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WANL-TME-1757
January 1968

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WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY

XE-2 FUEL REACTIVITY CHECK EXPERIMENT
(Title Unclassified)

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XE-2 FUEL REACTIVITY CHECK EXPERIMENT

(Title Unclassified)

SPECIAL REVIEW FINAL DETERMINATION	Reviewer	Class.	Date
	KAW	U	4-14-82
Class: <u>U</u>			

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1. INTRODUCTION

(U) A series of measurements have been carried out at WANEF on the PAX-E4 reactor (Figure 1), wherein the reactivity differences between NRX-A5 type fuel and XE-2 type fuel were measured. Both fuel from WNCO and the Oak Ridge Y-12 facility were employed in the experiment. Presented in this transmittal is the experimental data obtained during the experiment and also the reactivity coefficient measurements made prior to the experiment so that analysis of the experiment could be accomplished. No attempt has been made, at present, to analyze the experimental data by checking it against similar calculations because complete data on the fuel used in the experiment is not yet available.

2. SUMMARY AND CONCLUSIONS

(U) The experimental results obtained during the performance of the XE-2 fuel reactivity check (FRC) experiment are tabulated in Table 4. No attempt has been made at this time to calculate the effect of the FRC substitutions because complete data packages are not available on all the fuel involved. From the data that is available, it appears that about one-half of the NRX-A5 (WNCO) elements used in the experiment were recoated at some time, possibly to mockup the heavier NRX-A6 Build 1 coating. The large reactivity changes obtained in steps 1A and 2A are attributed to this recoating.

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3. EXPERIMENTAL METHODS AND DETAILS

(CRD) The fuel reactivity check (FRC) experiment performed in support of the XE-2 reactor was carried out on the PAX-E4 reactor which is shown in Figure 1. This reactor was very similar to the PAX-E2 and PAX-E3 cores which were used for experiments in support of the NRX-A6 reactor with the only differences being that the PAX-E4 had all of the niobium and molybdenum wires removed from the "F" row clusters where the FRC was performed. In addition, the shim positions in the PAX-E4 were changed slightly to accommodate the FRC measurements. Prior to beginning the FRC measurements, a number of measurements were made wherein the reactivity coefficients of uranium, carbon, niobium, and molybdenum were determined in the 2F2 position of the PAX-E4 core. These measurements were required because sufficient information was not available on reactivity coefficients in the rezoned PAX fuel portion of the PAX-E4 core. A detailed analysis of the experiment requires accurate reactivity coefficients. The reactivity coefficient measurements were made using the standard methods employed at WANEF, i.e., graphite and uncoated code 99 fuel elements were interchanged for the uranium measurement, solid and 19-hole graphite elements were interchanged for the carbon measurements, 0.080" OD x 0.0015" wall niobium tubes were used for the niobium measurement, and 0.040" diameter molybdenum wire was used for the molybdenum measurements. The WANEF "period-pickoff" system and the reactivity computer were used to measure the reactivity changes during all of the measurements.

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(U) Performance of the XE-2 FRC experiment was divided into four major steps wherein the reactivity differences between PAX type fuel, NRX-A5 fuel manufactured at both WNC0 and Y-12, and XE-2 type fuel manufactured at both WNC0 and Y-12 were measured. In the first step NRX-A5 (WNC0) fuel was substituted for PAX fuel in the PAX-E4; in the second step XE-2 (WNC0) fuel was substituted for the NRX-A5 (WNC0) fuel; in the third step XE-2 (Y-12) fuel was substituted for XE-2 (WNC0) fuel; and in the final step NRX-A5 (Y-12) fuel was substituted for the XE-2 (Y-12) fuel.

(CRD) In each of the fuel substitutions, 21 clusters of fuel (126 elements) were interchanged. The PAX-E4 core positions used for these substitutions were as follows:

1F1
(1,2,3,6)F2
(1,2,3,6)F3
(1,2,3,6)F4
(1,2,3,6)F5
(1,2,3,6)F6

Each of the fuel substitution steps was subdivided into two sub-steps wherein the clusters of sectors 1 and 2 were interchanged first and then after determining their effect on the core reactivity, the clusters of sectors 3 and 6 were interchanged. This subdividing of the major steps was required because of the facility limitation on the maximum number of elements (75) which can be changed in the core at one time.

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(U) The serial numbers and core positions of all the elements involved in the FRC fuel substitutions are tabulated in Table 1. The numbers in parentheses beside the element serial numbers were the storage positions of the elements prior to clustering.

(U) A tabulation of the weights of the cluster hardware used during the FRC experiment is given in Table 2, and the serial numbers and weights of the central elements used are given in Table 3. Each table has two complete tabulations of weights which were employed during the experiment. Hardware set number 1 was originally used on the PAX fuel and was reused later on the XE-2 WNC0 clusters and then on the NRX-A5 Y-12 clusters. Hardware set number 2 was used with the NRX-A5 WNC0 clusters and later with the XE-2 Y-12 clusters.

4. RESULTS AND ANALYSIS

(U) The measured reactivity effects obtained in the XE-2 FRC experiment are tabulated in Table 4. Both the reactivity effect as obtained by the reactivity computer and the period-pickoff system have been tabulated for each sub-step and also the reactivity effect obtained for each complete substitution is given.

(U) No detailed analysis of the FRC results has been attempted at this time because complete data is not available for all the fuel elements involved in the measurements. In addition, from the data that is available, it appears that about one-half of the NRX-A5 (WNC0) elements used in the measurements were elements which had been recoated to approximate

the original NRX-A6 type fuel. This additional coating appears to be the cause of the rather large reactivity effect that was measured in steps 1A and 2A.

