AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100

Silver Spring, Maryland 20910

301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

DATE
June 15, 1960

GENERAL ELECTRIC

ORD ATOM PRODUCT OPERATION - RICHLAND, WASHINGTON

TITLE

GAMMA ACTIVITY OF IRRADIATED ZIRCALLOY SAMPLES

AUTHOR

W. L. Bunch

CIRCULATING COPY
RECEIVED 700 AREA
APR 8 1960
RETURN TO

THIS DOCUMENT IS NOT TO BE LOANED, UNATTENDED OR WHERE AN UNAUTHORIZED PERSON MAY HAVE ACCESS TO IT. WHEN NOT IN USE, IT MUST BE STORED IN AN APPROVED LOCKED REPOSITORY WITHIN AN APPROVED FACILITY. WHILE IT IS IN YOUR POSSESSION, AND UNTIL YOU HAVE OBTAINED A SIGNED RECEIPT FROM THE ISSUING OFFICE, IT IS YOUR RESPONSIBILITY TO KEEP IT AND ITS CONTENTS WITHIN THE LIMITS OF THIS PROGRAM AND FROM AN UNAUTHORIZED PERSON. ITS TRANSMITTAL AND STORAGE IN YOUR PLACE OF RESIDENCE IS PROHIBITED. IT IS NOT TO BE DUPLICATED. IF A PERSONAL COPY IS REQUIRED, OBTAIN THEM FROM THE RELATED ISSUING OFFICE. ALL PERSONS READING THIS DOCUMENT ARE REQUESTED TO SIGN IN THE SPACE PROVIDED BELOW.

[illegible]

64-3886-348 (3-57) ALBERT EINSLAND, WASH

BEST COPY AVAILABLE

(CLASSIFICATION)

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

04/20/1994

DECLASSIFIED

HW-65736

1. WL Bunch
2. JM Fouts
3. FC Franklin
4. CG Lewis
5. R Nilson
6. RE Trumble
7. FW Van Wormer
8. 300 File
9. Record Copy

This document classified by

FW Van Wormer

COPY 1 OF 1, SERIES MA

This document consists of
6 pages.

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of CG-PR-2

W. A. Snyder, 1-31-94.

By Jerry Maley, 4-20-94.

Verified By MT Hanson, 4-20-94

June 15, 1960

GAMMA ACTIVITY OF IRRADIATED ZIRCALLOY SAMPLES

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

NOTICE

This report was prepared for use within General Electric Company in the course of work under Atomic Energy Commission Contract AT(45-1)-1330 and any views or opinions expressed in the report are those of the authors only. This report is subject to revision upon collection of additional data.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

DECLASSIFIED

04/20/1994

DECLASSIFIED

HW-65736

GAMMA ACTIVITY OF IRRADIATED ZIRCALLOY SAMPLES

SUMMARY

Three small samples of zircalloy-2, obtained from a KER tube, were irradiated in the Quickie Facility in F Reactor for one, four, and nine months, respectively. Each sample weighed approximately two grams. One day after discharge from the reactor, the specific activity of each of the samples was essentially the same (about 150 mr/hr/gram at one foot in air). Attenuation measurements taken one day after discharge using lead plates yielded a ten-fold reduction in gamma intensity for each 0.95 inches of lead. This indicates that an enclosure for kilogram samples of zircalloy which have been irradiated for long periods of time at fluxes up to 10^{14} neutrons per square centimeter per second should have six inch thick lead walls or the equivalent for gamma shielding. Based on the effective gamma energy and the half-life for the first day, it appears that Zr-89 may be the predominant isotope initially. After a few days, the half-life becomes long and gamma spectrometer measurements indicate the gamma softens revealing that Zr-95 might become the predominant isotope. However, isotopes were not determined specifically; impurities, other isotopes, or combinations of isotopes could yield the same results.

DISCUSSION

The radioactivity of low cross section materials irradiated in a reactor can seldom be calculated with any degree of accuracy. There are two primary reasons for the inadequacy of the calculations; 1) minute impurities whose presence are not known or detectable by ordinary chemical analysis can become more radioactive than the low cross section primary element, and 2) fast neutron reactions in the primary element can be of greater importance than the commonly considered thermal reactions and cross sections, and fluxes for these reactions are not known precisely at the present time. For these reasons it is best to determine experimentally the radioactivity of such materials as zircalloy to evaluate shielding requirements for irradiated samples. Zircalloy is of interest at the present time as a process tube material. These irradiations were made to determine the amount of shielding which would be required for post-irradiation examination of sections of zircalloy process tubes.

