

# Dose Estimation from Daily and Weekly Dosimetry Data

Grant R01 CCR412956-01

George Ostrouchov\*    Edward L. Frome\*    George D. Kerr†

September 30, 1998

## FINAL PERFORMANCE REPORT

### Abstract

Statistical analyses of data from epidemiologic studies of workers exposed to radiation have been based on recorded annual radiation doses. It is usually assumed that the annual dose values are known exactly, although it is generally recognized that the data contain uncertainty due to measurement error and bias. In our previous work [1], a probability distribution was used to describe an individual's dose during a specific period of time and statistical methods were developed for estimating it from weekly film dosimetry data. This study showed that there was a systematic underestimation of doses for Oak Ridge National Laboratory (ORNL) workers. This could result in biased estimates of dose-response coefficients and their standard errors. The result of this evaluation raised serious questions about the validity of the historical personnel dosimetry data that are being used in low-dose studies of nuclear industry workers.

Here we develop new methods for using additional information from daily pocket-meter data and combining it with film dosimetry data to improve the distribution estimates. Together, the methods take into account the "measurement error" that is produced by the film and pocket-meter dosimetry systems, the biases introduced by policies that lead to recording

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left-censored doses as zeros, and other measurement and recording practices. The combined methodology is applied to a sample of dose histories obtained from hard copy dosimetry records at ORNL for the years 1945 to 1955. First, the rigorous addition of pocket-meter information shows that the negative bias is generally more severe than was reported in [1], however the amount of bias also varies greatly between person-years. Second, the addition of pocket-meter information reduces uncertainty for some, while increasing it for others. Together, these results suggest that detailed pocket-meter and film dosimetry information is required to obtain unbiased and reliable dosimetry data for use in epidemiologic studies of workers at ORNL.

Finally, we comment on the benefits and feasibility of computerizing detailed pocket-meter and film information in hard copy records at ORNL.

### Significant Findings

We have developed rigorous methodology for quantifying bias and uncertainty in occupational radiation doses recorded during 1945 to 1955 at ORNL. Our study confirms previous studies that have shown negative bias in the recorded doses. The results of our study suggest that detailed pocket-meter and film dosimetry information is required to obtain unbiased and reliable dosimetry data for use in epidemiologic studies of workers at ORNL.

### Usefulness of Findings

The methodology that we developed for the ORNL cohort can be applied to other historical recorded dose settings at other facilities. Further, the availability of methodology for assessing uncertainty in dose estimates should provide additional motivation to develop methods that incorporate dose uncertainty into dose-response analyses.

The primary benefit of computerizing the ORNL hard copy data would be better external dosimetry data for use in future epidemiologic studies of the ORNL cohort.

### Publications and Aims of the Project

The major aim of developing methodology to combine detailed pocket-meter and film-badge information for better dose estimates is addressed in [2]. A section in the same report addresses the feasibility of computerizing hard copy records at ORNL. We expect to submit the report [2] for publication in an appropriate journal.

A second report [3] discusses some of the computational issues in applying the methodology. This report was submitted for publication to *Computational Statistics & Data Analysis*.

All aims of the project have been addressed.

- [1] Toby J. Mitchell, George Ostrouchov, Edward L. Frome, and George D. Kerr. A method for estimating occupational radiation dose to individuals, using weekly dosimetry data. *Radiation Research*, 147:195–207, 1997.
- [2] George Ostrouchov, Edward L. Frome, and George D. Kerr. Dose estimation from daily and weekly dosimetry data. Technical Report ORNL-6945, ORNL, Oak Ridge, TN 37830, September 1998.
- [3] George Ostrouchov, Asim YarKhan, and Edward L. Frome. Computing occupational radiation dose distributions for individuals. Technical Report ORNL-6792, Oak Ridge National Laboratory, Oak Ridge, TN 37831, 1998.

## FINANCIAL STATUS REPORT

This report, dated July 22, 1998, was sent under separate cover to Ms. Karen Reeves, Grants Management Branch, PGO, at Centers for Disease Control and Prevention in Atlanta, GA.