(U) A two-sigma uncertainty limit has been assigned to the measured reactivity effects of the fuel interchanges listed in Table 4. This limit was determined by examining the various individual uncertainties inherent in the measurement technique employed, which for the FRC measurements, was the "positive-period" and the "reactivity computer" technique. In both of these techniques, the reactivity of the core at a given drum angle, 90° for these measurements, is measured prior to and immediately after the core change. The difference in these two measurements is then the reactivity effect of the change. The uncertainties associated with these measuring techniques are: 1) normal variations inherent in the measuring devices themselves, 2) the reproducibility of the drum positioning system, and 3) basepoint reactivity variations. The first two of these variations, 1) and 2), are fairly well known and present no problem in their assessment. The third variation, those due to basepoint variations, was more difficult to assess due to the methods employed in conducting the experiment. Since the FRC experiment employed a large number of XE-2 candidate fuel elements, the PAX-E4 core bundling pressure was reduced from the normal 30 inch-pounds to 5 inch-pounds in order to eliminate as much friction as possible when inserting or removing these candidate elements. Also, core spreading devices were employed on the clusters adjacent to the FRC positions to further reduce any rubbing or scraping of the XE-2 candidate elements as they were inserted or removed.

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It is easy to see that these types of core movements necessitate the assignment of a larger basepoint shift uncertainty than would be normal. Normal basepoint shifts have been measured numerous times and have been found to range from about $\pm 0.0\phi$ to $\pm 0.2\phi$ on the average. Some extreme core movement effects were obtained on the original PAX core when the core bundling was relaxed and reapplied numerous times. These measurements indicated that the expected basepoint shift caused by bundling and unbundling the core ranged from $\pm 0.2\phi$ to $\pm 0.6\phi$. Based on the normal and core bundling uncertainties given above, it was decided to assign a $\pm 0.3\phi$ uncertainty in the FRC measurements due to basepoint variations.

(CRD) Tabulated in Table 5 are the reactivity coefficients obtained for uranium, carbon, niobium, and molybdenum in the 2F2 and 3F2 positions of the PAX-E4 core.

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Note: Except for 21F clusters

Figure 1. PAX-E4 Assembly

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TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION

FRC STEP NUMBER 1-A

TYPE FUEL INSERTED - WNCO NRX-A5

TYPE FUEL REMOVED - PAX

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
1F1-B	99-9496	99-28756 (1144)	1F4-B	99-9553	99-25335 (1159)
C	99-6043	99-25635 (1146)	C	99-7007	99-25666 (1159)
D	99-6121	99-25879 (1146)	D	99-7008	99-25674 (1159)
E	99-9472	99-25906 (1146)	E	99-7021	99-25692 (1159)
F	99-6129	99-25833 (1148)	F	99-9555	99-25759 (1159)
G	99-6130	99-25883 (1153)	G	99-6999	99-25683 (1159)
1F2-B	99-6415	99-25477 (1155)	1F5-B	99-7176	99-25334 (1160)
C	99-6419	99-28560 (1155)	C	99-7177	99-25371 (1160)
D	99-9488	99-25363 (1163)	D	99-6987	99-25475 (1160)
E	99-9494	99-25815 (1163)	E	99-7002	99-25653 (1160)
F	99-6132	99-25459 (1166)	F	99-7161	99-25682 (1160)
G	99-6145	99-25474 (1166)	G	99-9558	99-25729 (1160)
1F3-B	99-6898	99-25391 (1158)	1F6-B	99-9560	99-25691 (1164)
C	99-9512	99-25661 (1158)	C	99-9563	99-25716 (1167)
D	99-9530	99-25864 (1158)	D	99-7182	99-25758 (1167)
E	99-9541	99-25754 (1161)	E	99-7222	99-27969 (1167)
F	99-9550	99-25919 (1161)	F	99-7014	99-28099 (1167)
G	99-6896	99-25931 (1161)	G	99-7020	99-28104 (1168)

TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 1-A

TYPE FUEL INSERTED - WNCO NRX-A5

TYPE FUEL REMOVED - PAX

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
2F2-B	99-6359	99-28320 (1169)	2F5-B	99-5285	99-25701 (1178)
C	99-6362	99-28655 (1169)	C	99-9719	99-25835 (1178)
D	99-5582	99-25908 (1170)	D	99-5543	99-27992 (1238)
E	99-5980	99-25909 (1170)	E	99-5598	99-25681 (1279)
F	99-6357	99-26405 (1170)	F	99-5279	99-25811 (1283)
G	99-6358	99-28098 (1170)	G	99-5282	99-25447 (1285)
2F3-B	99-5094	99-26718 (1171)	2F6-B	99-9720	99-25435 (70)
C	99-5097	99-26719 (1171)	C	99-5799	99-25442 (79)
D	99-5103	99-26750 (1171)	D	99-5894	99-25752 (70)
E	99-5106	99-26353 (1175)	E	99-5897	99-25862 (70)
F	99-4317	99-27970 (1175)	F	99-5626	99-26584 (70)
G	99-5081	99-26733 (1176)	G	99-5644	99-26621 (70)
2F4-B	99-5235	99-25644 (1172)			
C	99-9658	99-25663 (1172)			
D	99-5255	99-25756 (1172)			
E	99-5259	99-25780 (1172)			
F	99-5175	99-26359 (1172)			
G	99-9707	99-26724 (1172)			

TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 1-B

TYPE FUEL INSERTED - WNCO NRX-A5

TYPE FUEL REMOVED - PAX

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
3F2-B	99-5970	99-25803 (79)	3F5-B	99-6393	99-28087 (96)
C	99-5971	99-26575 (79)	C	99-11403	99-28108 (96)
D	99-11386	99-26644 (79)	D	99-11405	99-28185 (96)
E	99-5978	99-28065 (79)	E	99-11407	99-28442 (96)
F	99-11369	99-28102 (79)	F	99-6385	99-28558 (96)
G	99-5969	99-28121 (79)	G	99-6389	99-28589 (96)
3F3-B	99-6022	99-28194 (79)	3F6-B	99-11465	99-26569 (97)
C	99-11377	99-28207 (79)	C	99-6418	99-26422 (97)
D	99-6041	99-28210 (79)	D	99-11466	99-26535 (97)
E	99-11379	99-28619 (79)	E	99-6421	99-26541 (97)
F	99-5995	99-28754 (79)	F	99-6406	99-26546 (97)
G	99-11387	99-28767 (79)	G	99-11514	99-26548 (97)
3F4-B	99-6156	99-26578 (96)	6F2-B	99-5792	99-26616 (97)
C	99-6309	99-26579 (96)	C	99-5829	99-26642 (97)
D	99-6327	99-27968 (96)	D	99-5854	99-26676 (97)
E	99-6330	99-27985 (96)	E	99-12739	99-26690 (97)
F	99-11388	99-27986 (96)	F	99-6066	99-26692 (97)
G	99-6155	99-28077 (96)	G	99-6067	99-26694 (97)

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TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 1-B

TYPE FUEL INSERTED - WNCO NRX-A5

TYPE FUEL REMOVED - PAX

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
6F3-B	99-12372	99-26699 (97)	6F6-B	99-12971	99-28137 (99)
C	99-11152	99-28158 (97)	C	99-6007	99-28143 (99)
D	99-6153	99-26615 (98)	D	99-12973	99-28153 (99)
E	99-13052	99-26640 (98)	E	99-13080	99-28161 (99)
F	99-11419	99-26524 (99)	F	99-9669	99-28542 (99)
G	99-5927	99-28786	G	99-9827	99-28557 (99)
6F4-B	99-5942	99-26691 (98)			
C	99-5943	99-26703 (98)			
D	99-5945	99-28441 (98)			
E	99-11432	99-28496 (98)			
F	99-12962	99-28537 (98)			
G	99-5936	99-28625 (98)			
6F5-B	99-12968	99-26528 (99)			
C	99-12969	99-26529 (99)			
D	99-5987	99-26533 (99)			
E	99-6003	99-26581 (99)			
F	99-5948	99-26582 (99)			
G	99-5951	99-28113 (99)			

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TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 2-A

TYPE FUEL INSERTED - WNCO XE-2

* CANDIDATE FUEL

TYPE FUEL REMOVED - WNCO NRX-A5

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
1F1-B	99-28756 (1144)	431-1042805 (116)	1F4-B	99-25335 (1159)	431-1042961 (97)
C	99-25635 (1146)	431-1042825 (116)	C	99-25666 (1159)	431-1042952 (97)
D	99-25879 (1146)	431-1042840 (116)	D	99-25674 (1159)	431-1042963 (97)
E	99-25906 (1146)	431-1042841 (116)	E	99-25692 (1159)	431-1042906 (97)
F	99-25833 (1148)	431-1042950 (116)	F	99-25759 (1159)	431-1042909 (97)
G	99-25883 (1153)	431-1042951 (116)	G	99-25683 (1159)	431-1042913 (97)
1F2-B	99-25477 (1155)	431-1042967*(46)	1F5-B	99-25334 (1160)	431-1042919 (97)
C	99-28560 (1155)	431-1042971*(46)	C	99-25371 (1160)	431-1042923 (97)
D	99-25363 (1163)	431-1042831*(44)	D	99-25475 (1160)	431-1042924 (97)
E	99-25815 (1163)	431-1042946*(44)	E	99-25653 (1160)	431-1042927 (97)
F	99-25459 (1166)	431-1042801*()	F	99-25682 (1160)	431-1043108 (49)
G	99-25474 (1166)	431-1042804*()	G	99-25729 (1160)	431-1043111 (49)
1F3-B	99-25391 (1158)	431-1042866 (116)	1F6-B	99-25691 (1164)	431-1043052 (49)
C	99-25661 (1158)	431-1042867 (116)	C	99-25716 (1167)	431-1042935 (49)
D	99-25864 (1158)	431-1042871 (97)	D	99-25758 (1167)	431-1043110 (49)
E	99-25754 (1161)	431-1042874 (97)	E	99-27969 (1167)	431-1041805 (50)
F	99-25919 (1161)	431-1042875 (97)	F	99-28099 (1167)	431-1042964 (46)
G	99-25931 (1161)	431-1042956 (97)	G	99-28104 (1168)	431-1041807 (50)

