. %	
		Initial	Adj.
σ^{cap}gr. 9	-9.6	20.0	9.6
σ^{cap}gr. 10	-9.6	20.0	9.5
σ^{cap}gr. 11	-9.6	20.0	9.6
σ^{cap}gr. 12	-9.6	20.0	9.6
σ^{cap}gr. 13	-9.6	20.0	9.5
σ^{cap} gr. 14	-9.6	20.0	9.5

Major Cross Section Adjustments

Pu239

Cross Sect.	Adjus. %	Stand. Deviat. %	
		Initial	Adj.
σ^{inel} gr. 3	-8.4	25.6	19.5
σ^{inel} gr. 4	-7.8	19.6	11.5
σ^{inel} gr. 5	-7.9	19.0	9.0
σ^{inel} gr. 6	-9.8	27.0	14.4
σ^{inel} gr. 7	-10.5	32.6	19.8
σ^{inel} gr. 8	-9.3	32.7	22.0
σ^{fis} gr. 4	0.5	0.9	0.8
σ^{fis} gr. 5	0.5	0.9	0.8
σ^{fis} gr. 6	0.4	0.8	0.7
σ^{cap} gr. 16	7.1	16.5	14.8
σ^{cap} gr. 17	7.1	16.5	14.8
σ^{cap} gr. 18	4.7	10.7	9.6

Uncertainty Evaluation

- **Reactors: ABR oxide and JAEA FBR as target, ABR metal and oxide recycled for extrapolability.**
- **Calculational data: provided RZ models, ENDF/B-VII 33 group cross sections, and COMMARA 2.0 covariance data.**
- **Integral parameters: K_{eff} and sodium void only in core regions**
- **Calculated Uncertainties: no correlation (only standard deviations), full covariance, no correlation with adjusted standard deviations, adjusted standard deviations and original correlations, and full adjusted covariance.**

Reactor	K_{eff}	Core Sodium Void (pcm)
ABR Oxide	1.05418	1362
JAEA FBR	0.99927	1109
ABR Metal	1.02675	1531
ABR Recycled Oxide	1.02749	2356

Assimilated Representativity Factor

- **Uncertainty:** $\Delta R_0^2 = S_R^+ D S_R$
- **Representativity Factor:** $r_{RE} = \frac{\left(S_R^+ D S_E\right)}{\left[\left(S_R^+ D S_R\right)\left(S_E^+ D S_E\right)\right]^{1/2}}$
- **Uncertainty Reduction on Target System:** $\Delta R_0^{'2} = \Delta R_0^2 \cdot \left(1 - r_{RE}^2\right)$
- **Uncertainty After Adjustment:** $\Delta R_0^{'2} = S_R^+ D' S_R$
- **Adjustment Uncertainty Reduction Factor:** $UR = \frac{\Delta R_0}{\Delta R_0^{'}}$
- **Assimilated Representativity Factor:** $r_{RE}^A = \sqrt{1 - \frac{1}{UR^2}}$

ABR Ox. Uncertainty on K_{eff} (pcm)

Original Covariance

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	278	29	112	105	547	0	633
PU239	308	223	71	30	79	161	428
FE56	170	0	0	172	147	0	283
PU240	61	45	82	5	17	24	116
NA23	4	0	0	20	80	0	82
CR52	21	0	0	38	18	0	47
O16	5	0	0	45	2	0	46
PU241	10	7	3	0	2	0	13
Total	453	229	156	213	578	163	830

Adjusted Covariance

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	-68	-7	-58	-30	-89	0	-130
PU239	108	58	26	11	24	-27	125
FE56	123	0	0	125	99	0	201
PU240	27	23	25	3	11	4	45
NA23	6	0	0	11	23	0	26
CR52	21	0	0	30	9	0	38
O16	5	0	0	44	2	0	45
PU241	10	7	4	0	2	0	13
Total	154	63	-45	133	56	-27	214

