Yelow colored: need to be confirmed by SG33 members.
Pink colored: Typo or correction. **Nov.29, 2012 M.Ishikawa**

Draft: October 11, 2012

Chapter 10

Stress Tests and Their Impact

10.1 Objective

In the SG33 study, the cross-section adjustment exercise treats typical 20 benchmarks of the fast reactor experiments as the reference. As seen in the previous chapters, the adjusted results of the reference case are quite satisfactory from both viewpoints of the integral and differential data. The objective of this chapter is to observe the impacts on the adjusted results when an integral experiment with different nature from the standard 20 data is added to the reference case, which is called as the "Stress test" here. Further, we try to add other peculiar integral data with extremely bad C/E (calculation/experiment) values to the reference case, to find what would happen in the adjusted results.

10.2 Survey Cases

Three adjustment cases are surveyed as follows:

1) Case J4: This is the reference adjustment case with the standard 20 integral data. Cross-sections and covariance data[1] are based on the JENDL-4.0 library (Ref.1, 2).
2) "Stress test": One integral experiment, criticality (keff, hereafter) of the ZPR-9/34 core (Ref.4), is added to the reference Case J4. The unique features of the ZPR-9/34 core are:
   - the core region consists of 93% enriched-uranium and iron,
   - the height and diameter of the core are 1.8m and 1.2m, respectively, and,
   - the core is surrounded by stainless steel reflector.
3) Case B: Four extra integral data are added to Case J4. Those are:
   - keff of the ZPR-9/34 core, which is added in the "Stress test",
   - keff of the ZPR-3/53 core (Ref.5), the core region of which consists of plutonium, uranium-238 [U-238] and carbon, and is surrounded by U-238 blanket,
   - keff of ZPR-3/54 core (Ref.6), the core of which is almost identical with that of ZPR-3/53, but is surrounded by iron reflector, and,
   - keff of the ZPR-6/10 core (Ref.7), the core of which consists of plutonium, carbon and stainless steel, and is surrounded by stainless steel reflector.

The experimental and analytical information of all 24 integral data treated in this chapter is summarized in Table10.1 [Table 10.1]. Numbers 1 through 20 are the data applied in the reference Case J4. Number 21 is the ZPR-9/34 core data added to Case J4 as the "Stress test". Note that the keff value of ZPR-9/34 is overestimated by +1,420 pcm, on the other hand, those of six cores treated in Case J4, numbers 1, 5, 6, 9, 13 and 20, are within only ±530 pcm. The concern of the "Stress test" is whether the adjustment operation could manage this bad C/E value of ZPR-9/34 without harmful influence to other integral data and/or cross-sections. Further, numbers 21 through 24 are the data added to Case J4 as the extreme Case B, where the keff value of ZPR-6/10 is overestimated by +3,380 pcm especially. Since the ratio of the C/E-1 value to the one-sigma total uncertainty, that is, the square root for the

[1] Crabon [Carbon] which only appears in Case B is the exception. Since JENDL-4.0 does not contain the covariance of carbon, that of the COMMARA-2.0 covariance (Ref.3) based on ENDF/B-VII is used here.

variance summation of the experimental uncertainty, the analytical modeling uncertainty and the cross-section-induced uncertainty, is more than 3.5 for this ZPR-6/10 keff as shown in the right-most column of Table 10.4. This means that the probability to realize this bad C/E value is less than 0.02% (=1-0.9998) assuming the normal distribution of the related uncertainty components. We should consider some troubles or mistakes might have occurred in the experimental procedure of the ZPR-6/10 core, in the analytical modeling, and/or in the evaluation of cross-section covariance.

As for Table 10.1, the experimental keff values and their uncertainties[2] of number 21 through 24 cores are based on the ICSBEP handbook (Ref.4~7). The analytical keff values of the four cores are calculated by a continuous-energy Monte Carlo code with two-dimensional homogenized RZ benchmark models, and applied with the corrective factors between the simplified RZ model and the as-built three-dimensional heterogeneous model which are supplied in the ICSBEP handbook. The analytical modeling uncertainties are based on the uncertainty estimation associated with the "Monte Carlo transformation of model" correction factors to convert the simplified RZ model values to the as-built model which is also supplied in the ICSBEP handbook. The Monte Carlo statistical uncertainties[3] of the simplified RZ model calculation are also added to the analytical modeling uncertainties, though they are negligible compared with the model transformation uncertainties.

Table 10.1 Integral data for adjustment to be applied in Case J4, "Stress test" and Case B

Case J4) Reference adjustment based on JENDL-4.0 (20 integral data) (+Stress test +Case B)

Case B (extreme case) (No. 1–24)
" Stress test " (No. 1–21)
Case J4 (reference case) (No. 1–20)