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FRC STEP NUMBER 2-A

TYPE FUEL INSERTED - WNCO XE-2

* CANDIDATE FUEL

TYPE FUEL REMOVED - WNCO NRX-A5

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
2F2-B	99-28320 (1169)	431-1042995* (48)	2F5-B	99-25701 (1178)	431-1042802 (116)
C	99-28655 (1169)	431-1043002* (48)	C	99-25835 (1178)	431-1042816 (116)
D	99-25908 (1170)	431-1042882* (48)	D	99-27992 (1238)	431-1042818 (116)
E	99-25909 (1170)	431-1042894* (44)	E	99-25681 (1279)	431-1042832 (116)
F	99-26405 (1170)	431-1042897* (44)	F	99-25811 (1283)	431-1042833 (116)
G	99-28098 (1170)	431-1042907* (44)	G	99-25447 (1285)	431-1042858 (116)
2F3-B	99-26718 (1171)	431-1043132 (49)	2F6-B	99-25435 (70)	431-1042922* (46)
C	99-26719 (1171)	431-1042977 (49)	C	99-25442 (79)	431-1042931* (46)
D	99-26750 (1171)	431-1043008 (49)	D	99-25752 (70)	431-1042937* (46)
E	99-26353 (1175)	431-1043017 (49)	E	99-25862 (70)	431-1042941* (46)
F	99-27970 (1175)	431-1043030 (49)	F	99-26584 (70)	431-1042943* (46)
G	99-26733 (1176)	431-1043045 (49)	G	99-26621 (70)	431-1042970* (46)
2F4-B	99-25644 (1172)	431-1042973* (46)			
C	99-25663 (1172)	431-1042974* (46)			
D	99-25756 (1172)	431-1042990* (46)			
E	99-25780 (1172)	431-1042939* (46)			
F	99-26359 (1172)	431-1042942* (44)			
G	99-26724 (1172)	431-1042835* (46)			

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TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 2-B

TYPE FUEL INSERTED - WNCO XE-2

* CANDIDATE FUEL

TYPE FUEL REMOVED - WNCO NRX-A5

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
3F2-B	99-25803 (79)	431-1043078*(45)	3F5-B	99-28087 (96)	431-1043051 (46)
C	99-26575 (79)	431-1042975 (49)	C	99-28108 (96)	431-1042968 (46)
D	99-26644 (79)	431-1043133 (49)	D	99-28185 (96)	431-1042982 (46)
E	99-28065 (79)	431-1041793 (45)	E	99-28442 (96)	431-1042987 (46)
F	99-28102 (79)	431-1041794 (45)	F	99-28558 (96)	431-1042991 (46)
G	99-28121 (79)	431-1041795 (45)	G	99-28589 (96)	431-1042994 (46)
3F3-B	99-28194 (79)	431-1043112 (49)	3F6-B	99-26569 (97)	431-1041797 (45)
C	99-28207 (79)	431-1043134 (49)	C	99-26422 (97)	431-1041798 (45)
D	99-28210 (79)	431-1043036 (46)	D	99-26535 (97)	431-1042892*(48)
E	99-28619 (79)	431-1043040 (46)	E	99-26541 (97)	431-1041800 (45)
F	99-28754 (79)	431-1043043 (46)	F	99-26546 (97)	431-1041802 (45)
G	99-28767 (79)	431-1043047 (46)	G	99-26548 (97)	431-1041803 (45)
3F4-B	99-26578 (96)	431-1042869*(44)	6F2-B	99-26616 (97)	431-1042864*(45)
C	99-26579 (96)	431-1042888*(44)	C	99-26642 (97)	431-1042865*(45)
D	99-27968 (96)	431-1042945*(44)	D	99-26676 (97)	431-1042872*(48)
E	99-27985 (96)	431-1042972*(44)	E	99-26690 (97)	431-1042873*(48)
F	99-27986 (96)	431-1042810*(45)	F	99-26692 (97)	431-1042876*(48)
G	99-28077 (96)	431-1042812*(45)	G	99-26694 (97)	431-1042877*(48)

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TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 2-B

TYPE FUEL INSERTED - WNCO XE-2

* CANDIDATE FUEL

TYPE FUEL REMOVED - WNCO NRX-A5

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
6F5-B	99-26699 (97)	431-1042998 (50)	6F6-B	99-28137 (99)	431-1043092 (50)
C	99-28158 (97)	431-1042999 (50)	C	99-28143 (99)	431-1042934 (46)
D	99-26615 (98)	431-1043000 (50)	D	99-28153 (99)	431-1042957 (46)
E	99-26640 (98)	431-1043004 (50)	E	99-28161 (99)	431-1042962 (46)
F	99-26524 (99)	431-1043009 (50)	F	99-28542 (99)	431-1041804 (45)
G	99-	431-1043013 (50)	G	99-28557 (99)	431-1042886 (44)
6F4-B	99-26691 (98)	431-1042879*(48)			
C	99-26703 (98)	431-1042878*(48)			
D	99-28441 (98)	431-1042880*(48)			
E	99-28496 (98)	431-1042881*(48)			
F	99-28537 (98)	431-1042887*(48)			
G	99-28625 (98)	431-1042889*(48)			
6F5-B	99-26528 (99)	431-1043029 (50)			
C	99-26529 (99)	431-1043034 (50)			
D	99-26533 (99)	431-1043038 (50)			
E	99-26581 (99)	431-1043104 (50)			
F	99-26582 (99)	431-1043088 (50)			
G	99-28113 (99)	431-1042989 (50)			

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TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 3-A