	Orig. Stand. Dev. (No Correl.)	Original Covariance	Adj. Stand. Dev. (No Correl.)	Adj. Stand. Dev. and Orig. Correl.	Adjusted Covariance	Adj. Reduction Factor	Assimilated Represent. Factor
Uncertainty	864	830	648	596	214	3.88	0.97

ABR Ox. Uncertainty on Sodium Void (%)

Original Covariance

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	3.5	0.1	0.4	1.3	3.7	0.0	5.3
PU239	1.0	2.8	0.9	0.4	0.8	0.2	3.2
FE56	1.8	0.0	0.0	2.6	0.9	0.0	3.3
PU240	0.6	0.3	0.5	0.1	0.1	0.2	0.9
NA23	0.2	0.0	0.0	1.9	4.4	0.0	4.9
CR52	0.1	0.0	0.0	0.8	0.1	0.0	0.8
O16	0.0	0.0	0.0	0.4	0.0	0.0	0.4
PU241	0.1	0.2	0.0	0.0	0.0	0.0	0.2
Total	4.2	2.8	1.1	3.6	5.9	0.3	8.7

Adjusted Covariance

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	2.2	0.1	0.3	0.5	1.0	0.0	2.4
PU239	0.9	2.2	0.7	0.2	0.4	-0.2	2.5
FE56	1.6	0.0	0.0	2.5	0.7	0.0	3.0
PU240	0.5	0.2	0.2	0.1	0.1	0.1	0.6
NA23	0.3	0.0	0.0	1.0	3.1	0.0	3.2
CR52	0.1	0.0	0.0	0.8	0.1	0.0	0.8
O16	0.0	0.0	0.0	-0.1	0.0	0.0	-0.0
PU241	0.1	0.2	0.0	0.0	0.0	0.0	0.2
Total	2.9	2.2	0.8	2.8	3.3	-0.2	5.7

	Orig. Stand. Dev. (No Correl.)	Original Covariance	Adj. Stand. Dev. (No Correl.)	Adj. Stand. Dev. and Orig. Correl.	Adjusted Covariance	Adj. Reduction Factor	Assimilated Represent. Factor
Uncertainty	5.9	8.7	5.2	7.2	5.7	1.51	0.75

FBR Uncertainty on K_{eff} (pcm)

Original Covariance

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	310	39	145	182	796	0	886
PU239	230	179	56	25	66	153	341
PU240	126	108	194	13	43	69	268
FE56	87	0	0	64	107	0	152
PU241	94	61	37	1	19	0	119
PU242	88	37	31	2	5	0	101
NA23	3	0	0	16	85	0	87
O16	7	0	0	36	3	0	37
Total	434	225	253	199	812	168	1015

Adjusted Covariance

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	48	15	38	18	58	0	87
PU239	-49	-48	-8	4	14	-62	-92
PU240	95	72	111	14	48	40	175
FE56	35	0	0	20	34	0	52
PU241	93	61	37	1	22	0	120
PU242	88	37	31	2	5	0	101
NA23	5	0	0	-8	37	0	36
O16	7	0	0	24	3	0	25
Total	163	90	126	38	94	-47	243

	Orig. Stand. Dev. (No Correl.)	Original Covariance	Adj. Stand. Dev. (No Correl.)	Adj. Stand. Dev. and Orig. Correl.	Adjusted Covariance	Adj. Reduction Factor	Assimilated Represent. Factor
Uncertainty	842	1015	611	626	243	4.18	0.97

FBR Uncertainty on Sodium Void (%)

Original Covariance

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	3.7	0.2	0.6	2.4	6.2	0.0	7.6
NA23	0.2	0.0	0.0	1.3	5.7	0.0	5.8
PU241	0.7	1.8	0.2	0.0	0.2	0.0	1.9
PU239	0.9	2.3	0.8	0.3	0.7	0.3	2.7
PU240	1.2	0.8	1.2	0.2	0.3	0.7	2.1
FE56	1.5	0.0	0.0	1.0	0.6	0.0	1.9
O16	0.1	0.0	0.0	0.3	0.0	0.0	0.3
PU242	0.5	0.2	0.2	0.0	0.0	0.0	0.6
Total	4.3	3.1	1.6	2.9	8.5	0.7	10.6