No.	Core	Parameter	Parameter value		C/E value	Relative uncertainty (%)		
			Experiment	Calculation		Experiment	Analytical modeling	*Sum*
1	JEZEBEL-Pu239	keff	1.0000	0.9987	0.9987	0.20	0.03	*0.202*
2		F28/F25	0.2133	0.2066	0.9686	1.1	0.94	*1.447*
3		F49/F25	1.461	1.437	0.9836	0.9	0.75	*1.172*
4		F37/F25	0.9835	0.9632	0.9794	1.4	0.80	*1.612*
5	JEZEBEL-Pu240	keff	1.0000	0.9984	0.9984	0.20	0.03	*0.202*
6	FLATTOP-Pu	keff	1.0000	0.9986	0.9986	0.30	0.03	*0.302*
7		F28/F25	0.1799	0.1758	0.9773	1.1	0.84	*1.384*
8		F37/F25	0.8561	0.8497	0.9925	1.4	0.69	*1.561*
9	ZPR-6/7	keff	1.0005	1.0058	1.0053	0.23	0.03	*0.231*
10		F28/F25	0.02230	0.02305	1.0336	3.0	2.24	*3.74*
11		F49/F25	0.9435	0.9237	0.9790	2.1	1.43	*2.54*
12		C28/F25	0.1323	0.1345	1.0167	2.4	1.22	*2.69*
13	ZPR-6/7 High-Pu240	keff	1.0008	1.0041	1.0033	0.22	0.03	*0.222*
14	ZPPR-9	keff	1.0008	1.0030	1.0021	0.12	0.02	*0.119*
15		F28/F25	0.02070	0.02034	0.9828	2.7	2.09	*3.41*
16		F49/F25	0.9225	0.9217	0.9992	2.0	1.21	*2.34*
17		C28/F25	0.1296	0.1320	1.0188	1.9	1.39	*2.35*
18		Central Na void*	29.39	31.39	1.0682	1.9	5.26	*5.59*
19		Large Na void*	31.68	33.34	1.0523	1.9	4.96	*5.31*
20	JOYO Mk-I	keff	1.0011	0.9992	0.9982	0.18	0.03	*0.182*
21	ZPR-9/34	keff	1.0004	1.0145	1.0142	0.11	0.24	*0.263*
22	ZPR-3/53	keff	1.0017	1.0101	1.0084	0.09	0.21	*0.230*
23	ZPR-3/54	keff	0.9981	1.0119	1.0139	0.17	0.21	*0.272*
24	ZPR-6/10	keff	1.0016	1.0355	1.0338	0.13	0.22	*0.256*

*Cent unit (beta value of ZPPR-9 by JENDL-4.0 = 0.003594)

[2] The experimental uncertainties among the additional ZPR cores might be correlated with other cores through the fuel composition uncertainties and/or experimental technique uncertainties, but it is assumed here they are independent of each other, since there is no information on such correlations in the ICSBEP handbook.

[3] The uncertainty of the Monte Carlo calulation is set as twice of the statistical uncertainty value evaluated by the MC code here, taking into account the effect of correlation among the fission source over successive MC cycles.

10.3 Result of Adjustment

10.3.1 Change of All C/E Values

The C/E value changes for all integral data in Case J4, "Stress test" and Case B are summarized in Fig.10.1, and Table 10.2 through 10.4. At first glance, both "Stress test" and Case B seem to give no critical harm to the standard 20 integral data of Case J4. In detail, the C/E values of two U-238 capture/U-235 fission ratio (C28/F25) data are altered by 2 % to the negative direction in Case B, but these are still within the summation of the experimental and analytical modeling uncertainties as shown in the right-most column of Table 10.1. The reason of these C28/F25 alterations will be explained later.

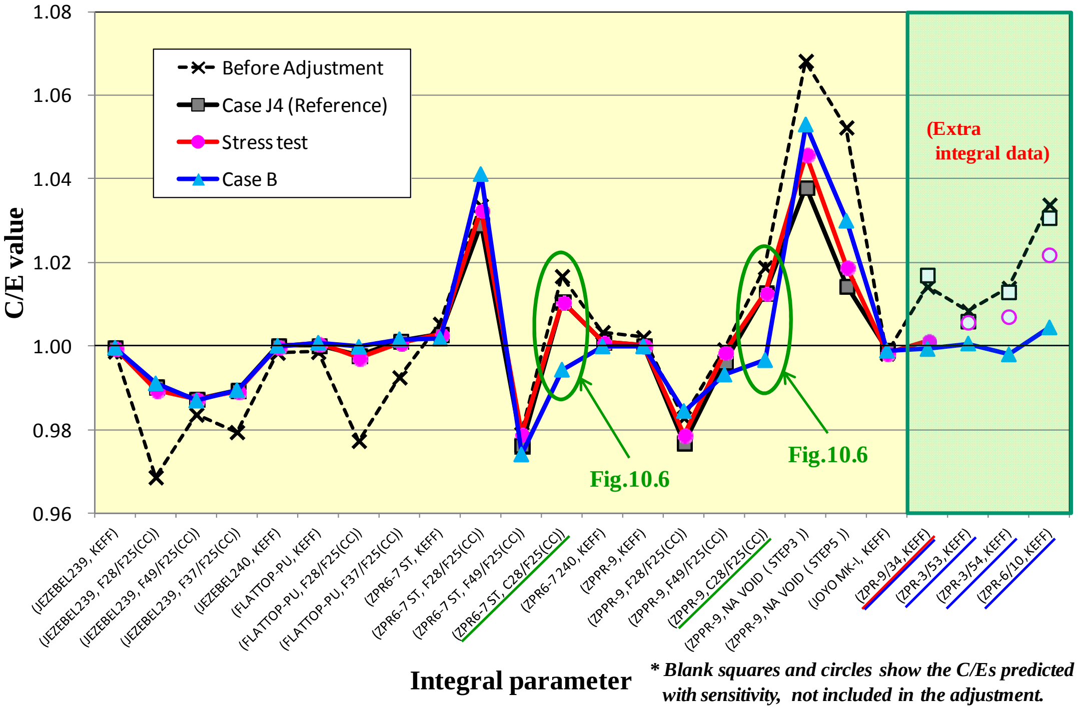

Figure 10.1 Change of C/E values by adjustment (All integral data)

Table 10.2 Results of adjustment (Case J4: Standard 20 data)

Result of Case J4: Reference adjustment based on JENDL-4.0 (20 integral data)

