National Institute for Occupational Safety and Health NIOSH

NIOSH Summary of Findings

Occupational Energy Research Program

Fernald Edition **January 2001**

Glossary of Terms

Remediation Workers: Workers who are involved in any of the following activities at DOE sites: decontamination, decommissioning, dismantlement, deactivation, waste management, and environmental restoration.

Decontamination: The removal of hazardous material (typically radioactive or chemical material) from facilities, soils, or equipment by washing, chemical action, mechanical cleaning, or other techniques.

Decommissioning: The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

Dismantlement: The disassembly or demolition and removal of any structure, system, or component after decommissioning and the satisfactory interim or long-term disposal of the residue from all, or portions of, the facility.

NIOSH Assessment of Information Needed for the Evaluation of the Health Effects Due to Occupational Exposures for DOE Site Remediation Workers.

Investigators: Sharon R. Silver, M.A., Cynthia F. Robinson, Ph.D., Greg Kinnes, M.S., Tim Taulbee, M.S., Steve Ahrenholz, Ph.D.

Sites Included in the Assessment: Fernald, Mound, Rocky Flats, Savannah River Site, Hanford, Oak Ridge, and Idaho National Engineering and Environmental Laboratory.

Purpose: This report summarizes the findings of two NIOSH projects which assessed whether records currently collected by DOE sites allow accurate identification of remediation workers and their exposure, work history, and medical information. This information is needed in order to evaluate any relationships between occupational exposures and health effects workers may experience.

Information Needed to Evaluate Health Effects: To conduct studies that can adequately evaluate the health effects of occupational exposures of current and future remediation workers, the following information is required:

1. Comprehensive worker rosters (lists) identifying all remediaton workers;
2. Adequate exposure, work history, and medical information for all remediation workers; and
3. Links which match individual workers with their exposure, work history and medical information.

How This NIOSH Assessment Was Done: The assessment included two recent National Institute for Occupational Safety and Health (NIOSH) projects, the Exposure Assessment Feasibility Study (EAFS) and the Integrated Health, Work History, and Exposure Database for DOE Site Remediation Workers. These two projects assessed the availability of information about remediation workers and their activities to address the following questions:

1. Can remediation workers be identified?
2. Are adequate exposure, work history, and medical data available for remediation workers?
3. Can individual workers be linked to their exposure and medical data?
4. With current knowledge and understanding, as described in this report, can epidemiologic, exposure assessment, or hazard surveillance studies of remediation workers and the technologies they employ be conducted now or in the foreseeable future?

CDC SAFER • HEALTHIER • PEOPLE

Glossary of Terms Cont.

Deactivation: The process of placing a formerly active processing facility in a safe and stable condition until it can be decommissioned or dismantled.

Further NIOSH Information:

- For a copy of the final summary report, executive summary, or individual site-specific reports, 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

Report Findings

1. Some remediation workers who have worked at DOE sites cannot be identified.
Complete rosters of current and former remediation workers do not exist. Reconstruction of rosters from multiple data sources at the sites is labor intensive and may exclude some groups of workers.

2. Accurate and complete exposure, work history, and medical records data are not available for this population.
Although radiation exposure records appear to be complete, decentralized responsibility for chemical exposure assessment and other records has led to gaps in exposure, work history, and medical data.

3. Individual workers cannot consistently be linked to their exposure and medical data.
The storage of data and records in hard copy format, on incompatible software platforms, and on media produced by now obsolete hardware has diminished the ability to identify workers and link them with their work history, exposure, and medical data. The failure to standardize data collection and archiving both within and among DOE sites will hinder linkage of individuals to their data.

4. At the present time the necessary information to conduct epidemiologic, exposure assessment, or hazard surveillance studies of remediation workers is not available.
The absence of worker rosters, the difficulty of creating such rosters with currently available data, gaps in work history, exposure, and medical data, and data linkage problems limit the ability to conduct accurate and comprehensive studies of remediation workers.

This report contains recommendations that address each of these findings.

Important Announcements

For more information including developments regarding the scheduling of site visits, please contact DOE site representative, Gary Stegner at (513) 648-3153. Copies of the complete report, **Evaluation of Data for DOE Site Remediation Workers** and individual site-specific reports can be found in the DOE Reading Room at the Public Environmental Information Center, 10995 Hamilton-Cleves Highway, Harrison, OH, 45030, (513) 648-7480. Questions concerning this study should be directed to the investigators at (513) 841-4400.