TYPE FUEL INSERTED - Y-12 XE-2

* CANDIDATE FUEL

TYPE FUEL REMOVED - WNCO XE-2

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
1F1-B	431-1042805 (116)	431-3051504 (85)	1F4-B	431-1042961 (97)	431-3051517 (54)
C	431-1042825 (116)	431-3051506 (85)	C	431-1042952 (97)	431-3051522 (54)
D	431-1042840 (116)	431-3051514 (85)	D	431-1042963 (97)	431-3051530 (54)
E	431-1042841 (116)	431-3051516 (85)	C E	431-1042906 (97)	431-3051535 (54)
F	431-1042950 (116)	431-3051519 (85)	F	431-1042909 (97)	431-3051537 (54)
G	431-1042951 (116)	431-3051521 (85)	G	431-1042913 (97)	431-3051542 (54)
1F2-B	431-1042967*(46)	431-3051789 (54)	1F5-B	431-1042919 (97)	431-3051761 (115)
C	431-1042971*(46)	431-3051795 (54)	C	431-1042923 (97)	431-3051776 (115)
D	431-1042831*(44)	431-3051800 (54)	D	431-1042924 (97)	431-3051778 (115)
E	431-1042946*(44)	431-3051802 (54)	R E	431-1042927 (97)	431-3051788 (115)
F	431-1042801*()	431-3051808 (54)	F	431-1043108 (49)	431-3051790 (115)
G	431-1042804*()	431-3051510 (54)	G	431-1043111 (49)	431-3051791 (115)
1F3-B	431-1042866 (116)	431-3051523 (85)	1F6-B	431-1043052 (49)	431-3051555 (88)
C	431-1042867 (116)	431-3051525 (85)	C	431-1042935 (49)	431-3051556 (88)
D	431-1042871 (97)	431-3051528 (85)	C D	431-1043110 (49)	431-3051560 (88)
E	431-1042874 (97)	431-3051529 (85)	E	431-1041805 (50)	431-3051575 (88)
F	431-1042875 (97)	431-3051533 (85)	F	431-1042964 (49)	431-3051576 (88)
G	431-1042956 (97)	431-3051534 (85)	G	431-1041807 (50)	431-3051577 (88)

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TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 3-A

TYPE FUEL INSERTED - Y-12 XE-2

* CANDIDATE FUEL

TYPE FUEL REMOVED - WNCO XE-2

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
2F2-B	431-1042995* (48)	431-3051579 (88)	2F5-B	431-1042802 (116)	431-3051739 (55)
C	431-1043002* (48)	431-3051713 (88)	C	431-1042816 (116)	431-3051741 (55)
D	431-1042882* (48)	431-3051714 (88)	D	431-1042818 (116)	431-3051743 (55)
E	431-1042894* (44)	431-3051715 (88)	E	431-1042832 (116)	431-3051749 (55)
F	431-1042897* (44)	431-3051717 (88)	F	431-1042833 (116)	431-3051752 (55)
G	431-1042907* (44)	431-3051721 (88)	G	431-1042858 (116)	431-3051759 (55)
2F3-B	431-1043132 (49)	431-3051659 (55)	2F6-B	431-1042922* (46)	431-3051748 (113)
C	431-1042977 (49)	431-3051728 (55)	C	431-1042931* (46)	431-3051753 (113)
D	431-1043008 (49)	431-3051733 (55)	D	431-1042937* (46)	431-3051756 (113)
E	431-1043017 (49)	431-3051734 (55)	E	431-1042941* (46)	431-3051757 (113)
F	431-1043030 (49)	431-3051735 (55)	F	431-1042943* (46)	431-3051760 (113)
G	431-1043045 (49)	431-3051736 (55)	G	431-1042970* (46)	431-3051762 (113)
2F4-B	431-1042973* (46)	431-3051737 (113)			
C	431-1042974* (46)	431-3051740 (113)			
D	431-1042990* (46)	431-3051742 (113)			
E	431-1042939* (46)	431-3051744 (113)			
F	431-1042942* (44)	431-3051745 (113)			
G	431-1042835* (46)	431-3051746 (113)			

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TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 3-B

TYPE FUEL INSERTED - Y-12 XE-2

* CANDIDATE FUEL

TYPE FUEL REMOVED - WNCO XE-2

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
3F2-B	431-1043078*(45)	431-3051538 (79)	3F5-B	431-1043051 (46)	431-3051558 (79)
C	431-1042975 (49)	431-3051539 (79)	C	431-1042968 (46)	431-3051561 (79)
D	431-1043133 (49)	431-3051541 (79)	D	431-1042982 (46)	431-3051562 (79)
E	431-1041793 (45)	431-3051543 (79)	E	431-1042987 (46)	431-3051564 (79)
F	431-1041794 (45)	431-3051549 (79)	F	431-1042991 (46)	431-3051572 (79)
G	431-1041795 (45)	431-3051553 (79)	G	431-1042994 (46)	431-3051578 (79)
3F3-B	431-1043112 (49)	431-3051781 (115)	3F6-B	431-1041797 (45)	431-3051770 (82)
C	431-1043134 (49)	431-3051783 (115)	C	431-1041798 (45)	431-3051771 (82)
D	431-1043036 (46)	431-3051784 (115)	D	431-1042892*(48)	431-3051772 (82)
E	431-1043040 (46)	431-3051785 (115)	E	431-1041800 (45)	431-3051774 (82)
F	431-1043043 (46)	431-3051786 (115)	F	431-1041802 (45)	431-3051775 (82)
G	431-1043047 (46)	431-3051700 (99)	G	431-1041803 (45)	431-3051780 (82)
3F4-B	431-1042869*(44)	431-3051763 (82)	6E2-B	431-1042864*(45)	431-3051702 (99)
C	431-1042888*(44)	431-3051765 (82)	C	431-1042865*(45)	99-79636 (114)
D	431-1042945*(44)	431-3051766 (82)	D	431-1042872*(48)	99-79639 (114)
E	431-1042972*(44)	431-3051767 (82)	E	431-1042873*(48)	99-79640 (114)
F	431-1042810*(45)	431-3051768 (82)	F	431-1042876*(48)	99-79643 (114)
G	431-1042812*(45)	431-3051769 (82)	G	431-1042877*(48)	99-79645 (114)