Adjusted Covariance

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	2.3	0.1	0.5	0.9	1.6	0.0	3.0
NA23	0.3	0.0	0.0	-0.1	4.2	0.0	4.2
PU241	0.7	1.8	0.2	0.0	0.3	0.0	1.9
PU239	0.7	1.6	0.6	0.2	0.3	-0.3	1.8
PU240	1.1	0.6	0.8	0.2	0.4	0.5	1.6
FE56	1.1	0.0	0.0	1.0	0.3	0.0	1.6
O16	0.1	0.0	0.0	-0.3	0.0	0.0	-0.3
PU242	0.5	0.2	0.2	0.0	0.0	0.0	0.6
Total	3.0	2.5	1.1	1.3	4.6	0.4	6.3

	Orig. Stand. Dev. (No Correl.)	Original Covariance	Adj. Stand. Dev. (No Correl.)	Adj. Stand. Dev. and Orig. Correl.	Adjusted Covariance	Adj. Reduction Factor	Assimilated Represent. Factor
Uncertainty	6.7	10.6	5.5	7.9	6.3	1.68	0.805

Uncertainties on non Targeted Reactors

Parameter	Orig. Stand. Dev. (No Correl.)	Original Covariance	Adj. Stand. Dev. (No Correl.)	Adj. Stand. Dev. and Orig. Correl.	Adjusted Covariance	Adj. Reduction Factor	Assimilated Represent. Factor
ABR Met. K_{eff} (pcm)	917	969	669	642	318	3.05	0.94
ABR Met. Sod. Void (%)	5.4	7.7	4.8	6.7	5.7	1.33	0.66
ABR Ox. Rec. K_{eff} (pcm)	902	1042	729	757	504	2.07	0.88
ABR Ox. Rec. Sod. Void (%)	5.0	7.6	4.4	6.4	5.3	1.43	0.71

Conclusions

- An adjustment was performed using COMMARA 2.0 covariance data and ENDF/B-VII cross sections.
- The major modifications indicated regard the U238 and Pu239 inelastic, and the U235 and Pu239 capture. The inclusion of fission spectrum does not seem to have any significant impact.
- The adjustment provide a good consistency test, and all the adjustment on cross sections are within the 1 sigma standard deviation range.
- The inclusion of experimental correlations, at least in this specific case, does not seem to have any significant impact.
- An uncertainty evaluation was performed on target reactors and shows significant reductions (mostly related to correlations) for Keff, and a lot less for sodium void reactivity coefficients. This indicates the necessity of including specific experiments aimed at the integral parameter of interest.
- The same conclusion is true for not targeted reactors (need to improve structural materials and minor actinides).