No.	Core	Parameter	C/E value		Relative uncertainty (%)		Nuclea-data-induced uncertainty (%)		Ratio of C/E-1 to prior total-uncertainty*
			Before	After	Experiment (Ve)	Analytical modeling	Before (GMG)	After (GM'G)	
1	JEZEBEL-Pu239	keff	0.9987	0.9997	0.20	0.03	0.69	0.15	0.18
2		F28/F25	0.969	0.990	1.1	0.94	3.20	1.02	0.89
3		F49/F25	0.984	0.987	0.9	0.75	0.63	0.47	1.23
4		F37/F25	0.979	0.989	1.4	0.80	1.50	0.67	0.93
5	JEZEBEL-Pu240	keff	0.9984	1.0001	0.20	0.03	0.65	0.14	0.24
6	FLATTOP-Pu	keff	0.9986	1.0002	0.30	0.03	1.26	0.28	0.11
7		F28/F25	0.977	0.998	1.1	0.84	2.94	0.97	0.70
8		F37/F25	0.993	1.001	1.4	0.69	1.44	0.72	0.35
9	ZPR-6/7	keff	1.0053	1.0029	0.23	0.03	0.82	0.12	0.62
10		F28/F25	1.034	1.029	3.0	2.24	4.82	1.85	0.55
11		F49/F25	0.979	0.976	2.1	1.43	1.15	0.83	0.75
12		C28/F25	1.017	1.011	2.4	1.22	2.00	1.12	0.50
13	ZPR-6/7 High-Pu240	keff	1.0033	1.0010	0.22	0.03	0.81	0.12	0.39
14	ZPPR-9	keff	1.0021	1.0001	0.117	0.02	0.90	0.11	0.23
15		F28/F25	0.983	0.977	2.7	2.09	5.28	2.02	0.27
16		F49/F25	0.999	0.996	2.0	1.21	1.15	0.83	0.03
17		C28/F25	1.019	1.013	1.9	1.39	2.03	1.12	0.60
18		Central Na void*	1.068	1.038	1.9	5.26	5.95	3.32	0.84
19		Large Na void*	1.052	1.014	1.9	4.96	7.31	4.04	0.58
20	JOYO Mk-I	keff	0.9982	0.9990	0.18	0.03	0.58	0.16	0.29
Chi-square/Freedom = 0.53									

* = (C/E-1)/[(GMG+Ve+Vm)**0.5]

Table 10.3 Results of adjustment ("Stress test": 21 data)

Result of "Stress test": Addition of keff of ZPR-9/34 to Case J4

No.	Core	Parameter	C/E value		Relative uncertainty (%)		Nuclea-data-induced uncertainty (%)		Ratio of C/E-1 to prior total-uncertainty*
			Before	After	Experiment (Ve)	Analytical modeling	Before (GMG)	After (GM'G)	
1	JEZEBEL-Pu239	keff	0.9987	0.9997	0.20	0.03	0.69	0.15	0.18
2		F28/F25	0.969	0.989	1.1	0.94	3.20	1.02	0.89
3		F49/F25	0.984	0.987	0.9	0.75	0.63	0.47	1.23
4		F37/F25	0.979	0.989	1.4	0.80	1.50	0.67	0.93
5	JEZEBEL-Pu240	keff	0.9984	1.0000	0.20	0.03	0.65	0.14	0.24
6	FLATTOP-Pu	keff	0.9986	1.0007	0.30	0.03	1.26	0.28	0.11
7		F28/F25	0.977	0.997	1.1	0.84	2.94	0.97	0.70
8		F37/F25	0.993	1.001	1.4	0.69	1.44	0.72	0.35
9	ZPR-6/7	keff	1.0053	1.0028	0.23	0.03	0.82	0.12	0.62
10		F28/F25	1.034	1.033	3.0	2.24	4.82	1.84	0.55
11		F49/F25	0.979	0.979	2.1	1.43	1.15	0.81	0.75
12		C28/F25	1.017	1.011	2.4	1.22	2.00	1.12	0.50
13	ZPR-6/7 High-Pu240	keff	1.0033	1.0009	0.22	0.03	0.81	0.12	0.39
14	ZPPR-9	keff	1.0021	1.0002	0.117	0.02	0.90	0.11	0.23
15		F28/F25	0.983	0.979	2.7	2.09	5.28	2.01	0.27
16		F49/F25	0.999	0.999	2.0	1.21	1.15	0.82	0.03
17		C28/F25	1.019	1.013	1.9	1.39	2.03	1.12	0.60
18		Central Na void*	1.068	1.046	1.9	5.26	5.95	3.29	0.84
19		Large Na void*	1.052	1.019	1.9	4.96	7.31	4.03	0.58
20	JOYO Mk-I	keff	0.9982	0.9984	0.18	0.03	0.58	0.16	0.29
21	ZPR-9/34	keff	1.0142	1.0012	0.11	0.24	1.15	0.25	1.21

Chi-square/Freedom = **0.63**

* = (C/E-1)/[(GMG+Ve+Vm)**0.5]

Table 10.4 Results of adjustment (Case B: 24 data)

Result of Case B: Addition of keff of ZPR-9/34 and other 3 cores to Case J4

No.	Core	Parameter	C/E value		Relative uncertainty (%)		Nuclea-data-induced uncertainty (%)		Ratio of C/E-1 to prior total-uncertainty*
			Before	After	Experiment (Ve)	Analytical modeling	Before (GMG)	After (GM'G)	
1	JEZEBEL-Pu239	keff	0.9987	0.9996	0.20	0.03	0.69	0.15	0.18
2		F28/F25	0.969	0.991	1.1	0.94	3.20	1.01	0.89
3		F49/F25	0.984	0.987	0.9	0.75	0.63	0.47	1.23
4		F37/F25	0.979	0.989	1.4	0.80	1.50	0.67	0.93
5	JEZEBEL-Pu240	keff	0.9984	1.0000	0.20	0.03	0.65	0.14	0.24
6	FLATTOP-Pu	keff	0.9986	1.0007	0.30	0.03	1.26	0.28	0.11
7		F28/F25	0.977	1.000	1.1	0.84	2.94	0.97	0.70
8		F37/F25	0.993	1.002	1.4	0.69	1.44	0.72	0.35
9	ZPR-6/7	keff	1.0053	1.0017	0.23	0.03	0.82	0.11	0.62
10		F28/F25	1.034	1.041	3.0	2.24	4.82	1.79	0.55
11		F49/F25	0.979	0.974	2.1	1.43	1.15	0.79	0.75
12		C28/F25	1.017	0.994	2.4	1.22	2.00	1.02	0.50
13	ZPR-6/7 High-Pu240	keff	1.0033	0.9999	0.22	0.03	0.81	0.11	0.39
14	ZPPR-9	keff	1.0021	0.9999	0.117	0.02	0.90	0.11	0.23
15		F28/F25	0.983	0.984	2.7	2.09	5.28	1.98	0.27
16		F49/F25	0.999	0.993	2.0	1.21	1.15	0.79	0.03
17		C28/F25	1.019	0.997	1.9	1.39	2.03	1.02	0.60
18		Central Na void*	1.068	1.053	1.9	5.26	5.95	3.27	0.84
19		Large Na void*	1.052	1.030	1.9	4.96	7.31	4.01	0.58
20	JOYO Mk-I	keff	0.9982	0.9988	0.18	0.03	0.58	0.16	0.29
21	ZPR-9/34	keff	1.0142	0.9993	0.11	0.24	1.15	0.25	1.21
22	ZPR-3/53	keff	1.0084	1.0006	0.09	0.21	0.62	0.16	1.28
23	ZPR-3/54	keff	1.0139	0.9980	0.17	0.21	0.83	0.22	1.59
24	ZPR-6/10	keff	1.0338	1.0044	0.13	0.22	0.93	0.21	3.52

