Occupational Energy Research Program
Completed Research

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National Institute for Occupational Safety & Health (NIOSH)

October 27, 2005
Completed OERP Research Studies Presentation Outline

• Number of completed intramural and extramural studies
• Issues faced in conducting large studies necessary to answer research questions
• Relevancy of studies to research principles
  – Idaho National Laboratory (INL)
  – Portsmouth Naval Shipyard Studies (PNS)
  – Female Nuclear Weapons Workers (FNW)
  – DOE Remediation Workers Feasibility Study
  – Impact of Downsizing at (5) DOE sites
Completed NIOSH Studies at the DoE Nuclear Weapons Complex

- 54 completed research projects
  - 20 DoE initiated (prior to MoU)
  - 34 NIOSH initiated
  - 151 completed products (reports, assessments, proceedings, manuscripts)
  - 45 communication documents (“one-pagers”)

- 13 Major Facilities located in 11 states

- Study Population: Approximately 600,000 current and retired workers
Completed Occupational Energy Research

Acronyms

INL: Idaho National Laboratory
LANL: Los Alamos National Laboratory
NTS: Nevada Test Site
PORTS: Portsmouth Gaseous Diffusion Plant
PNS: Portsmouth Naval Shipyard (Non-DOE site)
RFETS: Rocky Flats Environmental Technology Site
Brief Report of Research Grant Findings

Savannah River Edition

June 2000

Mortality Among Female Nuclear Weapons Workers

Investigator: Gregg S. Wilkinson, M.A., Ph.D., Professor, Department of Social and Preventive Medicine, State University of New York at Buffalo.

Study Population: A total of 67,976 women who worked at any of the following 12 Department of Energy sites before January 1, 1980: Oak Ridge (X-10, Y-12, K-25), Los Alamos National Laboratory, the Zia Company, Rocky Flats, Hanford, Mound, Savannah River, Fernald, Pantex, and Linde (closed in 1949).

How This Study Was Done: This study examined the occurrence of deaths among female nuclear weapons workers who worked at any of the 12 sites included in the study. The number of deaths that occurred among these workers was compared with the number of deaths expected to occur based on the mortality experience of the United States female population. The study also attempted to determine if there is a relationship between exposure to ionizing radiation and deaths due to certain diseases. The study report and findings were externally peer reviewed.

Study Findings: For most causes of death, including cancers related to ionizing radiation, fewer female workers died than would be expected based on the U.S. female population. For the entire study population, researchers expected 18,106 deaths from the start of operations through 1993, but found only 13,671 deaths. At all of the sites, the number of deaths were either similar to or lower than expected. These findings are not unusual for worker populations (due to the healthy worker effect).

There were certain causes of death that occurred more frequently than expected:
- More female workers died from mental disorders than expected (92 deaths expected, 135 deaths found). More female workers died from certain genito-urinary diseases than expected (89 deaths expected, 115 deaths found). More female workers died from ill-defined conditions than expected (182 deaths expected, 290 deaths found). The explanation of these findings is difficult because mental disorders, genito-urinary diseases, and ill-defined conditions are broad categories.
Further NIOSH Information:

- For a copy of the abstract or the final technical report for this study, call 1-800-356-4674.
- For a summary of NIOSH research involving Department of Energy workers, visit online at: www.cdc.gov/niosh/noinex.html

Additional Information:

- For information about medical monitoring for former Department of Energy workers, visit online at: tisaf.doe.gov/WorkersProgram.html-sni

This study was supported by the National Institute for Occupational Safety and Health (NIOSH) Research Grant Program, Grant No. 1 ROI CCR 612934. The conclusions expressed are those of the authors and not necessarily those of NIOSH.

Additional analyses of 21,440 female workers monitored for external radiation at the sites (excluding Linde and Mound) were conducted to explore the relationship between ionizing radiation and deaths from specific causes.

- An increase in leukemia mortality was observed among female workers who were more highly exposed to external radiation.
- It appears that there may be increases for all cancers combined, breast cancer, and hematologic cancers among female workers who were more highly exposed to external radiation.

Study Limitations:

- The fact that fewer deaths than expected were found raises the concern that undercounting of deceased female workers occurred.
- Recorded doses for external radiation are potentially subject to error because of inconsistent dose monitoring practices across sites, especially during the early years of operation, and because certain types of radiation such as neutrons were not measured very well in the past.
- Potentially important confounders such as lifestyle factors (e.g., smoking), radiation due to medical procedures, age-at-exposure, and other workplace exposures could not be evaluated.