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TABLE 1 - XE-2 FRC ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 3-B

TYPE FUEL INSERTED - Y-12 XE-2

* CANDIDATE FUEL

TYPE FUEL REMOVED - WNCO XE-2

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
oF3-B	431-1042998 (50)	99-79646 (114)	6F6-B	431-1043092 (50)	99-79635 (84)
C	431-1042999 (50)	99-79647 (114)	C	431-1042934 (46)	99-79655 (99)
D	431-1043000 (50)	99-79648 (114)	D	431-1042957 (46)	99-79656 (99)
E	431-1043004 (50)	99-79649 (114)	E	431-1042962 (46)	99-79657 (99)
F	431-1043009 (50)	99-79651 (114)	F	431-1041804 (45)	99-79658 (99)
G	431-1043013 (50)	99-79652 (114)	G	431-1042886 (44)	99-79663 (99)
oF4-B	431-1042879*(48)	99-79654 (114)			
C	431-1042878*(48)	99-79622 (84)			
D	431-1042880*(48)	99-79623 (84)			
E	431-1042881*(48)	99-79624 (84)			
F	431-1042887*(48)	99-79625 (84)			
G	431-1042889*(48)	99-79627 (84)			
6F5-B	431-1043029 (50)	99-79628 (84)			
C	431-1043034 (50)	99-79629 (84)			
D	431-1043038 (50)	99-79630 (84)			
E	431-1043104 (50)	99-79632 (84)			
F	431-1043088 (50)	99-79633 (84)			
G	431-1042989 (50)	99-79634 (84)			

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TABLE 1 - XE-2 FUEL ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 4-A

TYPE FUEL INSERTED - Y-12 NRX-A5

TYPE FUEL REMOVED - Y-12 XE-2

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
1F1-B	431-3051504 (85)	99-74452 (1073)	1F4-B	431-3051517 (54)	99-73129 (1147)
C	431-3051506 (85)	99-73412 (1140)	C	431-3051522 (54)	99-73184 (1147)
D	431-3051514 (85)	99-74101 (1140)	D	431-3051530 (54)	99-73317 (1147)
E	431-3051516 (85)	99-74182 (1140)	E	431-3051535 (54)	99-74278 (1147)
F	431-3051519 (85)	99-74647 (1140)	F	431-3051537 (54)	99-73037 (1156)
G	431-3051521 (85)	99-73260 (1141)	G	431-3051542 (54)	99-73043 (1156)
1F2-B	431-3051789 (54)	99-73062 (1142)	1F5-B	431-3051761 (115)	99-73578 (1148)
C	431-3051795 (54)	99-73438 (1142)	C	431-3051776 (115)	99-73023 (1150)
D	431-3051800 (54)	99-74184 (1142)	D	431-3051778 (115)	99-73530 (1150)
E	431-3051802 (54)	99-73526 (1144)	E	431-3051788 (115)	99-73545 (1150)
F	431-3051808 (54)	99-74307 (1144)	F	431-3051790 (115)	99-73546 (1150)
G	431-3051510 (54)	99-74460 (1144)	G	431-3051791 (115)	99-74638 (1150)
1F3-B	431-3051523 (85)	99-73064 (1143)	1F6-B	431-3051555 (88)	99-73595 (1149)
C	431-3051525 (85)	99-73078 (1143)	C	431-3051556 (88)	99-73734 (1149)
D	431-3051528 (85)	99-74275 (1143)	D	431-3051560 (88)	99-74102 (1149)
E	431-3051529 (85)	99-74553 (1143)	E	431-3051575 (88)	99-74663 (1149)
F	431-3051533 (85)	99-73660 (1145)	F	431-3051576 (88)	99-73838 (1154)
G	431-3051534 (85)	99-73987 (1145)	G	431-3051577 (88)	99-73860 (1154)

TABLE 1 - XE-2 FUEL ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 4-A

TYPE FUEL INSERTED - Y-12 NRX-A5

TYPE FUEL REMOVED - Y-12 XE-2

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
2F2-B	431-3051579 (88)	99-73027 (1151)	2F5-B	431-3051739 (55)	99-73261 (1197)
C	431-3051713 (88)	99-73157 (1151)	C	431-3051741 (55)	99-73308 (1197)
D	431-3051714 (88)	99-73500 (1151)	D	431-3051743 (55)	99-73361 (1197)
E	431-3051715 (88)	99-73510 (1151)	E	431-3051749 (55)	99-73414 (1197)
F	431-3051717 (88)	99-73964 (1151)	F	431-3051752 (55)	99-73479 (1197)
G	431-3051721 (88)	99-74315 (1151)	G	431-3051759 (55)	99-73646 (1197)
2F3-B	431-3051659 (55)	99-73383 (1152)	2F6-B	431-3051748 (113)	99-73699 (1197)
C	431-3051728 (55)	99-74222 (1152)	C	431-3051753 (113)	99-73583 (1195)
D	431-3051733 (55)	99-74363 (1152)	D	431-3051756 (113)	99-74027 (1195)
E	431-3051734 (55)	99-74412 (1152)	E	431-3051757 (113)	99-74055 (1195)
F	431-3051735 (55)	99-74473 (1152)	F	431-3051760 (113)	99-74157 (1195)
G	431-3051736 (55)	99-73018 (1158)	G	431-3051762 (113)	99-74586 (1195)
2F4-B	431-3051737 (113)	99-73514 (1153)			
C	431-3051740 (113)	99-73520 (1153)			
D	431-3051742 (113)	99-74199 (1153)			
E	431-3051744 (113)	99-74270 (1153)			
F	431-3051745 (113)	99-73041 (1157)			
G	431-3051746 (113)	99-73029 (1157)			