Chi-square/Freedom = **1.11**

* = (C/E-1)/[(GMG+Ve+Vm)**0.5]

10.3.2 Change of keff C/E Values

Next, the C/E changes of ten keff values are picked up for discussions in Fig.10.2, where the blank squares and circles mean the C/E values predicted with sensitivity coefficients, which is not included in the adjustment operation itself. If we carefully scrutinize the adjusted results, the following facts could be found:

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1) Case J4: Even applying the cross-sections adjusted by the reference Case J4, there is no improvements at all to predict the extra four data, number 21 through 24. This means that the adjusted results of the integral data and cross-sections would expect to be quite different between Case J4 and other two cases.
2) "Stress test": The adjusted results seem very excellent as well as Case J4. Even the C/E value of the extra ZPR-9/34 keff which is newly added to the adjustment, changes to almost 1.00. The other three extra data, number 22 through 24, which is not included in the "Stress test", would be also partly improved if the cross-sections adjusted by the "Stress test" are applied. This means that the extra three data possess somewhat similar sensitivity coefficients with those of ZPR-9/34.
3) Case B: The adjusted results seem great. Even the doubtful keff of ZPR-6/10 seems to be successfully adjusted.

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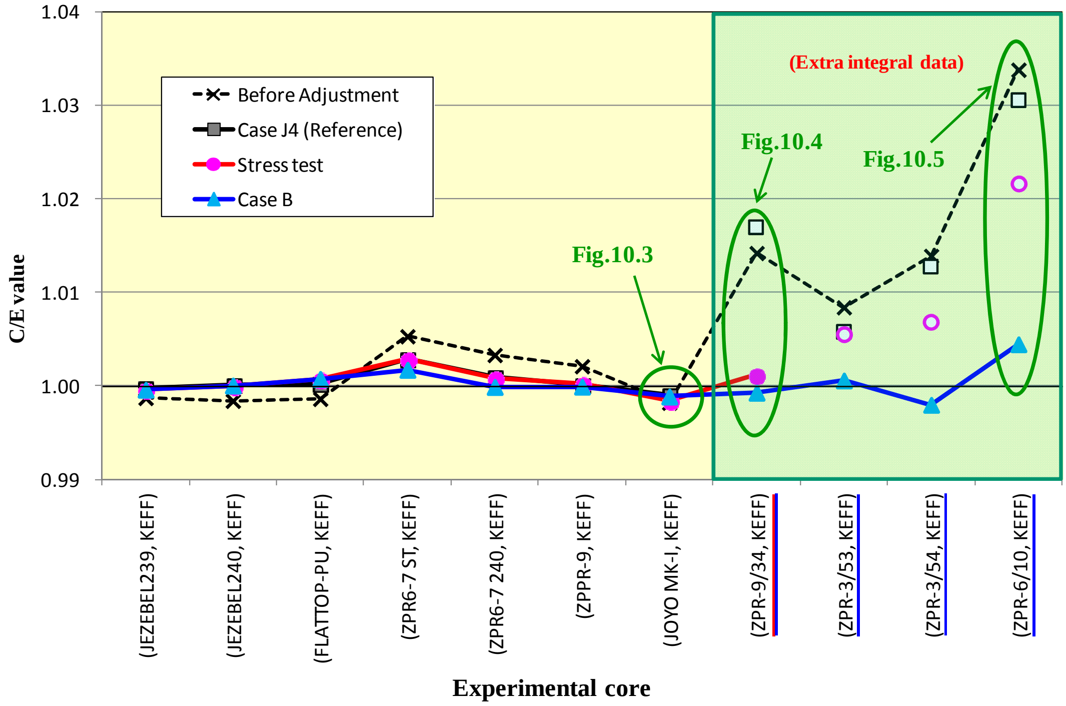

Figure 10.2 Change of C/E values by adjustment (Only keff data)

10.3.3 Component of Contribution to keff Changes

It is needed to confirm the adjustment gives no harm not only for integral data, but for differential cross-sections. Here, we check the nuclide- and reaction-wise contributions to the total keff alterations by the adjustment, comparing three survey cases.

Figure 10.3 shows the breakdown of the contributions for the keff alterations of the JOYO Mk-I core, which is included in all three cases. The total keff alterations are rather similar among three cases, but the components of the cross-section contributions are found to be significantly different from each other. In the "Stress test", Fe-56 contributes largely compared with that of Case J4, the reason of which would be caused by the stainless steel reflector effect of the extra ZPR-9/34 core. In the extreme Case B, it is notable that the major cross-sections, that is, U-238 capture and Pu-239 capture, contribute extremely, but cancelled with each other because of the opposite directions of the reactivity. It should be confirmed whether these large cross-section changes are reasonable from the nuclear data viewpoint.

