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LPTR IRRADIATION OF LLL METGLAS SAMPLES

Unclassified

Susan C. MacLean and Curtis L. Rowe

June 2, 1976

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Dr. Carl F. Cline of LLL requested irradiation of 15 MetGlas samples in the Livermore Pool Type Reactor (LPTR).

The LPTR is a 3MW heterogeneous tank-type pool research reactor. It is light water moderated and cooled, beryllium reflected. It has MTR-type fuel elements, composed of aluminum and enriched uranium.

The MetGlas samples were irradiated in position E-1 of the reactor core. This position is located at the northwest edge of the core, in the beryllium reflector. The neutron spectrum is, therefore, moderated to a greater degree than in the center of the core. The spectrum has been evaluated by Richard V. Griffith of LLL, using multiple foil activation and iterative computer fitting (UCRL-50007-74-2). The spectrum in the absence of cadmium can be summarized as follows:

<u>Neutron Energy</u>	<u>Flux(neutrons/cm²-sec)</u>
<0.54 eV	3.39×10^{13}
0.54 eV to 0.1 MeV	1.04×10^{13}
0.1 MeV to 1.0 MeV	8.05×10^{12}
>1.0 MeV	3.95×10^{12}

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Calculations indicate that the shape of the neutron spectrum above 0.54 eV should be unchanged to within 4% by the presence of cadmium. The relative contribution from neutrons of energies below 0.54 eV should be decreased by a factor of about 21.

Figure 1 shows the experimental assembly.

The irradiation was carried out by the LLL Radiochemistry Division LPTR Operating Staff during the period March 24 to April 14, 1976. The reactor water temperature was 40°C; the sample temperature was estimated to be less than 100°C. The reactor power was monitored continuously by ionization chambers and particularly by the heat balance across the core. The power was controlled at $3\text{MW} \pm 5\%$. The irradiation time was as follows:

<u>Date (1976)</u>	<u>Irradiation Time</u>
March 24	5 hr.
March 25	7 hr. 51 min.
March 26	8 hr. 13 min.
March 30	5 hr. 45 min.
March 31	8 hr.
April 1	6 hr. 34 min.
April 2	7 hr. 36 min.
April 6	5 hr. 16 min.
April 7	8 hr. 6 min.
April 8	8 hr. 4 min.
April 9	8 hr. 7 min.
April 13	6 hr. 30 min.
April 14	<u>7 hr. 49 min.</u>
TOTAL	93 hr. 11 min.

EXPERIMENT ASSEMBLY

FIG. 1

Following the irradiation, the sample can was stored for several days to allow for decay of short-lived isotopes. The MetGlas samples were returned to C. Cline. A piece of the 302 stainless steel liner was cut to be used for dosimetry (3.1 cm^2). It was delivered to Ruth N. Anderson in the LLL Radiochemistry Division for gamma ray counting.

The composition of 302 stainless steel is as follows:

<u>Element</u>	<u>%</u>
C	0.15
P	0.045
S	0.03
Mn	2.0
Si	1.0
Cr	18.0
Ni	9.0
Fe	69.775

The $^{54}\text{Fe}(n,p)^{54}\text{Mn}$ reaction in iron was used for the dosimetry measurements. The contribution of $^{55}\text{Mn}(n,2n)^{54}\text{Mn}$ was calculated to be negligible. The average fluence on the stainless steel dosimetry foil was calculated using the method described in UCRL-51393, Rev. 1. The values used in the calculations were as follows:

Stainless steel density - 7.9 gm/cm^3

^{54}Mn half-life - 312.3 days

Iron atomic mass - 55.847 amu

^{54}Fe isotopic abundance - 4.06% ($5.82\% \times 69.775\% \text{ Fe}$)

Yield of 835 keV gamma ray - 100%

From the gamma counting results, the specific activity of the foil at the end of the irradiation period was determined. Corrections were then made for decay during irradiation assuming a constant flux during the total time the samples were in the reactor, including periods of no power. This introduces a negligible error because of the long half-life of ^{54}Mn . The spectrum average cross sections used were as follows:

$$E > 0.54 \text{ eV} - 0.0149 \text{ barn}$$

$$E > 0.1 \text{ MeV} - 0.0275 \text{ barn}$$

$$E > 1.0 \text{ MeV} - 0.0831 \text{ barn}$$

These are based upon the spectrum measurements of Griffith, corrected for the cadmium, and upon ^{54}Fe cross-section data from the Livermore Evaluated Nuclear Cross Section Library (UCRL-50400, Vol. 4, (1971)).

The results were as follows:

Stainless Steel Fluence (neutrons/cm²)

$$\frac{>0.54 \text{ eV}}{7.56 \times 10^{18}}$$

$$\frac{>0.1 \text{ MeV}}{4.09 \times 10^{18}}$$

$$\frac{>1.0 \text{ MeV}}{1.35 \times 10^{18}}$$

The estimated overall uncertainty of these results is $\pm 30\%$. The relative uncertainty between any two values is about $\pm 2\%$. The values given here represent average fluences over the volume of the stainless steel foil. The fluence on the MetGlas samples are expected to correspond closely to these values because of the intimate contact between the foil and samples and the volume nature of the neutron source.

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EXTERNAL

Dr. Louis Ianniello, USERDA
 Division of Physical Research
 Washington, D. C. 20545

Dr. Donald Stevens, USERDA
 Division of Physical Research
 Washington, D. C. 20545

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