Important Announcements

Dr. Wilkinson will discuss study findings in a live satellite presentation from Washington D.C. to the study sites on Thursday, June 29, 2000, at 1:00 p.m., EDT. Broadcast of this presentation will be held at the American Museum of Science and Energy Auditorium, 300 South Tulane Avenue, Oak Ridge, TN 37830. Presentation will be videotaped and made available at the site. For more information please contact DOE site representative, Walter Perry at (423) 576-0885.

Questions concerning this study should be directed to NIOSH and Dr. Wilkinson at (513) 841-4400. Questions regarding proposed DOE compensation programs need to be directed to the DOE site representative listed above.

NIOSH/HERB Contact Points for further information...

National Institute for Occupational Safety and Health (NIOSH)
Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS)
Health-Related Energy Research Branch (HERB)

NIOSH-HERB MS R-44
4676 Columbia Parkway
Cincinnati, OH 45226

Phone: (513) 841-4400
Fax: (513) 841-4470
Primary Research Questions

- How do risks from fractionated exposures compare with acute exposure risks?
- Are current exposure limits adequate?
- What are the health risks from different forms of radiation?
- What is the joint effect of radiation and chemical exposures?
The Retrospective Cohort Mortality Study

• Purpose/Strength: Provides the most direct approach for evaluating the overall patterns of disease

• Steps:
  – Define the cohort
  – Roster development
  – Vital status follow-up
  – Building work history and exposure databases
  – Selection of comparison populations
  – Data analysis
Building a Study Cohort – INL

Example

Workers initially identified
n=101,998

Military
n=17,492

Offsite DOE
n=2,977

Hired after 1991
n=4,644

Visitors
n=557

No followup
n=12,767

Final number in cohort
n=63,561
Methods: Vital Status & Cause of Death for INL Study

• Vital status (living & deceased) 1/1/1949 through 12/31/99
  – US Social Security Administration Death Master File (prior to 1979)
  – National Death Index (since 1979)
  – Medicare
  – US Internal Revenue Service
  – Pension Benefits Inc.

• Cause of death
  – National Death Index Plus (includes COD)
  – Obtaining death certificates from States

• Causes of death coded to ICD-9
# Building Work History and Exposure Assessment Databases

## Primary Steps

- Understanding facility processes
- Capture records
- Determine what is available to code
- Review each person’s records
- Collapse of the Database
- Validate the Database

## PNS Leukemia Case-Control Study (n=575)

- 10,997 work history records
- 3,475 final Work history records
- 3,437 medical X-ray dose records
- 7,845 radiation dose records
# Recently Completed OERP Studies

- **In-House Studies**

<table>
<thead>
<tr>
<th>Title</th>
<th>Key Findings</th>
<th>Citation</th>
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<tbody>
<tr>
<td>PNS leukemia case-control study</td>
<td>Most cancers not associated with radiation (poss. exc. leukemia, NHL, brain tumors, breast cancer)</td>
<td>NIOSH 2005-104 Radiat Res 2005</td>
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<tr>
<td>INL cohort mortality study</td>
<td></td>
<td>NIOSH 2005-131 BMJ 2005 (as part of IARC cohort)</td>
</tr>
<tr>
<td>Portsmouth Gaseous Diffusion Plant Mortality Study</td>
<td>No radiation-related cancer risk at Portsmouth GDP</td>
<td>NIOSH 2001</td>
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## Recently Completed Extramural OERP Studies

- Grants, contracts and cooperative agreements recently completed

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<thead>
<tr>
<th>Title</th>
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<th>Citation</th>
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</thead>
<tbody>
<tr>
<td>Rocky Flats cohort study</td>
<td>Plutonium-related elevation in lung cancer risk</td>
<td>Am J Epidemiol 2004</td>
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<tr>
<td>Hanford cohort mortality study</td>
<td>Older workers may be at higher risk of radiation-induced cancer</td>
<td>Am J Indus Med 2004</td>
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<tr>
<td>Evaluating time-related variables in occupational epidemiology studies (ORNL)</td>
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<td>Occ Environ Med 2005</td>
</tr>
<tr>
<td>Risk of cancer following low doses of ionizing radiation—a 15 country study</td>
<td>Elevation in solid cancers and (non-significantly) leukemia</td>
<td>BMJ 2005</td>
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<tr>
<td>Research Principle</td>
<td>Completed Study Examples</td>
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<td>--------------------------------------------------------------</td>
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<tr>
<td>Consider Previously Unstudied Sites</td>
<td>Mortality Study of Workers at the Idaho National Laboratory (INL)</td>
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<td></td>
<td>Female Nuclear Weapons Workers Mortality (FNW)</td>
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<tr>
<td>Combine Cohorts for Greater Power</td>
<td>INL, Portsmouth Naval Shipyard (PNS)</td>
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<tr>
<td>Improve Exposure Assessment</td>
<td>INL, PNS, FNW, Impact of Downsizing</td>
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<tr>
<td>Include Non-Whites and Females</td>
<td>Remediation Workers, Impact of Downsizing</td>
<td></td>
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<td>Develop Studies of Current Workers</td>
<td>Impact of Downsizing at (5) DOE sites</td>
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<td>Increase Morbidity Studies</td>
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Primary Research Questions:

- Do mortality patterns among INL workers differ from the U.S. population?
- What is the relation between exposure to ionizing radiation and cancer mortality?
- What is the mortality risk in (non-radiological) exposure-based sub cohorts?
INL Study Characteristics

• Cohort Mortality Study
  – 63,561 workers
  – 10,906 (17%) deceased
  – 57 % monitored for external radiation exposure
  – Vital status follow-up through 1999

• Exposures
  – External radiation doses (gamma & neutron)
  – Internal radiation exposure
  – Exposure-based sub cohorts (chemical, construction, asbestos, transportation and painting)
INL Study Key Findings

- Overall mortality rate among INL workers is lower than the regional population.
- Overall cancer mortality rate is slightly elevated among INL workers.
- Overall mortality rate lower among radiation-monitored workers compared to non-monitored workers.
- Non-Hodgkin Lymphoma elevated in the cohort particularly among male painters and female construction workers.
- Asbestosis elevated among construction and maintenance workers.
PNS Cohort Mortality Study

**Primary Research Questions**

- Do mortality patterns among PNS workers differ from the U.S. population?
- What is the relation between exposure to ionizing radiation and cancer mortality?
- What is the mortality risk among non-radiation exposed workers?
PNS Cohort Mortality Study
Characteristics

• Cohort Mortality Study
  – 37,853 Males and females of all races ever employed as civilian workers at PNS between 1952 and 1992
  – 12,393 (32.7%) deceased
  – 36 % monitored for external radiation exposure
  – Vital status follow-up through 1996

• Exposures
  – External radiation (gamma)

• Primary Outcomes
  – Lung cancer and leukemia
PNS Cohort Study Key Findings

- Overall mortality rate among PNS workers is lower than the U.S. population
- Leukemia
  - no overall elevation
  - significant positive linear trend with external radiation dose
    - elevated excess risk with and without adjustment for potential confounding
- Lung cancer
  - elevated overall
  - elevations in intermediate dose groups, no significant trend
    - no association after adjusting for potential confounders
Leukemia Case Control Study of Civilian Workers at the Portsmouth Naval Shipyard (PNS)

*Primary Research Questions:*

- What is dose-response relation between exposure to external ionizing radiation and leukemia mortality?
- What is the impact on the dose-response when exposures from work-related medical X-rays are added to occupational dose?
- Can the effect of chemical exposures be assessed?
PNS Leukemia Case-Control Study Key Findings

- Leukemia mortality risk increased with increasing cumulative radiation dose among PNS workers.
- Incorporation of doses from work-related medical x-ray procedures did not change the leukemia risk estimate.
- Workers potentially exposed to benzene or carbon tetrachloride for longer periods of time appear to have greater risk of death from leukemia.
Study of the Mortality Among Female Nuclear Weapons Workers (FNW)

**Primary Research Questions:**

- Do mortality patterns among FNW workers differ from the U.S. population?
- What is the relation between exposure to ionizing radiation and cancer mortality?
- What is the mortality risk in non-radiation monitored workers?
FNW Study Characteristics

• Cohort Mortality Study
  – 67,976 Women
  – 13,671 (20%) deceased
  – 32% monitored for external radiation exposure
    – Vital status follow-up through 1994
• Exposures
  – External ionizing radiation
FNW Study Key Findings

• Overall mortality rate among female nuclear weapons workers is lower than the U.S. population
  – Mental disorders, urinary diseases, and ill-defined conditions all elevated

• Overall cancer mortality rate is lower than the U.S. population

• Among radiation-monitored workers leukemia and breast cancer are elevated
Assessment of Information Needed to Evaluate Health Effects Due to Occupational Exposures for Current DoE Site Remediation Workers

**Primary Research Questions:**

• Can remediation workers be identified?