The components of the keff alteration in the ZPR-9/34 core are compared for three cases[4] in Fig.10.4. In the "Stress test", it is found the large improvement of the C/E value, -1,300 pcm, is attained by the cross-section changes of Fe-56 capture and elastic scattering reactions, which are considered to result in the negative reactivity of the absorption effect by the iron in the core region, and the neutron leakage enhancement by the stainless steel reflector. These trends of the Fe-56 cross-section changes are exaggerated in the extreme Case B, but the U-235 cross-sections also change here to keep the adjusted C/E value around 1.0. Again, it is needed to investigate this reasonability from the nuclear data viewpoint.

The contributions of cross-sections to the ZPR-6/10 keff alterations are summarized in Fig.10.5. Note that the ZPR-6/10 keff is only included in the Case B adjustment, therefore, those of the other two cases show the prediction values with sensitivity. In the reference Case J4, there are little contributions of cross-section changes to the ZPR-6/10 keff. In the "Stress test", the predicted keff change is totally -1,200 pcm, which is close with that of the ZPR-9/34 core, because of the similar sensitivity coefficients of Fe-56 between ZPR-6/10 and ZPR-9/34. In the extreme Case B, the alteration of the ZPR-6/10 keff reaches -2,940 pcm to make the adjusted C/E value very close to 1.0. This large keff alteration is caused not only by the contributions of Fe-56 but by those of Pu-239 capture reaction. When needed, this negative reactivity by Pu-239 alterations is cancelled by other isotopes, for example, U-238 in the JOYO Mk-I core as already seen.

-1.200

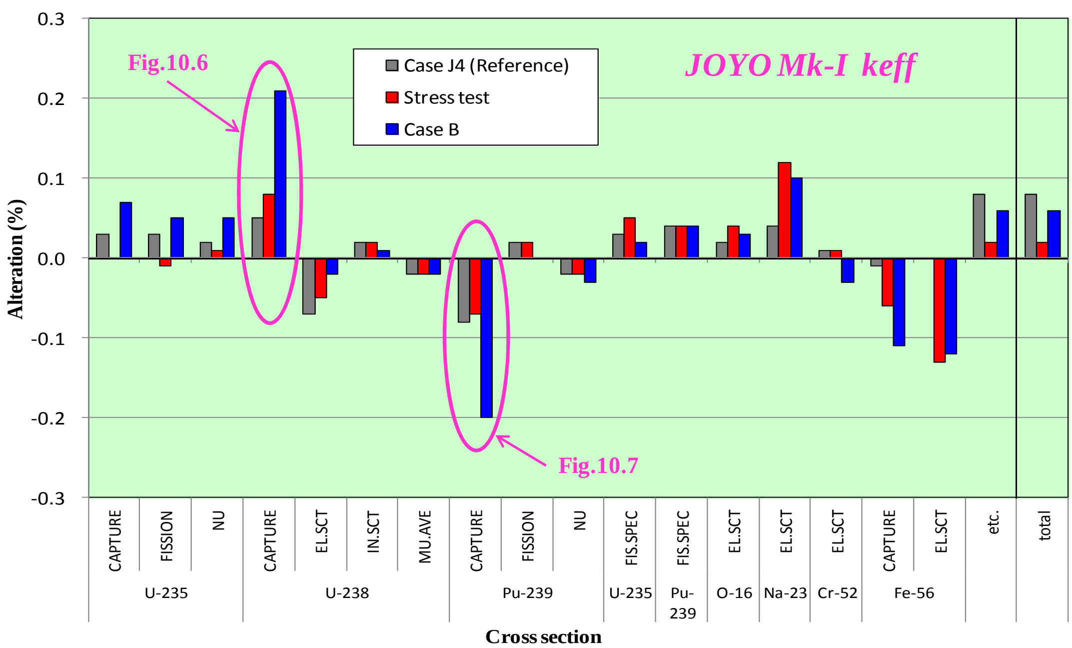

Figure 10.3 Contribution to C/E changes by adjustment (1/3): JOYO Mk-I, keff

[4] In the reference Case J4, ZPR-9/34 is not included in the adjustment. The comopnents with blank elements in the figure mean the predicted alterations of keff obtained by the sensitivity coefficients and the cross-section changes of Case J4.

