APPENDIX A

TEST REPORT

FOR

FLUX WIRE DOSIMETER

REMOVED FROM

LASALLE 1

AT

END OF CYCLE 1

GENERAL ELECTRIC

CLEAR FUEL ENGINEERING & MANUFACTURING DEPARTMENT

FMT TRANSMITTAL
NO. 86-212-0026

CORE MATERIALS TESTING AND ANALYSIS

TEST REPORT

DETERMINATION OF FAST NEUTRON FLUX DENSITY AND FLUENCE: LASALLE UNIT 1 NUCLEAR POWER STATION

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DETERMINATION OF FAST NEUTRON FLUX DENSITY AND FLUENCE: LASALLE UNIT 1 NUCLEAR POWER STATION

SUMMARY

The fast neutron flux density and fluence (integrated neutron flux) at a capsule near the reactor vessel wall of the LaSalle Unit 1 Nuclear Power Station of the Commonwealth Edison Company have been determined to be:

4.7×10^8 n/cm^2·s	>1 MeV full-power flux density
7.5×10^8 n/cm^2·s	>0.1 MeV full-power flux density
2.1×10^{16} n/cm^2	>1 MeV fluence
3.3×10^{16} n/cm^2	>0.1 MeV fluence

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

EXPERIMENTAL

Wires of iron and copper (three each) were irradiated in a GE pressure vessel capsule holder at LaSalle Unit 1 from July 21, 1982 (startup) to October 18, 1985 (end of cycle 1). Each wire was removed from the capsule, cleaned with 4N or 8N HNO_3, weighed, mounted on a counting card, and analyzed for its radioactivity content by gamma spectrometry. Each iron wire was analyzed for Mn-54 content and each copper wire for Co-60 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. LaSalle Irradiation Periods (Cycle 1)

Period	Date	Days	Percent of Full Power*	Between Period Time (Days)
1	07/21/82-12/31/82	164	0.164	
				49
2	02/19/83-04/14/83	55	0.274	
				44
3	05/29/83-08/20/83	84	0.502	
				36
4	09/26/83-11/03/83	39	0.417	
				59
5	01/02/84-02/13/84	43	0.526	
				32
6	03/17/84-09/29/84	197	0.813	
				55
7	11/24/84-03/21/85	118	0.753	
				16
8	04/07/85-10/18/85	195	0.678	
*Full power was 3323 MW_t.		895 (Total)	0.563 (Av)	

DISCUSSION OF RESULTS

From the activity measurements and power history, reaction rates for $^{54}Fe(n,p)^{54}Mn$ and $^{63}Cu(n,\alpha)^{60}Co$ were calculated. These data appear in Table 2. The LaSalle Unit 1 >1 MeV flux density reaction cross sections for iron and copper were calculated to be 0.212 barns and 0.00374 barns, respectively. These values were 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 LaSalle Unit 1 full-power >1 MeV flux density results were consistent for the two dosimeter types (Fe, Cu) (see Table 2). These results were 4.6×10^8 and 4.8×10^8 n/cm^2•s, respectively. The determined full-power flux density and actual fluence results at the reactor vessel wall capsule holder location are given in Table 2. The average >1 MeV and >0.1 MeV values of 4.7×10^8 and 7.5×10^8 n/cm^2•s from the flux monitors were calculated by dividing the reaction rate measurement data for the reactions $^{54}Fe(n,p)^{54}Mn$ and $^{63}Cu(n,\alpha)^{60}Cu$ by the appropriate cross sections. The corresponding fluence results, 2.1×10^{16} and 3.3×10^{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 (7.73×10^7 s) and the full-power fraction (0.563).

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 -LaSalle Unit 1
Irradiation: July 21, 1982 – October 18, 1985

Wire (Element)	Wire Weight g	dps/g Element (at end of Irradiation)	Reaction Rate [dps/nucleus (sat'd)]		ϕ_{FP}* Flux Density (n/cm²·s) >1 MeV	ϕ_{FP}* Flux Density (n/cm²·s) >0.1 MeV	ϕt Fluence (n/cm²) >1 MeV	ϕt Fluence (n/cm²) >0.1 MeV
Iron A	0.1256	3.17×10^{4}	9.85×10^{-17}					
Iron B	0.1292	3.16×10^{4}	9.83×10^{-17}					
Iron C	0.1219	3.19×10^{4}	9.92×10^{-17}					
			9.87×10^{-17}	(Av)	4.6×10^{8}	7.4×10^{8}	2.0×10^{16}	3.2×10^{16}
Copper A	0.4632	1.81×10^{3}	1.77×10^{-18}					
Copper B	0.4298	1.84×10^{3}	1.80×10^{-18}					
Copper C	0.4495	1.84×10^{3}	1.80×10^{-18}					
			1.79×10^{-18}	(Av)	4.8×10^{8}	7.6×10^{8}	2.1×10^{16}	3.3×10^{16}

*At Full Power (3323 MW_t).

REFERENCE 11

"GE Report SASR 87-59, "Flux Wire Dosimeter Evaluation for LaSalle Nuclear Power Station, Unit 2," DRF A00-02764, October 1987