TABLE 1 - XE-2 FUEL ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 4-B

TYPE FUEL INSERTED - Y-12 NRX-A5

TYPE FUEL REMOVED - Y-12 XE-2

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
3F2-B	431-3051538 (79)	99-73489 (1198)	3F5-B	431-3051558 (79)	99-73836 (1263)
C	431-3051539 (79)	99-73618 (1198)	C	431-3051561 (79)	99-73849 (1263)
D	431-3051541 (79)	99-73731 (1198)	D	431-3051562 (79)	99-73856 (1263)
E	431-3051543 (79)	99-73899 (1198)	E	431-3051564 (79)	99-73859 (1263)
F	431-3051549 (79)	99-74203 (1198)	F	431-3051572 (79)	99-73861 (1263)
G	431-3051553 (79)	99-74582 (1198)	G	431-3051578 (79)	99-73873 (1263)
3F3-B	431-3051781 (115)	99-73400 (1196)	3F6-B	431-3051770 (82)	99-73982 (1263)
C	431-3051783 (115)	99-74015 (1196)	C	431-3051771 (82)	99-73742 (1285)
D	431-3051784 (115)	99-74043 (1196)	D	431-3051772 (82)	99-73965 (1285)
E	431-3051785 (115)	99-74140 (1196)	E	431-3051774 (82)	99-74099 (1285)
F	431-3051786 (115)	99-74158 (1259)	F	431-3051775 (82)	99-74408 (1285)
G	431-3051700 (99)	99-74313 (1259)	G	431-3051780 (82)	99-74427 (1285)
3F4-B	431-3051763 (82)	99-73567 (1261)	6F2-B	431-3051702 (99)	99-73723 (1265)
C	431-3051765 (82)	99-73781 (1261)	C	99-79636 (114)	99-73757 (1265)
D	431-3051766 (82)	99-73797 (1262)	D	99-79639 (114)	99-74171 (1265)
E	431-3051767 (82)	99-74001 (1264)	E	99-79640 (114)	99-74604 (1265)
F	431-3051768 (82)	99-74108 (1264)	F	99-79643 (114)	99-74214 (1273)
G	431-3051769 (82)	99-74657 (1264)	G	99-79645 (114)	99-74384 (1273)

TABLE 1 - XE-2 FUEL ELEMENT POSITIONS AND IDENTIFICATION - CONTINUED

FRC STEP NUMBER 4-B

TYPE FUEL INSERTED - Y-12 NRX-A5

TYPE FUEL REMOVED - Y-12 XE-2

CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER	CLUSTER AND ELEMENT POSITION	OUT-GOING PAX ELEMENT SERIAL NUMBER	IN-GOING A5-WNCO ELEMENT SERIAL NUMBER
6F3-B	99-79646 (114)	99-73710 (1275)	6F6-B	99-79635 (84)	99-74489 (1283)
C	99-79647 (114)	99-74113 (1275)	C	99-79655 (99)	99-74500 (1283)
D	99-79648 (114)	99-74334 (1275)	D	99-79656 (99)	99-74458 (1286)
E	99-79649 (114)	99-74347 (1275)	E	99-79657 (99)	99-74477 (1286)
F	99-79651 (114)	99-74394 (1275)	F	99-79658 (99)	99-74527 (1286)
G	99-79652 (114)	99-74455 (1275)	G	99-79663 (99)	99-73737 (1288)
6F4-B	99-79654 (114)	99-74461 (1276)			
C	99-79622 (84)	99-74632 (1276)			
D	99-79623 (84)	99-74118 (1277)			
E	99-79624 (84)	99-74129 (1277)			
F	99-79625 (84)	99-74285 (1279)			
G	99-79627 (84)	99-74297 (1279)			
6F5-B	99-79628 (84)	99-74531 (1281)			
C	99-79629 (84)	99-74559 (1281)			
D	99-79630 (84)	99-74576 (1281)			
E	99-79632 (84)	99-74581 (1281)			
F	99-79633 (84)	99-74595 (1281)			
G	99-79634 (84)	99-74610 (1281)			

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TABLE 2 - XE-2 FRC EXPERIMENT CLUSTER HARDWARE

<u>ITEM NO.</u>	<u>DESCRIPTION</u>	<u>MATERIAL</u>	<u>QUANTITY PER SET</u>	<u>SET #1* MASS (GMS)</u>	<u>SET #2** MASS (GMS)</u>
1	Support Blocks	Graphite	21	2850	2852
2	Cluster Plate With Spacers and Pos. Springs	Gd-SS	21	1914	1877
3	Tie Rod Holders	Steel	21	741	744
4	Extractor Cups	Steel	21	149	149
5	Acorn Nuts	Steel	21	94	90
6	Support Cones	Moly	21	107	105
7	Support Washers	Graphite	21	62	61
8	Insulating Cup	Graphite	21	53	53
9	Insulating Washers	Graphite	21	12	11
10	Liner Tubes	Steel	21	592	639
11	Pyro Tiles	Graphite	294	2009	1981
12	Tie Rod	Steel	21	1643	1640
13	Split Washers	Steel	21	126	125
14	Split Bushings	Aluminum	21	33	32
15	Pre-Load Springs	Steel	21	469	475
16	Orifice	Steel	126	44	44

* Used on PAX fuel, XE-2 WNC0 and NRX-A5 Y-12 clusters.