Experiment Correl. with Original Covariance

No.	Core		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Jezebel - Pu239	keff	1																			
2		F28/F25	-0.48	1																		
3		F37/F25	-0.6	0.91	1																	
4		F49/F25	-0.09	0.61	0.72	1																
5	Jezebel - Pu240	keff	0.81	0.24	-0.33	0.03	1															
6	Flattop	keff	0.47	0.05	-0.14	0.11	0.42	1														
7		F28/F25	-0.38	0.97	0.87	0.6	-0.16	-0.17	1													
8		F37/F25	-0.52	0.85	0.96	0.72	-0.28	-0.33	0.87	1												
9	ZPR6-7	keff	0.13	0.16	0.12	0.16	0.17	-0.43	0.3	0.3	1											
10		F28/F25	0.01	0.22	0.15	0.11	0.04	-0.71	0.4	0.38	0.73	1										
11		F49/F25	0.09	0.17	0.21	0.46	0.09	-0.33	0.29	0.37	0.44	0.62	1									
12		C28/F25	0.01	0.04	-0.03	0.05	0	0.17	-0.07	-0.07	-0.53	-0.18	0.09	1								
13	ZPR6-7 Pu240	keff	0.13	0.16	0.12	0.16	0.19	-0.43	0.3	0.3	1	0.73	0.44	-0.52	1							
14	ZPPR-9	keff	0.1	0.16	0.12	0.14	0.14	-0.52	0.31	0.31	0.99	0.81	0.49	-0.52	0.99	1						
15		F28/F25	0.01	0.17	0.11	0.08	0.03	-0.74	0.35	0.35	0.74	0.99	0.6	-0.18	0.74	0.82	1					
16		F49/F25	0.09	0.15	0.18	0.42	0.09	-0.39	0.28	0.36	0.49	0.67	0.99	0.09	0.49	0.54	0.66	1				
17		C28/F25	0	0.02	-0.01	0.06	0	0.19	-0.06	-0.07	-0.55	-0.19	0.1	1	-0.55	-0.54	-0.2	0.09	1			
18		Central Na void	-0.04	0.08	0.09	0.07	-0.01	-0.6	0.2	0.27	0.46	0.68	0.37	0.01	0.47	0.54	0.71	0.44	-0.02	1		
19		Large Na void	-0.03	0.08	0.09	0.08	0	-0.61	0.21	0.28	0.49	0.71	0.4	0.01	0.5	0.56	0.73	0.47	-0.02	0.99	1	
20	Joyo	keff	0.12	0.02	-0.02	0	0.16	0.05	0.03	0	0.35	0.07	-0.11	-0.22	0.36	0.3	0.08	-0.08	-0.24	0.08	0.08	1

Experiment Correl. with Adjusted Covariance and Existing Correlations

No.	Core		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Jezebel - Pu239	keff	1																			
2		F28/F25	-0.16	1																		
3		F37/F25	-0.26	0.77	1																	
4		F49/F25	0.3	0.42	0.64	1																
5	Jezebel - Pu240	keff	0.79	-0.02	-0.08	0.25	1															
6	Flattop	keff	0.76	0.07	-0.07	0.3	0.63	1														
7		F28/F25	-0.07	0.98	0.76	0.46	0.05	0.08	1													
8		F37/F25	-0.17	0.69	0.97	0.68	-0.02	-0.1	0.71	1												
9	ZPR6-7	keff	0.23	0.2	0.13	0.13	0.25	0.25	0.23	0.15	1											
10		F28/F25	0.07	0.44	0.27	0.18	0.09	-0.04	0.51	0.3	0.29	1										
11		F49/F25	0.16	0.16	0.25	0.5	0.12	0.12	0.21	0.32	0.1	0.45	1									
12		C28/F25	-0.01	-0.01	0.02	0.13	-0.01	0.07	-0.02	0.01	-0.45	0.06	0.25	1								
13	ZPR6-7 Pu240	keff	0.24	0.2	0.14	0.13	0.28	0.26	0.23	0.16	1	0.29	0.1	-0.44	1							
14	ZPPR-9	keff	0.22	0.22	0.15	0.14	0.24	0.21	0.26	0.18	0.98	0.38	0.15	-0.49	0.98	1						
15		F28/F25	0.07	0.4	0.23	0.16	0.08	-0.08	0.47	0.28	0.3	0.98	0.4	0.08	0.31	0.4	1					
16		F49/F25	0.15	0.15	0.24	0.49	0.12	0.11	0.21	0.32	0.11	0.44	0.99	0.28	0.11	0.16	0.4	1				
17		C28/F25	-0.01	0	0.03	0.13	-0.01	0.07	-0.01	0.02	-0.46	0.08	0.29	1	-0.45	-0.49	0.09	0.31	1			
18		Central Na void	0	0.04	0.07	0.05	0.02	-0.03	0.06	0.1	-0.06	0.09	-0.02	0.18	-0.05	-0.03	0.14	0.02	0.17	1		
19		Large Na void	0.02	0.05	0.07	0.06	0.03	-0.01	0.07	0.11	-0.04	0.12	0.01	0.2	-0.03	-0.01	0.17	0.04	0.19	0.98	1	
20	Joyo	keff	0.16	0.04	-0.01	0.01	0.21	0.25	0.03	-0.03	0.5	-0.11	-0.26	-0.15	0.51	0.43	-0.06	-0.23	-0.19	0.03	0.03	1

