Occupational Energy Research Program Completed Research

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October 27, 2005

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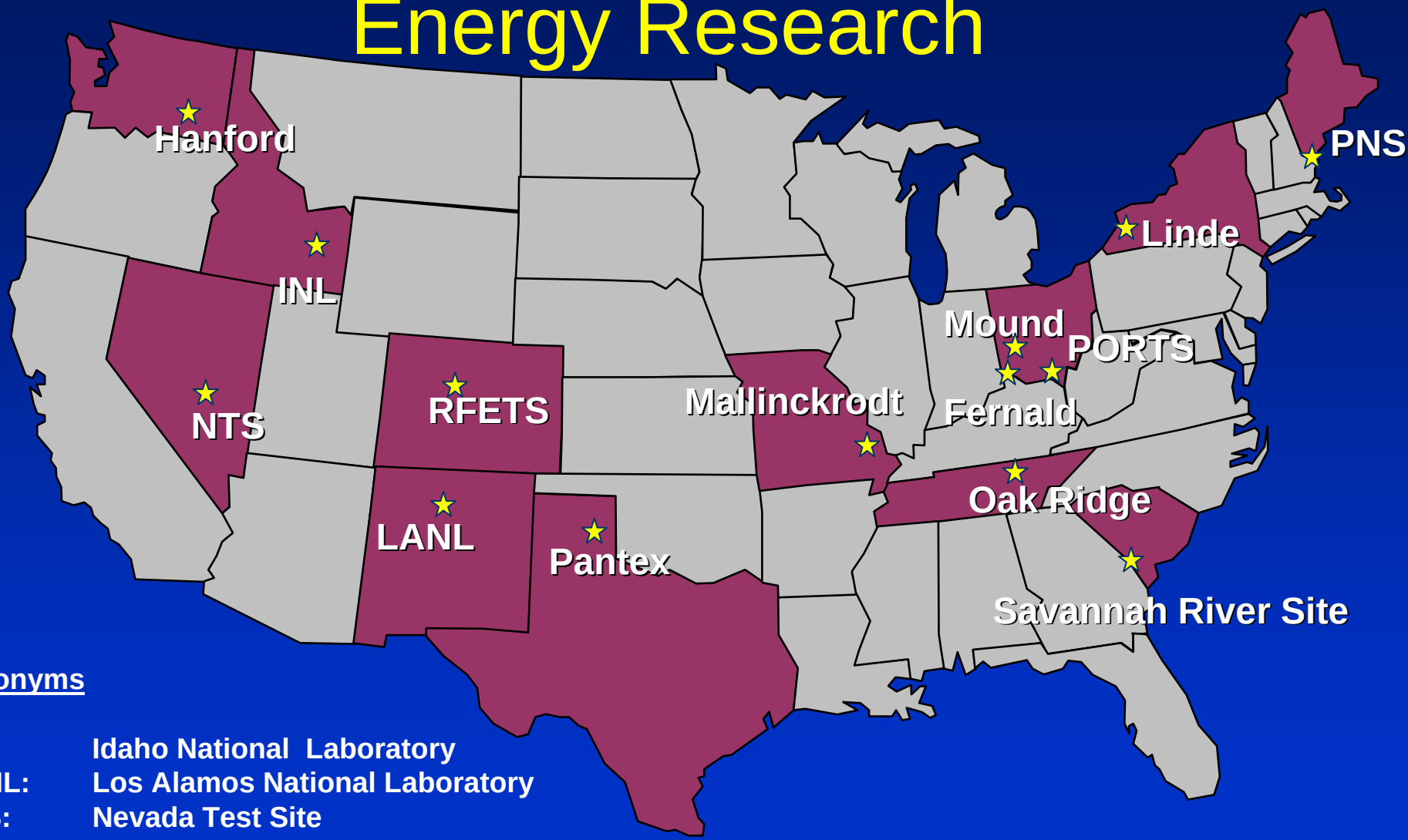
Completed OERP Research Studies Presentation Outline

