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APPENDIX A
ROD SUBSTITUTION SENSITIVITY

Measurements were performed using the LANL prototype UNCL to establish the position sensitivity for rod removal or rod substitution.

Three cases were examined:

1. empty rod substitution,
2. iron rod substitution, and
3. DU rod substitution.

The rod removals were performed with groups of 8 to 14 rods as shown in Fig. A-1 where one group of rods was removed at a time. The fuel assembly is described in Table IV. The results in Table A-1 are presented in terms of the percent change in R per rod removed. Long measurement times (~24 h) were needed for each configuration to obtain the statistical precision given in Table A-1.

The results show that the iron rod substitution gives the largest perturbation per rod because of thermal-neutron absorption. The DU rod substitution can still be detected in the center of the assembly with roughly half the sensitivity level at the perimeter. Fast neutron multiplication in the ^{238}U is the reason for the reduced perturbation from DU rod substitution.

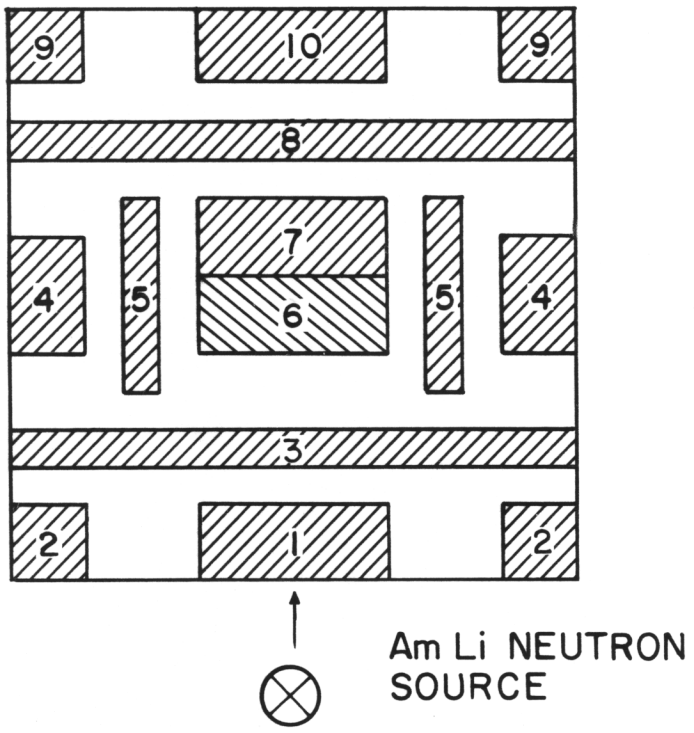

Fig. A-1. Diagram of mockup PWR fuel assembly (15 x 15 rod array) showing the fuel rod zones where the EU rods were replaced by DU rods or iron rods or empty rods. The substitutions were made one zone at a time.

TABLE A-1. Rod Substitution Sensitivity

Substitution Location	Empty Rod (%/rod)	Iron Rod (%/rod)	DU Rod (%/rod)
1	0.35	1.68	0.40
2	0.64	1.25	0.46
3	0.41	0.71	0.34
4	0.41	0.62	0.32
5	0.54	0.53	0.21
6	0.57	0.51	0.20
7	0.53	0.44	0.20
8	0.36	0.32	0.21
9	0.48	0.60	0.25
10	0.46	0.47	0.36
Av	0.48	0.71	0.30