Three samples of zircalloy-2 were obtained from a section of a KER tube. These samples were charged into sample pockets 10, 11 and 12 of the Quickie Facility at F Reactor on September 21, 1959. The first sample was discharged after approximately a one-month exposure (October 22, 1959), the second after approximately four months (January 13, 1960), and the third after approximately nine months (June 1, 1960). Each sample was discharged during equilibrium operation and only after several days of such operation. The samples were dropped from the Quickie Facility into a sample holder adjacent to an ionization chamber and the decay of the radioactivity was followed for approximately one day. At that time, gamma attenuation measurements were taken using lead plates in a fixed geometry. The decay measurements are shown in Figure 1 and the attenuation measurements in Figure 2. Table 1 summarizes the information for each sample.

DECLASSIFIED

HW-65736

Figure 1
Decay of gamma activity of strontium samples as a function of time after discharge from the Quickie facility

DECLASSIFIED

HW-65736

Figure 2
Attenuation of strontium gamma radiation in lead

DECLASSIFIED

HW-65736

TABLE 1
ZIRCALLOY-2 IRRADIATION DATA

Sample Number	1	2	3
Sample weight, grams	2.4764	2.050	2.4224
Exposure, operating days	29.37	90.80	203.54
Sample pocket number	10	11	12
Approximate flux intensity, n/cm^2 sec $\times 10^{-13}$	1.73	1.69*	1.64*
Approximate thermal flux exposure $n/cm^2 \times 10^{-19}$	4.73	13.25*	28.85*
Approximate half life during first day out	1	2.25	2.50
Inches of lead for factor of 10 reduction in gamma	0.95	0.95	0.95
Effective gamma energy	1.0	1.0	1.0
Gamma intensity mr/hr gm at one foot in air			
A. Cobalt calibration of quickie chamber	128	194	134
B. C.P. reading	90	-	180
C. Air Weasel (calculated sensitivity)	--	116	150

*Values based on flux distribution prior to charging of poison for shield protection in tube 2296 in December, 1959.

A zircalloy tube examination facility would be expected to handle kilogram samples which had been irradiated in maximum flux zones for extended periods of time. Based on the data presented in Table 1, a one kilogram sample irradiated for approximately a year in a conventional thermal neutron flux of 10^{14} neutrons per square centimeter per second would read:

$$I = 200 \text{ (mr/hr/gm)} \times 10/1.7 \text{ (flux ratio)} \times 10^3 \text{ (weight ratio)} = 1175 \text{ R/hr at one foot in air.}$$

A reduction in intensity of approximately a million would be needed to give a working rate in the order of one mr/hr at the surface of the examination facility. Since each factor of ten represents nearly one inch of lead, this indicates the need for a six inch thick shield wall. The following dimensions have been calculated for materials other than lead which might be used in an examination facility for economic and structural reasons: iron - 12 inches; high density concrete - 20 inches; ordinary concrete - 36 inches. These values make allowance for the additional reduction gained by distance from the sample.

The decay of the gamma radioactivity of the third sample was followed for ten days in a four pi ionization chamber with a special slow speed chart recorder. The activity became essentially constant after the first few days, indicating the predominance of a long-lived isotope. The radiation from the

DECLASSIFIED

HW-65736

sample was then examined with a gamma spectrometer and the fundamental gamma energy was found to be 0.7 Mev. It seems likely that Zr-95, which has a 65 day half-life and emits gamma of this approximate energy, becomes the most important isotope. However, it is possible that either an impurity or another zirconium isotope or a combination of isotopes could yield the same results. In any event, the shielding thicknesses quoted above should be adequate for zircalloy samples which contain no other impurities (and no greater concentration of impurities) than the test samples.

W. L. Bunch

Irradiation Testing

W. L. Bunch:bmr

DECLASSIFIED

04/20/1994

DATE

FILMED

10/7/94

END