NIOSH/HERB Contact Point 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

Evaluation of Data for DOE Site Remediation Workers

Sharon R. Silver, M.A., Cynthia F. Robinson, Ph.D., Greg Kinnes, M.S., Tim Taulbee, M.S., Steve Ahrenholz, Ph.D.

December 2000

Table of Contents

Acronyms

ACERER	Advisory Committee on Energy-Related Epidemiologic Research
ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
B&W	Babcox and Wilcox
BNFL	British Nuclear Fuels Limited
CAIRS	Computerized Accident and Incident Recordkeeping and Reporting System
CDC	Centers for Disease Control and Prevention
DHHS	Department of Health and Human Services
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
EAFS	Exposure Assessment Feasibility Study
EJTA	Employee Job Task Analysis
ERC	Environmental Restoration Contractor
ESH	Environmental Safety and Health
EWP	Enhanced Work Planning
FDF	Fluor-Daniel Fernald
FEMP	Fernald Environmental Management Project
FMPC	Feed Materials Production Center (Fernald)
HEHF	Hanford Environmental Health Foundation
HERB	Health-Related Energy Research Branch
HIS-20	Health Physics Information System (Fernald)
HOHP	Health of Hanford Plan
HR	Human Resources
HW	Hazardous Waste
IH	Industrial Hygiene
IMAC	Integrated Management Contract
INEEL	Idaho National Engineering and Environmental Laboratory
ISM	Integrated Safety Management
JHA	Job Hazard Analysis
LAN	Local Area Network
M&O	Management and Operating
MOU	Memorandum of Understanding
NIOSH	National Institute for Occupational Safety and Health
OESH	Office of Environment, Safety, and Health (DOE)
OMSC	Occupational Medicine Services Contractor
PHMC	Project Hanford Management Contract
PNNL	Pacific Northwest National Laboratories
REMS	Radiological Exposure Monitoring System
SRS	Savannah River Site
TLD	Thermoluminescent Dosimeter
WM	Waste Management (Federal Services of Hanford)

DOE Remediation Work Definitions

Decontamination: The removal of hazardous material (typically radioactive or chemical material) from facilities, soils, or equipment by washing, chemical action, mechanical cleaning, or other techniques (Office of Environment Safety and Health, 1997).

Decommissioning: The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use (Office of Environment Safety and Health, 1997).

Deactivation: The process of placing a formerly active processing facility in a safe and stable condition until it can be decommissioned or dismantled. Facilities may not require full decontamination if surveillance and control of contamination are maintained (Office of Environmental Management, 1996).

Dismantlement: The disassembly or demolition and removal of any structure, system, or component during decommissioning and the satisfactory interim or long-term disposal of the residue from all, or portions of, the facility (Office of Environmental Management, 1996).

Environmental Restoration: Cleanup and restoration of sites contaminated with hazardous substances during past production or disposal activities (Office of Environment Safety and Health 1997). Environmental restoration encompasses a wide range of cleanup activities such as stabilizing contaminated soil; pumping and testing ground water; decommissioning process buildings, nuclear reactors, chemical separations plants, and many other facilities; and exhuming sludge and buried drums of waste (Office of Environmental Management, 1996).

Hazardous Waste: Waste regulated by the Resource Conservation and Recovery Act (RCRA), Subtitle C. A solid waste or combination of solid wastes that, because of its quantity, concentration, physical, chemical, or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed (Office of Environmental Management, 1996).

Historical Changes in Remediation Terminology
DOE's remediation terminology has changed several times. For example, in 1988, the Office of Environment Safety and Health used the term "decommissioning" to incorporate activities such as facility stabilization and demolition ("deactivation and dismantlement"). By 1996, the Office of Environmental Management use of "decommissioning" encompassed surveillance and maintenance, decontamination and dismantlement, while facility stabilization was defined separately as "deactivation." A year later, DOE's orders excluded decontamination and dismantlement from "decommissioning" (Office of Environmental Safety and Health, 1997). These changes complicate identification of hands-on remediation workers and their activities.