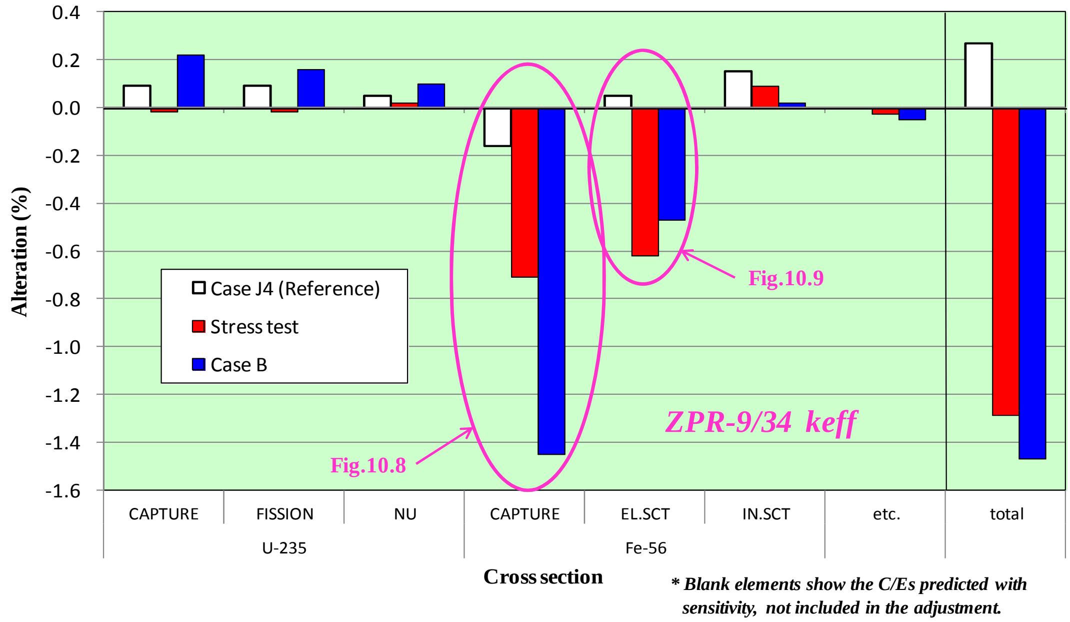

Figure 10.4 Contribution to C/E changes by adjustment (2/3): ZPR-9/34, keff

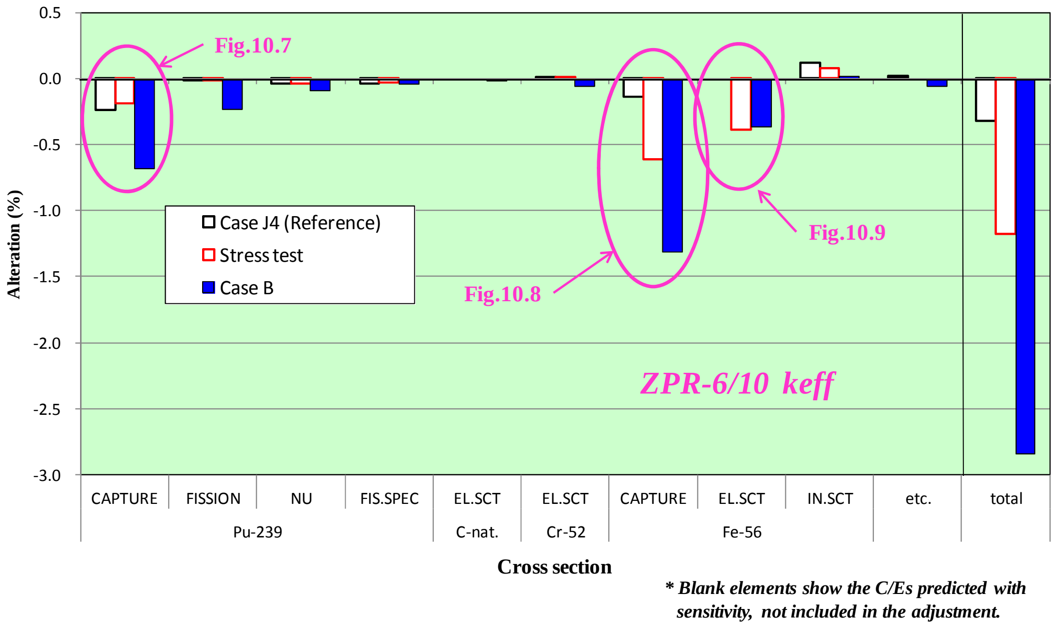

Figure 10.5 Contribution to C/E changes by adjustment (3/3): ZPR-6/10, keff

10.3.4 Cross-section Alteration by Adjustment

For three survey cases, it is investigated here whether the cross-section alteration by the adjustment is physically reasonable from the nuclear data viewpoint.

capture, but

Figure 10.6 shows the cross-section alterations of U-238 capture reaction with neutron energy. For the reference Case J4 and the "Stress test", there is little movement of U-238 capture ,but in the extreme Case B, it is decreased by -2~3% in the important energy region, a few~100keV, in order to cancel the negative reactivity due to Pu-239 capture changes in JOYO Mk-I and other cores such as ZPR-6/7 and ZPPR-9. This affects the C/E values of C28/F25 as seen in Fig.10.1, but the degrees of the C/E value alterations are within the experimental and analytical modeling uncertainties as already mentioned.

The alterations of Pu-239 capture cross-sections by the adjustment are depicted in Fig.10.7. In Case J4 and the "Stress test", the change is approximately +3~5% which is within one standard deviation (STD) value of the JENDL-4.0 covariance, that is, ±6~9% in the dominant energy region. However, in the extreme Case B, Pu-239 capture is significantly increased by +9~13%, to adjust the keff of ZPR-6/10. This cross-section change exceeds the STD value, and could be considered quite improbable from the statistical viewpoint.

appear

More drastic cross-section alterations appears for Fe-56 capture reaction in Fig.10.8. In the reference Case J4, there are little changes of the cross-sections. However, quite large cross-section alterations occur in the "Stress test". The degree is +11% below 100keV, which is very close to the STD value, ±10%. This changing amount might be close to the limitation of allowance from the viewpoint of the nuclear data evaluation . In the extreme Case B, the cross-section changes exceed +24%, more than twice of the STD value, which is definitely unacceptable.

Figure 8 illustrates the changes of the Fe-56 elastic scattering cross-sections. In the Case J4, there is little alterations. On the other hand, in the "Stress test" and the Case B, the Fe-56 elastic cross-sections are decreased to adjust keff values of the stainless steel or iron reflector cores, ZPR-9/34, -3/54 and -6/10. These cross-section changes are quite large, but still within the STD values, which would be acceptable from the nuclear data viewpoint.

It is also necessary to check the adjusted results of the carbon-natural which is newly introduced in the Case B adjustment, since its elastic scattering cross-sections have very large sensitivity to the keff values of the ZPR-3/53, -3/54 and -6/10 cores. Figure 9 shows that the carbon elastic cross-sections are not altered by the adjustment at all, the reason of which would be the very small STD values of the COMMARA-2.0 covariance adopted here.