- 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

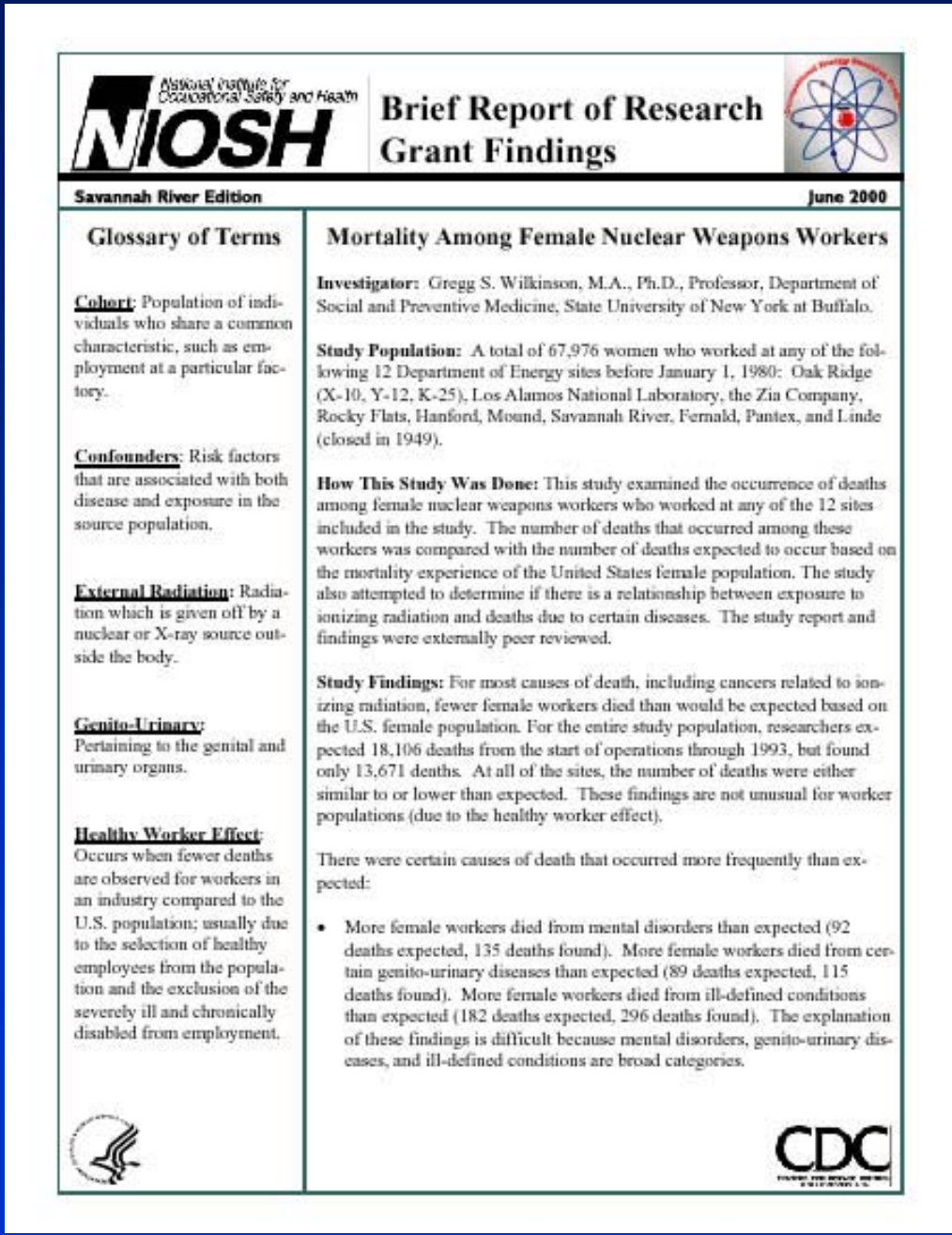
Completed Occupational Energy Research



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

OERP Brief Report of Findings



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Brief Report of Research Grant Findings

Savannah River Edition — **June 2000**

Glossary of Terms

Cohort: Population of individuals who share a common characteristic, such as employment at a particular factory.

Confounders: Risk factors that are associated with both disease and exposure in the source population.

External Radiation: Radiation which is given off by a nuclear or X-ray source outside the body.

Genito-Urinary: Pertaining to the genital and urinary organs.

Healthy Worker Effect: Occurs when fewer deaths are observed for workers in an industry compared to the U.S. population; usually due to the selection of healthy employees from the population and the exclusion of the severely ill and chronically disabled from employment.

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, 296 deaths found). The explanation of these findings is difficult because mental disorders, genito-urinary diseases, and ill-defined conditions are broad categories.