Abstract

Many U.S. Department of Energy (DOE) nuclear weapons facilities have recently shifted from active processing to site remediation. Workers involved in site remediation processes encounter diverse exposure scenarios not faced by site production workers. Both future epidemiologic studies of remediation workers and risk reduction efforts depend on the ability to identify these workers and assess their work history, exposure, and medical data. However, a NIOSH feasibility assessment at seven DOE sites has found that the current environment of decentralized management and increased subcontracting at DOE sites has led to fragmented and inconsistent data collection and maintenance. In this environment, rosters of remediation workers are rarely maintained and are difficult to compile from other site data. In addition, the availability of exposure data varies across disciplines. Radiation monitoring practices are standardized throughout the complex, leading to reasonably comprehensive exposure data. In contrast, industrial hygiene monitoring and data collection requirements are not codified or standardized, so non-radiologic exposure data tend to be incomplete. Remediation workers employed by subcontractors are excluded from some data and records systems. Site information systems are segregated by department, and sometimes by contractor, complicating linkage of workers to their data, and some useful historical data may no longer be accessible. Collectively, these administrative factors have led to gaps in data critical to the assessment of remediation workers' exposure histories and health outcomes. Centralized collection of a standardized core of data on remediation workers throughout the DOE complex should begin as soon as possible.

EXECUTIVE SUMMARY

Since 1989, workers have been involved in remediation activities at 134 Department of Energy (DOE) sites (Office of Environmental Management, 1998). These remediation workers face diverse and sometimes unanticipated exposure hazards. Exposures to hazardous, radioactive, and mixed waste from past and present site activities raise potential health concerns for these workers.

Evaluation of current and future health effects of DOE site remediation workers' occupational exposures requires a core of information on these workers. Critical components include comprehensive worker rosters, individual-level exposure potential, work history, and medical data, and the ability to link workers to their data. Two recent National Institute for Occupational Safety and Health (NIOSH) projects, the Exposure Assessment Feasibility Study (EAFS) and the Integrated Health, Work History, and Exposure Database for DOE Site Remediation Workers, assessed the availability of information about remediation workers and their activities. The questions addressed by these projects, as well as summary observations, are given below:

Can remediation workers be identified?

- Historical rosters of remediation workers do not exist, necessitating piecemeal reconstruction from multiple department-level data sources at the sites.
- Reconstructing rosters will be complicated by the exclusion of subsets of remediation workers (subcontract, transient, construction workers) from some site personnel, training, medical, and exposure monitoring data collection and records systems.

Are adequate exposure, work history, and medical data available for this population?

- Decentralized responsibility for exposure assessment and recordkeeping has led to gaps in exposure, work history, and medical data.
- Rapid changes in workers' tasks and activities, as well as the potential for uncharacterized exposures from remediation activities and technologies, intensify the need for thorough monitoring.
- While radiologic exposure data are generally complete, the absence of standard requirements for contractor-based industrial hygiene monitoring and data collection has led to significant information gaps on workers' non-radiologic exposures.
- Adoption of generic job titles hinders the use of work history information to group workers into exposure categories. A decline in tracking of workers' activities exacerbates this problem.

Can individual workers be linked to their exposure, work history, and medical data?

- At some sites, inconsistencies in the use of personal identifiers, as well as re-use of some identifiers by multiple workers over time, diminish the ability to link individual workers to their exposure, work history, and medical data.
- The storage of data and records in hard-copy format, on incompatible software platforms, and on media produced by now obsolete hardware also complicates these linkages.
- The failure to standardize data collection and archiving both within and across DOE sites makes historical and concurrent linkages difficult.

With current knowledge and understanding, as described in this report, can epidemiologic, exposure assessment, or hazard surveillance studies of remediation workers and the technologies they employ be conducted now or in the foreseeable future?

- The absence of worker rosters, the difficulty of creating such rosters with currently available data, gaps in work history, exposure, and medical data, and data linkage problems limit the ability to conduct comprehensive studies of remediation workers.

Across the DOE weapons complex, identifying remediation workers, their exposure potentials, and their medical data is hindered by a number of organizational and administrative factors. Many of these factors involve failures to standardize and enforce data collection rules in the face of increasing decentralization of remediation work. In the absence of centralized, standardized data collection and maintenance procedures, critical data deficiencies will persist. An administrative solution would include the following: 1) development of a centralized, uniform, complex-wide information collection system for remediation workers; 2) establishment of DOE rules for industrial hygiene and occupational health monitoring and data collection; 3) development of adequate retention schedules for all remediation worker data; 4) development of standardized contract language specifying the conduct of items 1-3; 5) collection of historical data for remediation workers from subcontractors; and 6) development of directives, with budget support, for conversion of historical data to accessible formats. These changes would facilitate development of a comprehensive worker database which could be used to target prevention and intervention efforts and to increase understanding of the health effects associated with remediation workers' occupational exposures.