Figure 10.10

Figure 10.9

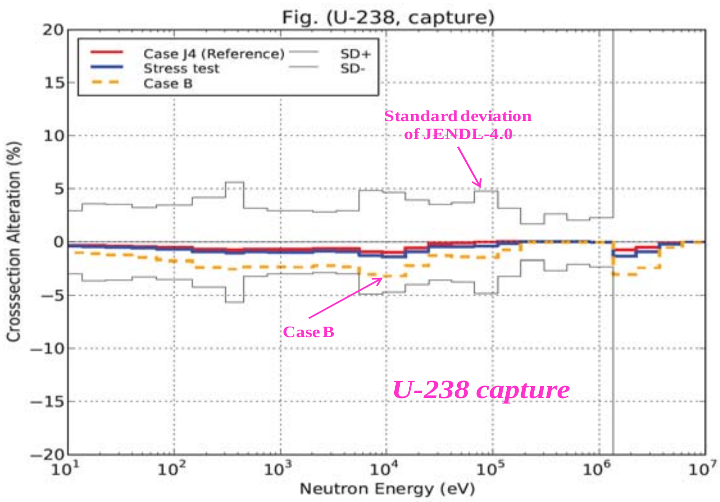

Figure 10.6 Change of cross-sections by adjustment (1/5): U-238 capture

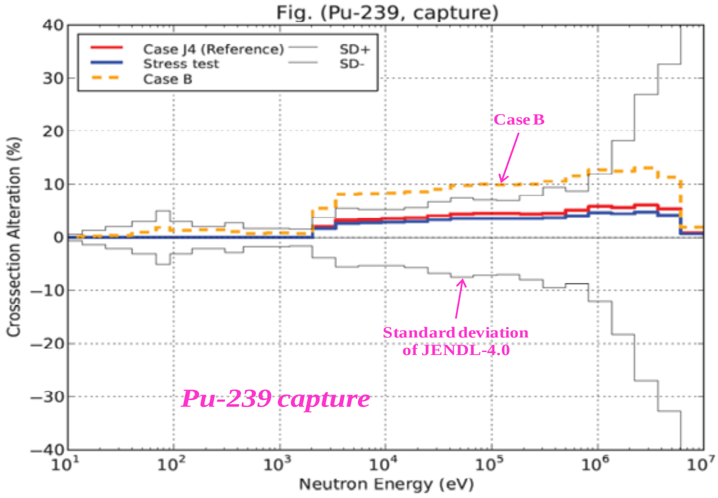

Figure 10.7 Change of cross-sections by adjustment (2/5): Pu-239, capture

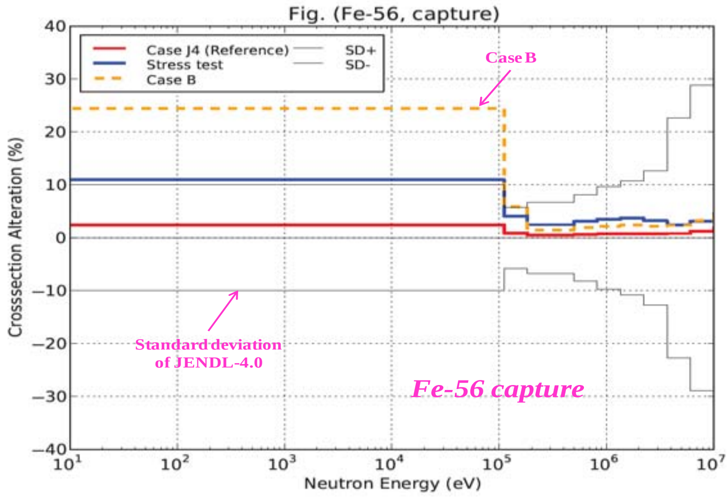

Figure 10.8 Change of cross-sections by adjustment (3/5): Fe-56, capture

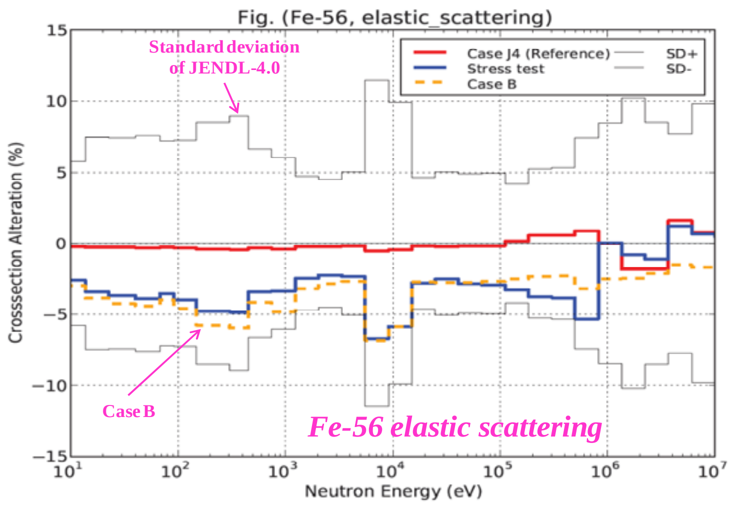

Figure 10.9 Contribution to C/E changes by adjustment (4/5): Fe-56, elastic scattering

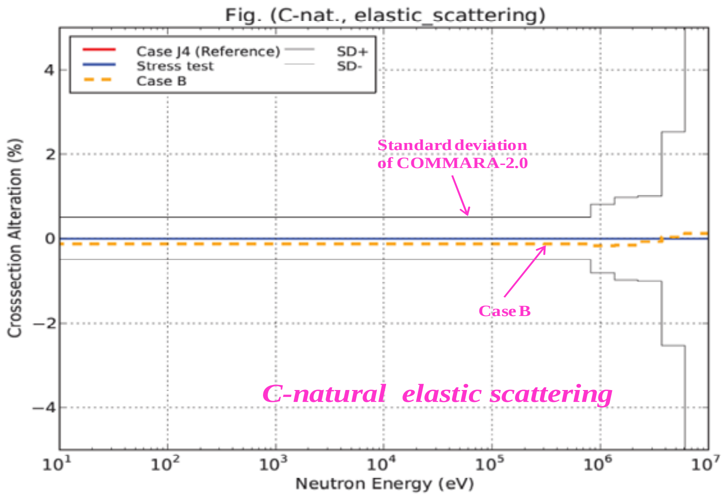

Figure 10.10 Contribution to C/E changes by adjustment (5/5): C-natural, elastic scattering

10.4 Effects on Target Cores

Applying the adjusted cross-section sets of three cases to the SG33 targets, that is, JAEA-FBR, ABR-Oxide and ABR-Metal cores mentioned in chapter 2, the influence of the extra integral data is surveyed. Table 10.5 compares the keff changes of the target cores with the adjusted data of Case J4, "Stress test" and Case B.