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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/oeindex.html

Additional Information:

- For information about medical monitoring for former Department of Energy workers, visit online at:

  tis.eh.doe.gov/workers/program.html-ssi

This study was supported by the National Institute for Occupational Safety and Health (NIOSH) Research Grant Program, Grant No. 1 R01 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

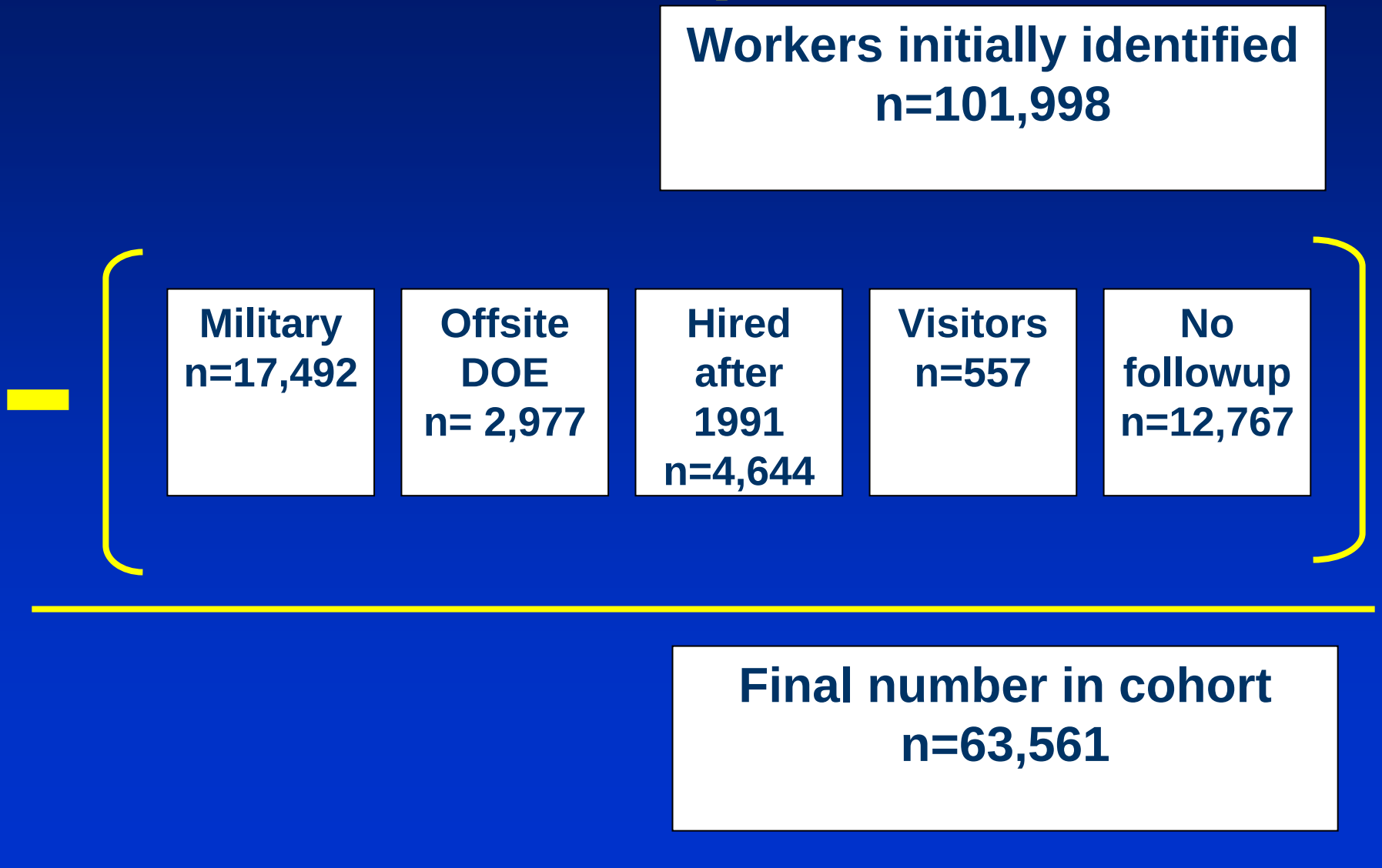
Primary Research Questions

- 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



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 persons 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

Title	*Key Findings*	*Citation*
Portsmouth Naval Shipyard cohort mortality study	Portsmouth Naval Shipyard workers exhibit gamma dose-related elevation of leukemia	J Occ Med 2004 Radiat Res 2005
PNS leukemia case-control study		NIOSH 2005-104 Radiat Res 2005
INL cohort mortality study	Most cancers not associated with radiation (poss. exc. leukemia, NHL, brain tumors, breast cancer)	NIOSH 2005-131 BMJ 2005 (as part of IARC cohort)
Portsmouth Gaseous Diffusion Plant Mortality Study	No radiation-related cancer risk at Portsmouth GDP	NIOSH 2001