1. INTRODUCTION

Since 1977, the Department of Energy (DOE) has held responsibility for management of the U.S. nuclear weapons program. Many nuclear weapons complex facilities have recently shifted from production to remediation processes comprising deactivation, decontamination, decommissioning, dismantlement, environmental restoration, and waste management. Collectively, workers performing these tasks constitute the DOE's hands-on remediation workforce. The many other workers present at DOE sites during the remediation phase, though lacking hands-on involvement, can also be considered part of the remediation workforce. These workers conduct critical support activities in areas such as planning, engineering, administration, laboratory, storage, transportation, and disposal services.

While many production-era workers performed the same tasks repeatedly, remediation work is more varied (Zuck et al., 1997). Potential exposures at a single DOE site include combinations of low-level radioactive and mixed waste products, asbestos, silica, acids, heavy metals, and radon (Stevens and Back, 1996). The risks of remediation work may exceed those of production activities (Office of Oversight, 1995; Defense Nuclear Facilities Safety Board, 1994). Secrecy surrounding materials used during weapons production, the use of treatment technologies which may involve or produce additional exposure hazards, and the reliance on subcontractors who may not be familiar with site production processes increase the likelihood that remediation workers will encounter unanticipated hazards during clean-up efforts. These exposure complexities can hinder efforts to predict and minimize potential threats to worker health.

The Department of Health and Human Services (DHHS) Advisory Committee on Energy-Related Epidemiologic Research (ACERER) has emphasized the importance of exposure and health protection issues related to remediation workers (ACERER, 1997; ACERER, 1994). In 1995, ACERER passed a resolution strongly supporting establishment of a national registry for cleanup (remediation) workers involved at DOE nuclear weapons production and testing sites (ACERER, 1995). In response, the National Institute for Occupational Safety and Health (NIOSH) has explored the availability of information necessary to evaluate the exposure potentials and health outcomes of remediation workers across the DOE complex.

To evaluate the health effects of remediation workers' occupational exposures, the following are required: 1) comprehensive worker rosters; 2) adequate exposure, work history, and medical data; and 3) linkages between individual workers and their data. An information system constructed from these elements would provide a sound basis for future epidemiologic studies, reduce exposure misclassification in these studies, and facilitate ongoing risk reduction, medical surveillance, and intervention efforts. This report summarizes NIOSH's assessment of the adequacy of current DOE remediation worker data and records for epidemiologic studies and risk reduction efforts. Four questions have been addressed:

- Can comprehensive rosters of DOE site remediation workers be generated?
- Are adequate work history, exposure, and medical data available for remediation workers?
- Can individual workers be linked to their work history, exposure, and medical data?
- With current knowledge and understanding, can epidemiologic, exposure assessment, or hazard surveillance studies of remediation workers and the technologies they employ be

conducted now or in the foreseeable future?

2. DATA SOURCES AND METHODS

Two NIOSH projects have explored the information available for DOE remediation workers: 1) the Remediation Workers Exposure Assessment Feasibility Study, Phase I (formerly entitled Exposure Assessment of Hazardous Waste, Decontamination and Decommissioning, and Cleanup Workers, Phase I); and 2) the Integrated Health, Work History, and Exposure Database for DOE Site Remediation Workers (formerly the Registry for Health and Work Histories Information project). This report summarizes the findings of these two projects, as well as several government reports on information collection efforts and health and safety issues at DOE sites.

2.1 Primary Data Sources

2.1.1 Remediation Workers Exposure Assessment Feasibility Study: Phase I

The Remediation Workers Exposure Assessment Feasibility Study (EAFS) evaluated the feasibility of identifying remediation activities, the associated workforce, and potential exposures at seven DOE sites: Fernald (Stevens and Back, 1996), Mound (Stevens and Back, 1997), Rocky Flats (Back and Stevens, 1998), Hanford (Zimmerman, 1999), Savannah River Site (Tankersley et al., 1998), Oak Ridge (Tankersley et al., 1999), and the Idaho National Engineering and Environmental Laboratory (Zimmerman and Moore, 2000). Collectively, the sites selected for this project encompassed most phases of nuclear weapons production, including uranium refining and enrichment, fuel and target fabrication, plutonium production, chemical separation, and nuclear component fabrication.