** Used on NRX-A5 WNC0 and XE-2 Y-12 clusters.

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TABLE 3 - XE-2 FRC EXPERIMENT CENTRAL ELEMENT WEIGHTS

<u>CLUSTER NO.</u>	<u>SET NUMBER 1</u>		<u>SET NUMBER 2</u>	
	<u>SERIAL NO.</u>	<u>MASS-(GMS)</u>	<u>SERIAL NO.</u>	<u>MASS-(GMS)</u>
1F1	PAC-01-02177	616.1	PAC-01-02236	615.9
1F2	PAC-01-02231	611.9	PAC-01-02178	615.9
1F3	PAC-01-03079	618.0	PAC-01-01698	615.2
1F4	PAC-01-02062	617.3	PAC-01-02186	618.0
1F5	PAC-01-03029	618.8	PAC-01-03019	618.4
1F6	PAC-01-02235	616.3	PF-9498	620.0
2F2	PAC-01-01122	613.4	PF-9406	620.0
2F3	PAC-01-02188	615.1	PAC-01-01091	613.7
2F4	PAC-01-02076	618.6	PAC-01-03035	615.7
2F5	PAC-01-03031	618.4	PF-9332	612.7
2F6	PAC-01-02185	616.2	PAC-01-01658	615.9
3F2	PAC-01-02238	615.2	PAC-01-03030	619.0
3F3	PAC-01-03115	617.9	PF-9314	613.2
3F4	PAC-01-02080	620.5	PAC-01-02258	615.7
3F5	PAC-01-02181	616.0	PAC-01-03109	616.1
3F6	PAC-01-03033	616.4	PAC-01-02244	623.1
6F2	PAC-01-02210	616.4	PAC-01-02002	615.9
6F3	PAC-01-02179	615.7	PAC-01-02261	615.5
6F4	PAC-01-03038	614.3	PAC-01-03034	615.7
6F5	PAC-01-01604	615.2	PAC-01-03098	617.1
6F6	PAC-01-02204	616.2	PAC-01-03093	617.9

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TABLE 4 - XE-2 FRC EXPERIMENTAL RESULTS

FRC STEP NO.	DESCRIPTION OF CHANGE	MEASURED REACTIVITY EFFECT		
		REACTIVITY COMPUTER (%)	PERIOD PICK-OFF (%)	TOTAL PER STEP (A + B) (%)
1-A	Substituted NRX-A5 (WNC0) Fuel for PAX Fuel in 1F (1-6) and 2F (2-6)	- 10.9 ± 0.8	- 10.7 ± 1.2	- 13.2 ± 1.2
1-B	Substituted NRX-A5 (WNC0) Fuel for PAX Fuel in 3F (2-6) and 6F (2-6)	- 2.4 ± 0.8	- 2.3 ± 1.0	
2-A	Substituted XE-2 (WNC0) Fuel for NRX-A5 (WNC0) Fuel in 1F (1-6) and 2F (2-6)	+ 9.9 ± 0.8	+ 10.0 ± 0.8	+ 10.5 ± 1.0
2-B	Substituted XE-2 (WNC0) Fuel for NRX-A5 (WNC0) Fuel in 3F (2-6) and 6F (2-6)	+ 0.6 ± 0.8	+ 0.6 ± 0.8	
3-A	Substituted XE-2 (Y-12) Fuel for XE-2 (WNC0) Fuel in 1F (1-6) and 2F (2-6)	- 1.1 ± 0.8	- 1.1 ± 0.8	- 1.3 ± 1.0
3-B	Substituted XE-2 (Y-12) Fuel for XE-2 (WNC0) Fuel in 3F (2-6) and 6F (2-6)	- 0.2 ± 0.8	- 0.1 ± 0.8	
4-A	Substituted NRX-A5 (Y-12) Fuel for XE-2 (Y-12) Fuel in 1F (1-6) and 2F (2-6)	+ 1.8 ± 0.8	+ 1.9 ± 0.8	+ 2.7 ± 1.0
4-B	Substituted NRX-A5 (Y-12) Fuel for XE-2 (Y-12) Fuel in 3F (2-6) and 6F (2-6)	+ 0.9 ± 0.8	+ 0.9 ± 0.8	

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TABLE 5 - FRC REACTIVITY COEFFICIENT MEASUREMENTS

<u>DESCRIPTION OF MEASUREMENT</u>	<u>MASS PERTURBED (Kg)</u>	<u>AVE RADIUS (CM)</u>	<u>REACTIVITY COEFFICIENT (ϕ/Kg)</u>
<u>Uranium Reactivity Coefficient</u> Measured by interchanging 4-19 hole graphite elements and 4 uncoated Code 99 fuel elements.	+ 0.488 (U) - 0.171 (C)	28.2	$14.9 \pm 0.8^*$
<u>Carbon Reactivity Coefficient</u> Measured by interchanging 4 solid graphite elements (FCX AGOT's) and 4-19 hole graphite elements.	- 0.591 (C)	28.2	$4.7 \pm 0.6^*$
<u>Niobium Reactivity Coefficient</u> Measured by inserting approximately 228 - 0.080" OD x 0.0015" wall Nb tubes into 2F2 and 3F2	0.600 (Nb)	28.2	$- 5.7 \pm 0.6^*$
<u>Molybdenum Reactivity Coefficient</u> Measured by inserting 0.040" dia. Mo wires into 2F2 and 3F2.	1.001 (Mo)	28.2	$- 6.1 \pm 0.6^*$

* Uncertainties assigned two-sigma limits.

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