Recently Completed Extramural OERP Studies

- Grants, contracts and cooperative agreements recently completed

Title	*Key Findings*	*Citation*
Rocky Flats cohort study	Plutonium-related elevation in lung cancer risk	Am J Epidemiol 2004
Hanford cohort mortality study	Older workers may be at higher risk of radiation-induced cancer	Am J Indust Med 2004 Occ Environ Med 2005
Evaluating time-related variables in occupational epidemiology studies (ORNL)		Am Stat Assoc Suppl 2005
Risk of cancer following low doses of ionizing radiation—a 15 country study	Elevation in solid cancers and (non-significantly) leukemia	BMJ 2005

ACERER: Research Principles

Research Principle	Completed Study Examples
Consider Previously Unstudied Sites	Mortality Study of Workers at the Idaho National Laboratory (INL)
Combine Cohorts for Greater Power	Female Nuclear Weapons Workers Mortality (FNW)
Improve Exposure Assessment	INL, Portsmouth Naval Shipyard (PNS)
Include Non-Whites and Females	INL, PNS, FNW, Impact of Downsizing
Develop Studies of Current Workers	Remediation Workers, Impact of Downsizing
Increase Morbidity Studies	Impact of Downsizing at (5) DOE sites

INL Cohort Mortality Study

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)