Experiment Correl. with Adjusted Covariance and Full Correlations

No.	Core		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Jezebel - Pu239	keff	1																			
2		F28/F25	-0.15	1																		
3		F37/F25	-0.24	0.59	1																	
4		F49/F25	0.08	0.29	0.62	1																
5	Jezebel - Pu240	keff	0.19	0	0.01	0.25	1															
6	Flattop	keff	0.27	0.2	0.07	0.3	0.06	1														
7		F28/F25	-0.01	0.94	0.54	0.46	0.01	0.08	1													
8		F37/F25	-0.13	0.46	0.95	0.68	0.03	-0.09	0.5	1												
9	ZPR6-7	keff	0.01	0.02	0.02	0.13	0.02	0.13	0	0	1											
10		F28/F25	0.1	0.12	-0.03	0.18	0.01	-0.24	0.23	0.06	-0.17	1										
11		F49/F25	0.05	0.03	0.16	0.5	0	0.03	0.06	0.23	-0.08	0.34	1									
12		C28/F25	0.04	0.02	0.04	0.13	0.02	-0.02	0.04	0.07	0.02	0.32	0.37	1								
13	ZPR6-7 Pu240	keff	-0.05	0.02	0.03	0.13	0.12	0.1	-0.01	0	0.97	-0.13	-0.07	0.04	1							
14	ZPPR-9	keff	0.01	0	0.01	0.14	0.03	-0.04	0.01	0.02	0.81	0.1	0.04	-0.12	0.79	1						
15		F28/F25	0.11	0.06	-0.06	0.16	0.01	-0.35	0.18	0.05	-0.17	0.96	0.27	0.37	-0.13	0.13	1					
16		F49/F25	0.05	0.01	0.14	0.49	0	0	0.06	0.23	-0.06	0.33	0.99	0.42	-0.05	0.05	0.29	1				
17		C28/F25	0.04	0.03	0.05	0.13	0.02	0	0.04	0.08	0.01	0.34	0.41	1	0.03	-0.12	0.37	0.45	1			
18		Central Na void	0.01	-0.01	0.02	0.05	0.01	-0.12	0.01	0.07	-0.07	0.08	-0.02	0.15	-0.05	0.02	0.17	0.02	0.14	1		
19		Large Na void	0.01	-0.01	0.02	0.06	0.02	-0.11	0.01	0.07	-0.08	0.11	0	0.19	-0.05	0.03	0.2	0.04	0.18	0.97	1	
20	Joyo	keff	-0.01	-0.01	-0.02	0.01	0.03	0.02	-0.02	-0.02	0.12	-0.04	-0.06	-0.01	0.13	0.09	-0.03	-0.06	-0.02	0.01	0.01	1