• Are adequate exposure, work history and medical data available for remediation workers?

• Can individual workers be linked to their exposure and medical data?

• Can epidemiologic studies be conducted?
Key Findings—Current DoE Site Remediation Workers

- Complete rosters of current and former remediation workers do not exist.
- Significant gaps in chemical exposure, work history, and medical data exist.
- Data collection and archiving methods are not standardized within and among DoE sites.
- Ability to conduct accurate and comprehensive epidemiological studies of remediation workers is limited.
Impact of Downsizing and Reorganization on Employee Health

*Primary Research Question:*

- What is the relationship between workplace restructuring and individual health and workplace functioning?
### The Impact of Downsizing and Reorganization-Study Characteristics

<table>
<thead>
<tr>
<th>Site</th>
<th>Number of workers surveyed</th>
<th>% Responded</th>
</tr>
</thead>
<tbody>
<tr>
<td>LANL</td>
<td>3,528</td>
<td>45%</td>
</tr>
<tr>
<td>NTS</td>
<td>1,034</td>
<td>67%</td>
</tr>
<tr>
<td>Oak Ridge (Y-12)</td>
<td>2,442</td>
<td>48%</td>
</tr>
<tr>
<td>Pantex</td>
<td>1,274</td>
<td>62%</td>
</tr>
<tr>
<td>INEEL</td>
<td>2,368</td>
<td>71%</td>
</tr>
</tbody>
</table>
Findings-The Impact of Downsizing and Reorganization Study

• If downsizing process was fair, communication open and honest, less job insecurity and fewer medical symptoms (e.g., headaches, shortness of breath, backaches), reported.

• Workers directly involved with the downsizing process (i.e., delivered layoff notices, laid off and rehired, changed jobs/departments) reported more stress, job insecurity and medical symptoms.
Health Hazard Evaluations (HHEs)

- NIOSH responds to employer or employee’s requests for assistance to evaluate potential health hazards
- Since 1991, NIOSH has conducted HHEs at several DoE facilities
- HHEs typically result in recommendations and guidance for reducing worker exposures
# Examples of HHEs at DoE Facilities

<table>
<thead>
<tr>
<th>Site</th>
<th>Year</th>
<th>Problem</th>
<th>NIOSH Recommendations</th>
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<tbody>
<tr>
<td>Sandia NL</td>
<td>1991</td>
<td>Chemicals, UV and EMF radiation</td>
<td>Improve exhaust ventilation and monitoring; training improvements; UV-protective glasses; ergonomic improvements</td>
</tr>
<tr>
<td>INL</td>
<td>1993</td>
<td>Noise, lead</td>
<td>Air supply reconfiguration; Substitution of copper-jacketed bullets; handwashing and use of barriers to prevent lead exposures; medical surveillance; use of both earmuffs and plugs.</td>
</tr>
<tr>
<td>PGDF</td>
<td>1994</td>
<td>Arsenic</td>
<td>Use of supplied-air respiratory protection and protective clothing in non-radiological areas; increased exposure monitoring and control</td>
</tr>
<tr>
<td>PGDF</td>
<td>1996</td>
<td>Neutrons</td>
<td>Improvements for monitoring of neutrons</td>
</tr>
<tr>
<td>PGDF</td>
<td>2002</td>
<td>Arsenic, cutting scrap</td>
<td>Improved respirator cleaning and vent methods; continue air &amp; urine monitoring; require respirators</td>
</tr>
<tr>
<td>Hanford</td>
<td>2004</td>
<td>Tank farm contents</td>
<td>Provide respirators for workers in tank farms; monitor real-time exposures in head space and breathing zone; medical monitoring of vapor exposed persons</td>
</tr>
</tbody>
</table>
Key Findings of OERP Research

- Most nuclear worker cohorts relatively young (>85% still living)
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Low average exposures to photon radiation (10-20 mGy)
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- International nuclear worker study shows elevation in solid cancers and (non-significantly) leukemia.

- Older workers may be at higher risk of radiation-induced cancer at ORNL and Hanford.

- Workers at Rocky Flats show plutonium-related elevation in lung cancer risk.

- No radiation-related cancer risk at Portsmouth GDP.
Impact of OERP Research

- Health effects from low level chronic fractionated radiation exposures observed in some cohorts.
- Improved exposure assessment enables analyses of mixed exposures.
- Observed health effects from different forms of radiation exposure.
- Health effects with increased follow-up and addition of current workers.
- Reductions in worker exposures through HHE recommendations