For the keff value of the JAEA-FBR core, there are no effects regardless of the adjustment cases. On the other hand, for the ABR-Oxide core, the "Stress test" affects the keff value by -120 pcm, but the Case B by -400 pcm, compared with the reference Case J4. Figure 10.11 clearly reveals the reason, that is, the differences of the keff changes between the JAEA-FBR and ABR-Oxide cores among adjustment cases are caused by the differences of those sensitivity coefficients to the capture cross-sections of Fe-56 and Pu-239.

Table 10.5 Effects of adjustment on keff of target cores

Core	Change of keff by adjustment		
	Case J4 (Reference)	Stress test	Case B
JAEA-FBR	-0.18 %Δk	-0.16 %Δk	-0.18 %Δk
ABR-Oxide	-0.25 %Δk	-0.37 %Δk	-0.65 %Δk
ABR-Metal	-0.22 %Δk	-0.40 %Δk	-0.55 %Δk

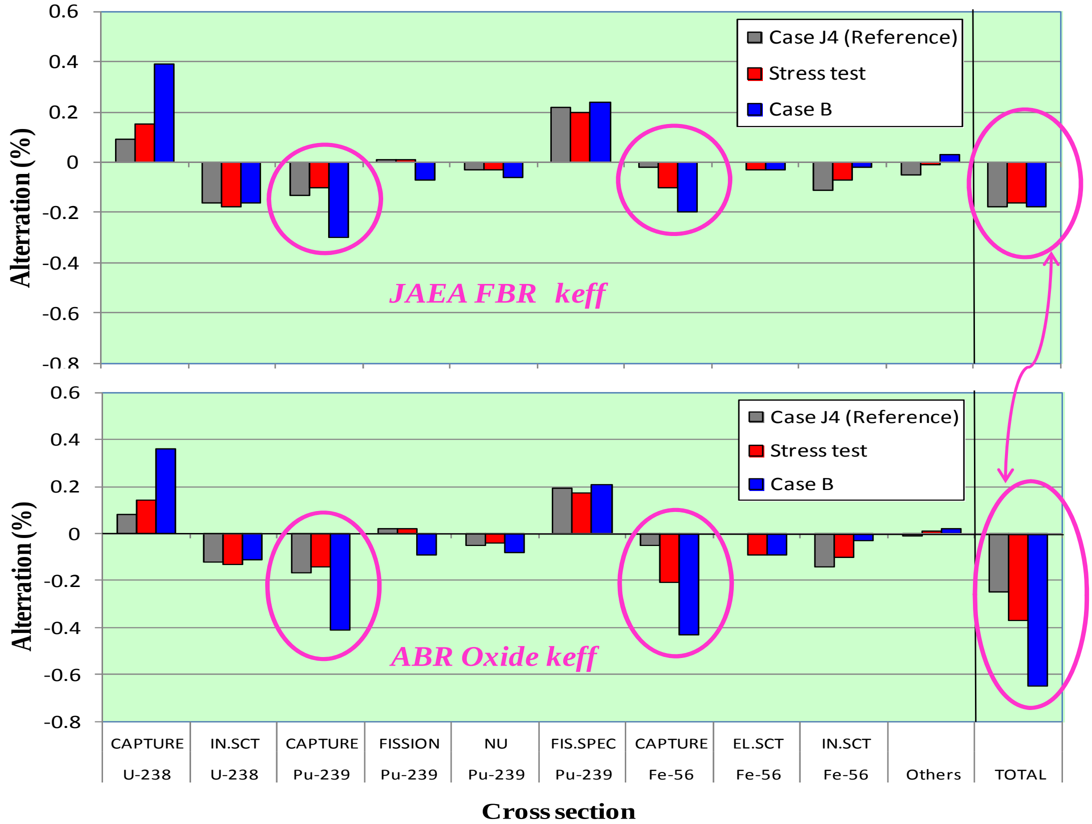

Figure 10.11 Contribution to keff changes of target cores by adjustment

10.5. Concluding Remarks

The lessons from the "Stress test" and the extreme Case B are summarized as follows:

a) In the "Stress test", the overestimation of keff for the extra core, ZPR-9/34 (+1,400 pcm) was successfully adjusted with no harm to the standard 20 integral data and the nuclear data based on JENDL-4.0. It is judged that the "Stress test" of the SG33 adjustment exercise was passed to demonstrate its robustness.
b) In the extreme Case B (maximum: +3,400 pcm), some cross-sections were changed unacceptably exceeding their STD ranges, though the all C/E values seemed to be successfully adjusted at a glance.
c) It would be required to eliminate some doubtful or abnormal integral data from the adjustment procedure. A proposal of the measure is that the ratio of absolute C/E-1 value to the total uncertainty (= the square root for the variance summation of the cross-section-induced uncertainty, the experimental uncertainty and the analytical modeling uncertainty) must be less than 1.5~2 to adopt the data in the adjustment[5].

[5] To confirm this recommendation, one extra adjustment case was surveyed, where the doubtful ZPR-9/10 keff was removed from the Case B data. As for the remaining 23 intagral data, the ratio of the C/E-1 values to the total uncertainties are all less than 1.6 as shown in Table 10.4. The adjusted results of the extra 23 data case were found to be rather similar with those of the "Stress test", which is reasonable from not only the integral but nuclear data viewpoint.

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