Uncertainties Before and After Adjustment

Experiment	Unc. before adj	Unc. after adj Existing Corr.	Unc. after adj Full Corr.	Experiment	Unc. before adj	Unc. after adj Existing Corr.	Unc. after adj Full Corr.
JEZEBEL_Pu239 Keff (pcm)	± 636	± 409	± 164	ZPR6-7 Pu239 F49/F25 (%)	± 0.8	± 0.7	± 0.6
JEZEBEL_Pu239 F28/F25 (%)	± 3.7	± 2.0	± 1.1	ZPR6-7 Pu239 C28/F25 (%)	± 1.5	± 1.0	± 0.9
JEZEBEL_Pu239 F37/F25 (%)	± 2.4	± 1.2	± 0.8	ZPR6-7 Pu240 Keff (pcm)	± 971	± 504	± 134
JEZEBEL_Pu239 F49/F25 (%)	± 0.8	± 0.6	± 0.5	ZPPR9 Keff (pcm)	± 1191	± 533	± 121
JEZEBEL_Pu240 Keff (pcm)	± 656	± 498	± 181	ZPPR9 F28/F25 (%)	± 7.9	± 2.5	± 1.8
FLATTOP Keff (pcm)	± 764	± 358	± 222	ZPPR9 F49/F25 (%)	± 0.9	± 0.6	± 0.6
FLATTOP F28/F25 (%)	± 3.1	± 1.7	± 0.9	ZPPR9 C28/F25 (%)	± 1.5	± 1.0	± 0.9
FLATTOP F37/F25 (%)	± 2.0	± 1.1	± 0.7	ZPPR9 Na Void Step 3 (%)	± 7.6	± 4.7	± 3.6
ZPR6-7 Pu239 Keff (pcm)	± 968	± 503	± 131	ZPPR9 Na Void Step 5 (%)	± 9.7	± 5.7	± 4.5
ZPR6-7 Pu239 F28/F25 (%)	± 6.4	± 2.4	± 1.6	JOYO Keff (pcm)	± 863	± 514	± 185

ABR Ox. Uncertainty on K_{eff} (pcm)

Original Covariance

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	278	29	112	105	547	0	633
PU239	308	223	71	30	79	161	428
FE56	170	0	0	172	147	0	283
PU240	61	45	82	5	17	24	116
NA23	4	0	0	20	80	0	82
CR52	21	0	0	38	18	0	47
O16	5	0	0	45	2	0	46
PU241	10	7	3	0	2	0	13
Total	453	229	156	213	578	163	830

Adjusted Covariance Exist. Corr.

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	184	29	104	32	135	0	254
PU239	226	154	71	21	37	101	303
FE56	166	0	0	160	139	0	269
PU240	59	42	64	5	16	24	101
NA23	4	0	0	20	69	0	72
CR52	21	0	0	38	18	0	47
O16	5	0	0	44	2	0	44
PU241	10	7	4	0	2	0	13
Total	341	162	141	175	211	104	499

Adjusted Covariance Full Corr.

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	-68	-7	-58	-30	-89	0	-130
PU239	108	58	26	11	24	-27	125
FE56	123	0	0	125	99	0	201
PU240	27	23	25	3	11	4	45
NA23	6	0	0	11	23	0	26
CR52	21	0	0	30	9	0	38
O16	5	0	0	44	2	0	45
PU241	10	7	4	0	2	0	13
Total	154	63	-45	133	56	-27	214

FBR Uncertainty on K_{eff} (pcm)

Original Covariance

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	310	39	145	182	796	0	886
PU239	230	179	56	25	66	153	341
PU240	126	108	194	13	43	69	268
FE56	87	0	0	64	107	0	152
PU241	94	61	37	1	19	0	119
PU242	88	37	31	2	5	0	101
NA23	3	0	0	16	85	0	87
O16	7	0	0	36	3	0	37
Total	434	225	253	199	812	168	1015

Adjusted Covariance Exist. Corr.

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	204	39	134	57	194	0	319
PU239	167	125	55	17	30	97	239
PU240	122	101	151	14	42	67	233
FE56	84	0	0	59	102	0	145
PU241	94	61	37	1	19	0	119
PU242	88	37	31	2	5	0	101
NA23	3	0	0	16	73	0	75
O16	7	0	0	35	3	0	36
Total	329	180	215	94	238	118	515

Adjusted Covariance Full Corr.

Isotope	σ_{cap}	σ_{fiss}	ν	σ_{el}	σ_{inel}	χ	Total
U238	48	15	38	18	58	0	87
PU239	-49	-48	-8	4	14	-62	-92
PU240	95	72	111	14	48	40	175
FE56	35	0	0	20	34	0	52
PU241	93	61	37	1	22	0	120
PU242	88	37	31	2	5	0	101
NA23	5	0	0	-8	37	0	36
O16	7	0	0	24	3	0	25
Total	163	90	126	38	94	-47	243