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AECU-3249

Date of Issue: June 30, 1955

Report Number: (KS-499)

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THE ESTIMATION OF RADIATION DOSES FROM INDIUM FOIL ACTIVITY

J. C. Bailey and H. F. Henry

Classification cancelled (or changed to UNCLASSIFIED)

by authority of Dr. C. E. Carter 10/29/56

by Lisa Israel TIE, date 1/2/57

CARBIDE AND CARBON CHEMICALS COMPANY
UNION CARBIDE AND CARBON CORPORATION
K-25 Plant
Oak Ridge, Tennessee

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Technology-Hanford Processes-
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UNITED STATES ATOMIC ENERGY COMMISSION

THE ESTIMATION OF RADIATION
DOSES FROM INDIUM FOIL ACTIVITY

By
J. C. Bailey
H. F. Henry

Photostat Price \$ 1.80

Microfilm Price \$ 1.80

Available from the
Office of Technical Services
Department of Commerce
Washington 25, D. C.

Carbide and Carbon Chemicals Co.
K-25 Plant
Oak Ridge, Tennessee

June 30, 1955

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THE ESTIMATION OF RADIATION DOSES FROM INDIUM FOIL ACTIVITY

(KS-499)

J. C. Bailey and H. F. Henry

Introduction

Indium foils are included in the K-25 security badges to provide a means of estimating radiation exposures in the event of an inadvertent critical reaction, the estimates being based upon the beta activity induced in the foils by exposure to the neutrons from such a reaction.¹

Estimation of Dose

A Geiger-Muller (GM)* type beta-gamma survey meter is used to determine the foil activity, and the procedure for estimating the radiation dose is as follows:

1. Open the beta window on the probe of the instrument.
2. Note the background reading.
3. Place the open window against the security badge so as to cover the name and security number.
4. Read the survey meter.
5. Subtract the background reading to get the net reading.
6. Determine the dose factor from figure 1, using the net reading.
7. From figure 2 obtain the correction factor for the time elapsed between the occurrence of the critical reaction and the time of the meter reading.
8. Multiply the dose factor by the correction factor. This product is the estimate of the total radiation dose received.

Examples

1. One hour after a criticality incident occurred, a GM meter indicated 0.1 mr/hr. when placed against an employee's badge. From figures 1 and 2 the dose factor and decay correction factor are 8.4×10^{-2} rem.** and 2.15, respectively. The dose, given by the product of these values, is 0.18 rem., or 180 mrem.
2. With the situation as outlined above, the reading on an employee's badge was 20 mr/hr. In this case, the values of the dose factor and decay correction factor are 94 rem. and 2.15, respectively; the total indicated radiation dose is 202 rem.

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1 Bailey, J. C., Henry, H. F., and Rohr, R. C., Calibration of Indium Foils for Personnel Monitoring, Carbide and Carbon Chemicals Company, K-25 Plant, Oak Ridge, Tennessee, June 1, 1953, (K-999)

2 Geller, L., and Henry, H. F., Analysis of a Possible Radiation Burst, 6-2-53, (K-1095)

* GM meters in use at K-25 include the El-Tronics GM meter and the 2610 and 2610A meters manufactured by the Nuclear Instrument and Chemical Corp.

** A radiation dose of 1 rem. of beta, gamma, or neutron radiation produces the same biological effect as 1 r of gamma radiation.

Discussion

The dose factor of figure 1 is the dose which would be indicated if an employee's badge were read immediately after a reaction which lasted for only a few seconds and which occurred very near the employee. Although the effects of distance from the reactor and the duration of the reaction, as well as radioactive decay between the time of the reaction and the time the foil activity is measured, were considered in the original report,¹ it is anticipated that for an accident at K-25 only the last of these factors will actually have a significant effect on the interpretation.

In addition, the most probable type of reaction at K-25 involves a well-moderated system² and no evaluation of the dose from an unmoderated reactor has been attempted.

Since activation of the indium foil occurs only as a result of exposure to neutrons, an exposure to beta or gamma radiation in the absence of neutrons will produce no such activation; such exposures are monitored where desirable by film badges, film rings, or pocket chambers. However, the gamma dose associated with a nuclear reaction is included in the dose interpretation as obtained above.

It should be noted that external contamination on a security badge may give a false indication of neutron exposure.

Figure 1

DOSAGE FACTOR VS EL-TRONICS METER READING ON UNSPLIT BADGE

(MASS OF FOIL IN BADGE - 1g)

EL-TRONICS METER READING ON BADGE (MR/HR)

Figure 2
CORRECTION FOR TIME
BETWEEN
EXPOSURE AND COUNTING OF
FOIL

$[F_2(T)]$

$$F_2(T) = e^{\lambda T}$$

CORRECTION FACTOR - $F_2(T)$

TIME SINCE EXPOSURE (MINUTES)

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