The goals of this project were to 1) locate records systems which identify the hands-on remediation workforce, 2) examine remediation activities and technologies, and 3) identify electronic records systems which could be used to obtain demographic, industrial hygiene, health physics, and medical data on remediation workers. The project focused on group-level data for remediation workers, with no collection of personally-identifiable data.

Information for this project was collected from publicly available documents, previously assembled DOE or contractor reports, and individual contacts at each of the sites. NIOSH technical monitors and contractors met with representatives of the Personnel, Labor Relations, Contracting, Medical, Industrial Hygiene, and Radiation Protection departments, as well as remediation workers conducting or responsible for waste management, environmental restoration, safe shutdown, deactivation, decontamination, decommissioning, and dismantlement. Publicly available documents were obtained from DOE Public Reading Rooms and the Internet.

2.1.2 Integrated Health, Work History, and Exposure Database for DOE Site Remediation Workers

To explore the feasibility of creating a remediation worker information system from current DOE site records and data systems, NIOSH surveyed data and records for remediation workers at one site, the Fernald Environmental Management Project (FEMP). FEMP's relatively small number of workers and streamlined organizational structure (one prime contractor and limited subcontracting) were considered conducive to identifying remediation workers and their data. NIOSH researchers interviewed Fluor-Daniel Fernald (FDF) staff from the Medical, Industrial

Hygiene, Radiological Control, Personnel, Records, Training, and Industrial Relations departments, as well as workers from two labor organizations at the site, the Greater Cincinnati Building and Construction Trades Coalition and the Fernald Atomic Trade and Labor Council. Initial evaluation of data systems focused on the following elements: personal identifiers used by different departments; the extent of hard copy versus electronic data; the compatibility of computer platforms, database languages, and data elements; and existing interdepartmental linkages.

Changes in site organization and work practices are common during the remediation era. Observations from each EAFS report reflect information gathered at the time of the report, and observations from the Integrated Health, Work History, and Exposure Database project reflect information collected in 1998. Subsequent changes in administration, worker activities, and record collection and retention practices which may have occurred at the seven sites are not reflected in this document.

2.2 Secondary Data Sources

A number of federal agency reports also provided useful information. DOE's Office of Oversight has issued a series of reports assessing safety and health programs at specific sites, as well as across the complex (2000, 1999a, 1999b, 1998a, 1998b, 1998c, 1995). The Office of Technology Assessment of the U.S. Department of Commerce discussed remediation issues across the complex in their report, "Hazards ahead: managing cleanup, worker health and safety at the nuclear weapons complex" (Office of Technology Assessment, 1993). The National Academy of

Public Administration's report "Ensuring worker safety and health across the DOE complex" examined complex-wide administrative factors affecting worker safety and health (Zuck et al., 1997). The Defense Nuclear Facilities Safety Board (DNFSB) evaluates safety issues across the complex, and the General Accounting Office (GAO) has reported on efforts to establish a comprehensive health surveillance system within the DOE (1993). Reports from these sources were reviewed for information pertinent to the four questions discussed above.

