APPENDIX A

TEST REPORT

FOR

FLUX WIRE DOSIMETER

REMOVED FROM

GRAND GULF 1

AT

END OF CYCLE 1

GENERAL ELECTRIC

NUCLEAR FUEL & ENGINEERING SERVICES DEPARTMENT

FMT TRANSMITTAL
NO. 87-212-0007

FUEL MATERIALS TECHNOLOGY

TEST REPORT

DETERMINATION OF FAST NEUTRON FLUX DENSITY AND FLUENCE: GRAND GULF NUCLEAR STATION UNIT 1

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DETERMINATION OF FAST NEUTRON FLUX DENSITY AND FLUENCE: GRAND GULF NUCLEAR STATION UNIT 1

SUMMARY

The fast neutron flux density and fluence (integrated neutron flux) at a capsule near the reactor vessel wall of the Grand Gulf Nuclear Power Station Unit 1 of Systems Energy Resources, Inc. have been determined to be:

8.9×10^{8} n/cm^2·s	>1 MeV full-power flux density
1.4×10^{9} n/cm^2·s	>0.1 MeV full-power flux density
2.6×10^{16} n/cm^2	>1 MeV fluence
4.2×10^{16} n/cm^2	>0.1 MeV fluence

following the analysis of irradiated iron flux dosimeters, in accordance with the GE CM&S Method No. 10.1.6.0 R3.

EXPERIMENTAL

Three iron wires were irradiated in a GE pressure vessel capsule holder at Grand Gulf Unit 1 from September 25, 1983 (startup) to September 5, 1986 (end of cycle 1). Each wire was removed from the capsule, cleaned with 4N HNO_3, weighed, mounted on a counting card, and analyzed for Mn-54 content at a calibrated 4 cm source-to-detector distance with 100-cc and 80-cc Ge(Li) detector systems.

From daily thermal power generation summary tables, the irradiation time periods were calculated. Operating days for each period and the reactor average power fraction are shown in Table 1. Zero power days between fuel periods are also listed.

TABLE 1. Grand Gulf Unit 1 Irradiation Periods (Cycle 1)

Period	Date	Days	Percent of Full Power*	Between Period Time (Days)
1	09/25/83-11/08/83	45	0.019	
				166
2	04/23/84-06/01/84	40	0.028	
				97
3	09/07/84-02/09/85	156	0.167	
				46
4	03/28/85-10/12/85	199	0.690	
				58
5	12/10/85-08/25/86	259	0.655	
				6
6	09/01/86-09/05/86	5	0.634	

(*During operation. Full power was 3833 MW_t.) 704 (Total) 0.48[illegible] (Av)

DISCUSSION OF RESULTS

From the activity measurements and power history, reaction rates for $^{54}Fe(n,p)^{54}Mn$ were calculated. These data appear in Table 2. The Grand Gulf Unit 1 >1 MeV flux density reaction cross section for iron was calculated to be 0.187 barns. This value was obtained from measured cross section data functions from more than 65 spectral determinations for BWRs and for the General Electric Test Reactor using activation monitors and spectral unfolding techniques. These data functions were applied to BWR pressure vessel locations based on water gap (fuel to pressure vessel) distances. The >1 MeV/>0.1 MeV cross section ratio at BWR pressure vessel locations is approximately 1.6.

The determined full-power flux density and actual fluence results at the Grand Gulf reactor vessel wall capsule holder location are given in Table 2. The >1 MeV and >0.1 MeV values of 8.9×10^8 and 1.4×10^9 $n/cm^2 \cdot s$ from the iron flux monitors were calculated by dividing the reaction rate measurement data for the $^{54}Fe(n,p)^{54}Mn$ reaction by the 0.187 barn and 0.187/1.6 barn cross sections. The corresponding fluence results, 2.6×10^{16} and 4.2×10^{16} n/cm^2 for >1 MeV and >0.1 MeV, respectively, were obtained by multiplying the full-power flux density values by the product of the total seconds irradiated (6.08×10^7 s) and the full-power reaction (0.480).

The 2σ errors of the values in Table 2 are estimated to be:

± 5% for dps/g
±10% for dps nucleus (sat'd)
±25% for ϕ and ϕt >1 MeV
±35% for ϕ and ϕt >0.1 MeV

TABLE 2. Flux Density and Fluence Determinations -Grand Gulf Unit 1
Irradiation: September 25, 1983 -- September 5, 1986

Wire (Element)	Wire Weight g	dps/g Element (at end of Irradiation)	Reaction Rate [dps/nucleus (sat'd)]	ϕ_{FP}* Flux Density ($n/cm^2 \cdot s$) >1 MeV	ϕ_{FP}* Flux Density ($n/cm^2 \cdot s$) >0.1 MeV	ϕt Fluence (n/cm^2) >1 MeV	ϕt Fluence (n/cm^2) >0.1 MeV
Iron A	0.1190	4.39×10^{4}	1.67×10^{-16}				
Iron B	0.1263	4.38×10^{4}	1.67×10^{-16}				
Iron C	0.1338	4.41×10^{4}	1.68×10^{-16}				
			1.67×10^{-16} (Av)	8.9×10^{8}	1.4×10^{9}	2.6×10^{16}	4.2×10^{16}

*At Full Power (3833 MW_t).