Project ID: 59918

Project Title: Improved Radiation Dosimetry/Risk Estimates to Facilitate Environmental Management of Plutonium Contaminated Sites

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Lead Principal Investigator:
Bobby R. Scott, Ph.D.
Lovelace Respiratory Research Institute
P.O. Box 5890, Albuquerque, NM 87185
Phone: 505-845-1176
E-mail: bscott@lrri.org

Co-Investigators:
Mark D. Hoover, Ph.D.
Lovelace Respiratory Research Institute
P.O. Box 5890, Albuquerque, NM 87185
Phone: 505-845-1040
E-mail: mhoover@lrri.org

Yung-Sung Cheng, Ph.D.
Lovelace Respiratory Research Institute
P.O. Box 5890, Albuquerque, NM 87185
Phone: 505-845-1034
E-mail: ycheng@lrri.org

Helmut Schöllnberger, Ph.D. (postdoctoral participant)
Lovelace Respiratory Research Institute
P.O. Box 5890, Albuquerque, NM 87185
Phone: 505-845-1106
E-mail: hscholln@lrri.org

Graduate Students/Post Doctorates: 1 post-doctoral participant

Specific DOE Problem Addressed: Two specific DOE problems are being address. (1) The need for improved characterization of the health risks from plutonium for DOE workers involved in decommissioning/decontamination activities. (2) The need for improved characterization of health risks for public exposures arising from residual plutonium in soil at remediated (cleaned-up) DOE sites. The more credible *health risk distributions* that account for variability/uncertainty are needed for the plutonium exposures of interest rather than the less credible *point estimates of health risk*.

Research Objective: The main objective of this research is to evaluate health-risk distributions for plutonium (Pu) inhalation-exposure scenarios relevant to environmental management of plutonium-dioxide (PuO_2)-contaminated sites. These distributions incorporate variability/uncertainty.

Research Progress and Implications: This report summarizes work after 2.5 years of a 3-year project. Our research has mainly focused on two areas of Monte Carlo modeling related to inhalation exposure of humans to PuO_2. The present source of PuO_2 being considered is the Rocky Flats Environmental Technology Site near Denver, Colorado, commonly called Rocky Flats. Aerosols considered include the alpha emitters $^{244}PuO_2$, $^{242}PuO_2$, $^{239}PuO_2$, $^{240}PuO_2$, and $^{238}PuO_2$ (ordered here by increasing specific activity).

Research Area 1 relates to evaluating the variability/uncertainty in health risks associated with variability/uncertainty in the respiratory tract intake of pure PuO_2 by DOE workers during decommissioning/decontamination accidents at Rocky Flats and other DOE facilities. Our focus is on the variability/uncertainty associated with inhaling relatively small numbers of polydisperse (i.e., varying sizes) PuO_2 particles. *Research Area 2* relates to evaluating variability/uncertainty in health risks associated with intake by inhalation of PuO_2-contaminated dust in air, over years, arising from Rocky Flats or another PuO_2-contaminated site after remediation. Significant research findings are summarized below.

Key results obtained in Research Area 1 that are highly relevant to protecting DOE workers engaged in decommissioning/decontamination activities at Rocky Flats are as follows: (1) Considerable variability in intake of PuO_2 would be expected for inhalation exposure during decommissioning/decontamination accidents. (2) The variability can involve orders-of-magnitude differences in the amount of PuO_2 inhaled by different workers. (3) The variability should be considered in establishing a respiratory protection system for workers engaged in decommissioning/decontamination activities. (4) The *immediately dangerous to life or health (IDLH)* concept that has been used for respiratory selection criteria for hazardous agents is inappropriate for workers at risk of inhaling plutonium because inhaled, possibly-lethal amounts of PuO_2 can lead to late-occurring health impairments and late-occurring deaths (e.g., from radiation pneumonitis) without any immediate harm. Applying the IDLH concept to airborne PuO_2 could invite costly litigation against the DOE. Results from Research Area 1 also apply to plutonium fires.

Key results obtained in Research Area 2 that are highly relevant to establishing final radionuclide soil action levels at Rocky Flats are as follows: (1) Sampling (via inhalation) from airborne PuO_2-contaminated dust particles of many sizes (polydisperse) is not likely to lead to significant variability in the intake of plutonium when uptake by inhalation occurs over years (e.g., future resident farm family or future onsite office worker exposure scenarios). (2) The variability considered most important is the variability in the amount of contaminated dust inhaled by different individuals. (3) Likely to contribute significantly to the variability in the intake amount is the variability in the number of years at risk for different individuals and differences in lifestyles. (4) Uncertainty in key exposure pathway model (e.g., RESRAD) parameters (identified by sensitivity analyses) should be included in characterizing uncertainty in overall health risk estimates. (5) A very important uncertainty that is often neglected in evaluating radionuclide-associated risks is the uncertainty in dose conversion factors that relate radionuclide intake to radiation dose. Uncertainty in dose conversion factors was not addressed by the Radionuclide Soil Action Level Oversight Panel in

developing revised radionuclide soil action levels for Rocky Flats. Soil action levels are used to determine if remediation-related operations are needed. Unreliable soil action levels can lead to wasting millions or more dollars in site cleanup operations.

Planned Activities: Finalize all remaining project tasks via a no-cost, 1-year extension of the project. Produce the project final report. Present project-related material and results at scientific meetings and publish key project results. New research needs may be addressed via a competing renewal application.

Information Access:

Web resources arising from full or partial support from this project follow:

- Improving Radionuclide Soil Action Levels for Rocky Flats (poster): http://www.radiation-scott.org/rocky
- Plutonium Resources (at our Institute): http://www.radiation-scott.org/
- Plutonium-Related Cases (via hyperlinks): http://www.radiation-scott.org/Cases.htm
- Plutonium-Induced Health Effects (based on publications on Mayak workers): http://www.radiation-scott.org/health.htm
- Other Plutonium-Related Web Sites: http://www.radiation-scott.org/other.htm
- Deposition of Radioactive Substances in the Respiratory Tract: http://www.radiation-scott.org/deposition
- Radiation Glossary for Students: http://www.lrri.org/radiation/rad.htm
- Electronic Borders' Dictionary of Health Physics: http://www.hpinfo.org

Year 1999-2000 publications fully or partially supported by this project follow:

Cheng, Y.-S., Zhou, Y., and Chen, B. T. "Particle deposition in a cast of human oral airways," Aerosol Sci. Technol. (in press).

Glissmeyer, J. A., Alvarez, J. L., Blunt, B. C., Frame, P. W., Hoover, M. D., Hull, A. P., Karhnak, J. M., McFarland, A. R., Newton, G. J., and Rodgers, J. C. *American national standard for sampling and monitoring releases of airborne radioactive substances from the stacks and ducts of nuclear facilities*, ANSI/HPS N13.1-1999, Health Physics Society, McLean, VA, 1999.

Hoover, M. D., Mewhinney, C. J., and Newton, G. J. "Modular glovebox connector and associated good practices for control of radioactive and chemically toxic materials," Health Phys. 76 (1): 66-72, 1999.

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Scott, B. R. and Schöllnberger, H. "Introducing biological microdosimetry for ionizing radiation," Radiat. Prot. Dosim. (submitted).

Optional Additional Information: None

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