## EQUIPMENT INVENTORY

No major equipment was acquired under this grant.

## FINAL INVENTION STATEMENT

No inventions were conceived under this grant.



## Memorandum

Date: May 9, 2001

From: Roy M. Fleming, Sc.D., Director, Research Grants Program RMF  
Office of Extramural Programs, NIOSH, D30

Subject: Final Report Submitted for Entry into NTIS for Grant 1 R01 CC412956-01.

To: William D. Bennett  
Data Systems Team, Information Resources Branch, EID, NIOSH, P03/C18

The attached final report has been received from the principal investigator on the subject NIOSH grant. If this document is forwarded to the National Technical Information Service, please let us know when a document number is known so that we can inform anyone who inquires about this final report.

Any publications that are included with this report are highlighted on the list below.

### Attachment

cc: Sherri Diana, EID, P03/C13

### List of Publications

Ostrouchov G, Frome EL, Kerr GD: Dose Estimation from Daily and Weekly Dosimetry Data. Technical Report ORNL6945, ORNL, Oak Ridge, TN 37830, September 1998

Ostrouchov G, YarKhan A, Frome EL: Computing Occupational Radiation Dose Distributions for Individuals. Technical Report ORNL-6792, Oak Ridge National Laboratory, Oak Ridge, TN 37831, 1998

Mitchell TJ, Ostrouchov G, Frome EL, Kerr GD: A Method for Estimating Occupational Radiation Dose to Individuals, Using Weekly Dosimetry Data. Radiation Research 147:195-207, 1997

## **NIOSH Extramural Award Final Report Summary**

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Mitchell TJ, Ostrouchov G, Frome EL, Kerr GD: A Method for Estimating Occupational Radiation Dose to Individuals, Using Weekly Dosimetry Data. Radiation Research 147:195-207, 1997

## NIOSH Extramural Award Final Report Summary

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**Title:** Dose Estimation from Daily and Weekly Dosimetry Data  
**Investigator:** George Ostrouchov, Ph.D.  
**Affiliation:** Oak Ridge National Laboratory  
**City & State:** Oak Ridge, TN  
**Telephone:** (423) 574-3137  
**Award Number:** 1 R01 CC412956-01  
**Start & End Date:** 9/30/1996–12/31/1997  
**Total Project Cost:** \$149,404  
**Program Area:** Exposure Assessment  
**Key Words:**

### Abstract:

Statistical analyses of data from epidemiologic studies of workers exposed to radiation have been based on recorded annual radiation doses. It is usually assumed that the annual dose values are known exactly, although it is generally recognized that the data contain uncertainty due to measurement error and bias. In our previous work, a probability distribution was used to describe an individual's dose during a specific period of time and statistical methods were developed for estimating it from weekly film dosimetry data. This study showed that there was a systematic underestimation of doses for Oak Ridge National Laboratory (ORNL) workers. This could result in biased estimates of dose-response coefficients and their standard errors. The result of this evaluation raised serious questions about the validity of the historical personnel dosimetry data that are being used in low-dose studies of nuclear industry workers.

Here we develop new methods for using additional information from daily pocket-meter data and combining it with film dosimetry data to improve the distribution estimates. Together, the methods take into account the "measurement error" that is produced by the film and pocket-meter dosimetry systems, the biases introduced by policies that lead to recording left-censored doses as zeros, and other measurement and recording practices. The combined methodology is applied to a sample of dose histories obtained from hard copy dosimetry records at ORNL for the years 1945 to 1955. First, the rigorous addition of pocket-meter information shows that the negative bias is generally more severe than was reported earlier; however, the amount of bias also varies greatly between person-years. Second, the addition of pocket-meter information reduces uncertainty for some, while increasing it for others. Together, these results suggest that detailed pocket-meter and film dosimetry information is required to obtain unbiased and reliable dosimetry data for use in epidemiologic studies of workers at ORNL.

### Publications

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