

**EPIDEMIOLOGIC STUDY OF ONE MILLION U.S. WORKERS AND VETERANS
EXPOSED TO IONIZING RADIATION
DOE AWARD/CONTRACT NUMBER: DE-SC0004307
FINAL TECHNICAL REPORT
02/27/2015**

Overview. Proposal for full study submitted Sep 2009. Meetings at Oak Ridge held Oct 2010 and Feb 2011. One million subjects now identified. Population is ten times larger than atomic bomb survivor study, has more high-dose subjects and many more deaths, indicating statistical power of study to evaluate low-dose rate effects. Presentations made before congressional committee on Science, Space and Technology, DOE Low-Dose Program, DOE EFCOG, NRC, VBDR and International Congress of Epidemiology.

Aim 1. Department of Energy 200,000 Uranium Workers Feasibility Study, 1943-2008- COMPLETE

- Over 194,000 unique DOE workers from 16 facilities identified, and dose information obtained.
- Over 104,000 workers found to have died, as of 2009.
- Social Security Administration application approved and linkage identified 75,000 alive.
- Application made and approval received from National Death Index to obtain “cause of death.”
- Additional dosimetry received from linkages with Landauer (1953-2008) and REMS dose files.
- Approval and linkage with US Renal Disease registry identified 1% of workers with kidney disease.
- CONCLUSION: It is feasible to study DOE Uranium workers and relate radiation doses received over years of employment to the lifetime risk of death from cancer and renal disease.

Aim 2. Second Follow-Up of the Rocketdyne Radiation Worker Study, 1948-2008 --- COMPLETE

- A second follow-up was conducted and manuscript published: Boice JD, Cohen S, Mumma M, Ellis E, Eckerman K, Leggett R, Boecker B, Brill AB, Henderson BE. Updated mortality analysis of radiation workers at Rocketdyne (Atomics International), 1948-2008. Radiat Res 2011.
- The study is unique in capturing radiation doses from practically all places of employment and incorporating internal doses from ingested radionuclides, notably uranium aluminide.
- No significant associations between radiation and cancer were found, but numbers small. Thus, the need for an expanded study as proposed.
- Historical Notes: Rocketdyne developed a sodium reactor that provided the first commercial use of electricity in the US, lighting the city of Moorpark in 1957. Rocketdyne also developed the Saturn rocket used during Apollo for the moon landings.

Aim 3. Second Follow-Up of the Mound Radiation Worker Study, 1944-2008 --- COMPLETED

- Among 7,291 workers, 49.7% have died, 49.0% are known alive. SSA linkage updated.
- Organ dose estimates for workers exposed to polonium and tritium complete.
- Plutonium bioassay data received August 2011 and organ dose determinations ongoing.
- Cancer Incidence and State Mortality data obtained from Ohio. Renal Disease linkage complete.
- Manuscript written and will be submitted to Radiation Research.
- Historical Notes: Mound Polonium was used with beryllium to generate neutrons and trigger/initiate the Trinity Site and Nagasaki “Fat Man” bombs. Polonium also was the 2006 poison that resulted in the death of a Russian citizen in London.

Aim 4. Feasibility Initiatives to Study DOE Plutonium Workers, Nuclear Power Plant Workers, Other Radiation Workers, and Atomic Veterans

- **Plutonium workers:** Director, Office of Health and Safety, approved access to over 156,000 plutonium workers at 6 DOE facilities. Data files and external doses received Dec 2010. 29,300 death certificates obtained and scanned. 52,000 deaths identified to date. – COMPLETE

- **Nuclear Power Plant Workers:** 212,000 nuclear power plant workers identified from Landauer dosimetry records supplemented with REIRS data files. Microfilm records from 1960s are being scanned to identify additional workers. U.S. Nuclear Regulatory Commission approved access to REIRS to supplement doses and increase number of workers hired before 1985. Met with NEI Dec 2010 to discuss utility issues and dosimetry. Seminar presented NRC 22 Feb 2011. Data sets being merged from REIRS and Landauer. It is feasible to conduct study. -- COMPLETE
- **Other Radiation Workers, including Medical and Industrial Radiography:** 2700 roles of microfilm of early radiation workers 1950s - 1976 available from Landauer and 550 roles are being scanned. Records after 1976 are in electronic format, and over 70,000 non-NPP workers identified with cumulative dose > 5 rem. 3100 deaths identified. Industrial Radiographers to be captured from Landauer supplemented with REIRS. Additional historical account information obtained from Landauer to help identify specific occupational groups for study. Data set for Industrial Radiography can be defined from the REIRS files so the study is deemed feasible. The Medical workers can be identified but the inconsistent use of identifiers makes the followup challenging. Nonetheless it is feasible to conduct this study. -- COMPLETE
- **Atomic Veterans:** 5 year NIH grant awarded in cooperation with Department of Defense (DTRA) and Department of Veteran Affairs (VA) to study 120,000 nuclear weapons test participants including Trinity (1945) and 7 other series in Nevada and Bikini Islands. Two dosimetry meetings held Oct and Nov 2010. Investigator meeting held 19-20 Jan 2011 in Nashville. 11 Mar presentation at VBDR. Next annual meeting planned 12-13 October 2011 in Nashville. VA has provided their follow-up data on Hardtack I cohort, and has linked our files against BIRLS to obtain new mortality data. – FEASIBLE and NIH Grant funded
- **Other study possibilities:** Nuclear Navy submariners (76,000), Navy Shipyard Workers (70,000), recognizing that special permissions from the U.S. Navy/others would be required. INEL of possible interest. Neutron exposures (e.g., Rocky Flats) and other high-LET radiation will be carefully evaluated. Lung cancer among non-smokers exposed to high-LET radiations of NASA interest. Priority for inclusion is given to radiation cohorts that have previously been identified and followed beyond 1979. Negotiations continue with U.S. Navy about the submariner study. The Navy Shipyard study was given to Johns Hopkins University. A Navy Shipyard cohort, however was identified from the REIRS data base and is feasible to study.
- **Websites:** Developed <http://www.onemillionworkerstudy.org/> and <http://www.atomicvetsstudy.org/>

CONCLUSION. The pilot study was successful and all components proved feasible. A larger grant submission will be made to conduct the full study.