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DETERMINATION OF RADIATION DOSE TO PORTIONS
OF THE BODY BY USING THERMOLUMINESCENT DOSIMETERS

By

R. D. Anderson
and
E. E. Oscarson

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INTRODUCTION

Thermoluminescent dosimeters were used to confirm the adequacy of a chest worn dosimeter and estimate the exposure to significant portions of the body. A study was performed to determine the radiation dose to three portions of the body and to evaluate the radiation measurements program within the Atlantic Richfield Hanford Company located at Richland, Washington. When work is performed on material which can expose portions of the body or extremities to radiation of various intensity, one may question the accuracy of a Beta-Gamma Film Dosimeter, when worn on the chest, to correctly record the radiation dose received by the gonads and upper extremities. The reasons for doubts can be illustrated by a brief description of the type of work performed by the chemical operators.

The method of obtaining process samples in the Waste Processing facility requires the employee to bend over the sample port in a squatting position while inserting the sampling equipment into the sample port, which is level with the canyon deck. (Figures 1 and 2) When the sampling equipment is removed from the port and the sample is transferred to the shielded sample container, known at Hanford as a "door stop", the employee can receive, for short periods, a radiation dose rate up to 5 rads/hr. Although the sampling equipment contains a shield for the employees' hands, the employees expressed concern about the radiation dose to the wrists and because of the squatting position, the radiation dose to their gonads.

MATERIALS AND METHODS

A two-part study was conducted using thermoluminescent dosimeters to compare the radiation dose of the chest with that of the wrists and gonads of employees engaged in obtaining process samples. The thermoluminescent dosimeters used were Harshaw Chemical Company's "TLD 100" Lithium Fluoride chips. These chips are 1/8 inch by 1/8 inch by 0.035 inch. Because it would be necessary for the employee to wear the dosimeters for an eight-hour period each day for seven days, a plastic holder was designed to hold the dosimeters. (Figure 3) It became apparent that comfort would be an important factor as well as durability. The dosimeter holder was fabricated from 2 and 3 mil polyvinylchloride sheet plastic which measured one inch by ten inches. A one-inch by two-inch irridescient red flag was placed in the pouch because the small size of the thermoluminescent material and the clear plastic pouch made the dosimeter easy to lose or misplace while wearing white protective clothing. At the end of each plastic pouch a metal clip was attached. This metal clip allowed the employee to attach the dosimeter to his underclothing or around the wrist by fastening the metal clip to both ends of the pouch. If it was not possible for the employee to attach the dosimeter to his underclothing, he was requested to wear the dosimeter on his inner pair of protective coveralls or as close to the skin as possible. A total of 196 sets of dosimeters were worn during the ten-week period of this study. The dosimeter holders proved quite comfortable and durable. Only two sets of dosimeters were lost.

Each dosimeter holder contained unshielded and shielded dosimeters. A folded piece of 10-mil thick (226 mg/sq cm) copper was used to shield the dosimeter in each case where a penetrating measurement was desired.

Sample dosimeters were exposed to calibrated sources of radium gamma and ^{90}Sr to obtain dose measurements ranging from 10 mRad to 50 Rad. From these sample dosimeters, calibration graphs were established after reading the dosimeters on a Harshaw model 2000 Thermoluminescence Analyzer.

DISCUSSION

The study was performed in two parts. In the first part, about 658 process samples were obtained during the processing of normal waste material. During this portion of the study, most of the samples obtained were of a comparatively low level. The maximum estimated dose rate observed was 3500 mrads/hr and the minimum dose rate was 6 mrads/hr. In the second part of the study, Purex Current Acid Waste was processed through the facility which yielded samples estimated to measure 5000 mrads/hr. Approximately 502 sample were taken at this time. As a comparison, the estimated average dose rate to personnel during the first study was 127 mrads/hr as compared to 295 mrads/hr during the second study.

The study was conducted over a period of ten weeks; during this time teams of two operators each wore dosimeters attached to their chests, wrists and gonad areas for periods of five to seven days. Several operators wore the dosimeters for more than one sampling period. During the study, Radiation Monitoring personnel were requested to record the estimated dose rate to the operator for each

sample obtained. These radiation measurements were acquired with the use of a CP type portable dose rate instrument with a shield thickness of 0.125 inches of phenolic (440 mg/sq cm). The information obtained in this way is as follows:

Total number of observations:	1160 samples obtained
Estimated average dose rate per observation:	211 mrad/hr
Range of dose rates noted: Maximum	5000 mrad/hr
Minimum	6 mrad/hr

The exposed TLD chips were read on a Harshaw Model 2000 Thermoluminescence Analyzer. The results of dose interpretation received by the nuclear chemical operators as measured by Thermoluminescent Lithium Fluoride dosimeters is as follows:

Average Radiation Dose per Employee per Week in mRads

	<u>Chest</u>	<u>Wrist</u>	<u>Gonad</u>
Non-penetrating	29	24	29
Penetrating	15	15	17
Total (non-penetrating and penetrating)	44	39	46

CONCLUSIONS

This study indicates that, under the conditions observed, the radiation dose to the gonads as compared to the chest is not sufficiently different to warrant a special interpretation of the chest-mounted Hanford personnel film badge dosimeter. The radiation dose to the wrist does not indicate a dose to the extremity which would be considered excessive as compared to the whole body. Therefore, the whole body dose can realistically be used as the controlling

factor. The radiation doses received to all three locations (chest, wrist, and gonad) indicated that the employees received exposure from sources which were general in nature and no excessive exposure was received by any one location of the body including the extremities.

Figure 1

BATTELLE-NORTHWEST
PHOTOGRAPHY

PHOTO NO. 71 19 18-1

Figure 2

BATTELLE-NORTHWEST
PHOTOGRAPHY

PHOTO NO. 7119 18-2

Figure 3

BATTELLE-NORTHWEST
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