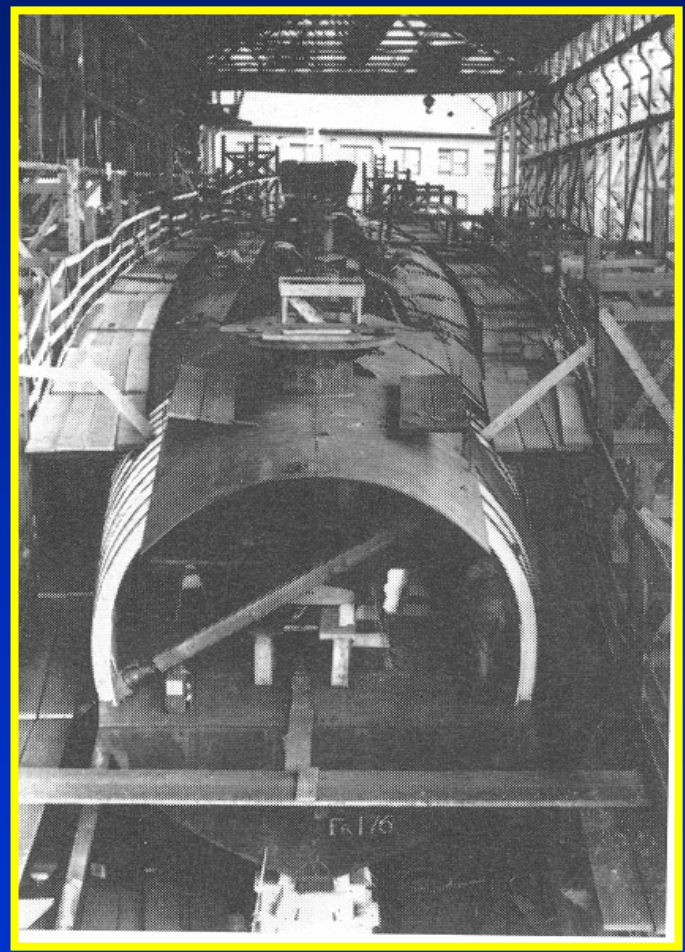
INL Study Key Findings

- 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

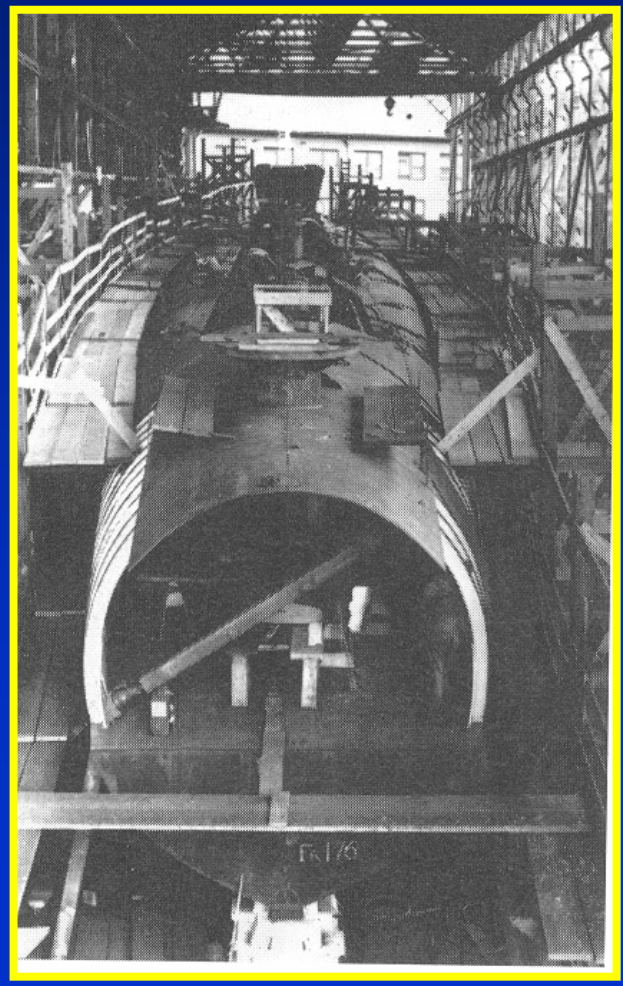
PNS Cohort Study Key Findings

- 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?

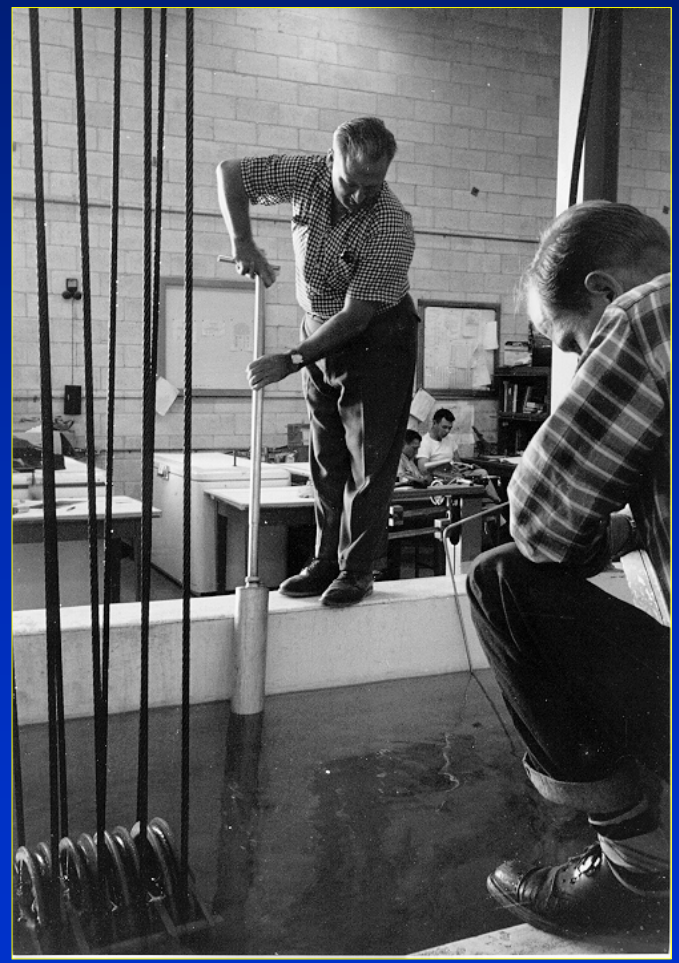
Key Findings—Current DoE Site Remediation Workers

- 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

Site	Number of workers surveyed	% Responded
LANL	3,528	45%
NTS	1,034	67%
Oak Ridge (Y-12)	2,442	48%
Pantex	1,274	62%
INEEL	2,368	71%

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

Site	*Year*	*Problem*	*NIOSH Recommendations*
Sandia NL	1991	Chemicals, UV and EMF radiation	Improve exhaust ventilation and monitoring; training improvements; UV-protective glasses; ergonomic improvements
INL	1993	Noise, lead	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.
PGDF	1994	Arsenic	Use of supplied-air respiratory protection and protective clothing in non-radiological areas; increased exposure monitoring and control
PGDF	1996	Neutrons	Improvements for monitoring of neutrons
PGDF	2002	Arsenic, cutting scrap	Improved respirator cleaning and vent methods; continue air & urine monitoring; require respirators
Hanford	2004	Tank farm contents	Provide respirators for workers in tank farms; monitor real-time exposures in head space and breathing zone; medical monitoring of vapor exposed persons

Key Findings of OERP Research

Most nuclear worker cohorts relatively young (>85% still living)

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

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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