3. ISSUES AND FINDINGS

3.1 Administrative and Organizational Issues

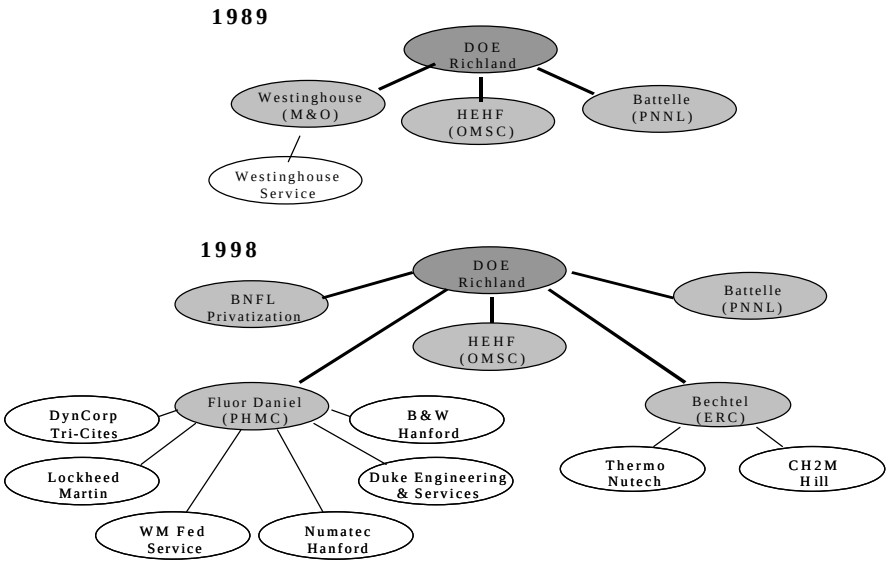
A common observation of the NIOSH projects, as well as other government reports, is that administrative and organizational factors hinder efforts to identify remediation workers and lead to deficiencies in their work history, exposure, and medical data. These factors include frequent changes in organizational structure, accelerated cleanup timelines, reductions in resources, and increases in multi-tiered subcontracting (Tankersley et al., 1998; Office of Oversight, 1998c).

Prime and subcontractor turnover is a major issue. Since the beginning of concerted remediation efforts within the DOE complex in 1988, prime contractors have changed at least once at each of the seven sites studied in the NIOSH EAFS, and more than once at several sites. Contractor turnover can create knowledge gaps; new subcontractors may not be familiar with historical site processes (Office of Oversight, 1998c). In addition, they may lack developed worker health and safety infrastructures (Zuck et al. 1997). Because contractors frequently assume responsibility only for records covering their tenure at the site, turnover can lead to dispersion of records and

data loss. Subcontractor budgets are frequently short term and do not support long-term record retention schedules. At Fernald, one of four remediation subcontractors contacted for the NIOSH EAFS had gone out of business entirely, and the location of this company's records is unknown (Stevens and Back, 1996). Discussions at other sites suggested that some subcontractors may have taken worker exposure and medical surveillance records with them when their contracts expired.

Increasing organizational complexity also adversely affects data collection and retention. During the production era, operations at DOE sites were generally managed by a single prime contractor in direct supervision of a few subcontractors. Remediation efforts, however, are generally managed through contractual agreements between the DOE, its prime contractors, and subcontractors. In the mid 1990s, both Hanford and the Rocky Flats Environmental Technology Site changed from a Management and Operating (M&O) contract system, in which the prime contractor directly employed the majority of the workforce, to an Integrated Management Contract (IMAC), in which the prime contractor oversees a large tiered system of contractors, who are the actual employers of the remediation workforce (Back and Stevens, 1998; Zimmerman, 1999). Figure 1 shows changes in the organizational structure at Hanford following the move to the IMAC system.

Figure 1- Changes in Hanford Organizational Structure: 1989 (M&O) – 1998 (IMAC)



Prime contractors and first-level major subcontractor are noted by name. For both time periods, there are also multiple second and third tier subcontractors

Such multi-tiered contracting has become common across the complex (see Appendix A). In this increasingly dispersed work environment, responsibilities for medical and exposure monitoring, data collection, and data maintenance are often complex, diffuse, and non-uniform (Office of Technology Assessment, 1993; Office of Oversight, 1998c).

The enforcement relationships among DOE, its contractors, and subcontractors also affect the collection and maintenance of critical worker data. DOE promulgates worker safety and health standards through two mechanisms, orders and rules. Under the Price-Anderson Act Amendments of 1998, DOE can fine and take legal action against contractors for rules violations. In constrast, contractors violating orders can only be penalized through payment reductions (Zuck et al., 1997). The result is that worker monitoring and records are generally comprehensive and standardized where covered by rules, and less so where only orders exist.

3.2 Feasibility of Creating Comprehensive Remediation Worker Rosters

No comprehensive historical or current roster of remediation workers (all workers on site during remediation work, or all hands-on remediation workers) was found at any of the seven sites included in the Remediation Workers Exposure Assessment Feasibility Study. In the absence of historical remediation worker rosters, researchers must attempt to reconstruct such rosters retrospectively. Several factors complicate retrospective reconstruction of remediation worker rosters.

3.2.1 Human Resource Data for Remediation Worker Rosters

Human Resource (HR) or Personnel departments are a logical starting place for roster development. However, at the sites studied, HR department data do not adequately and comprehensively identify remediation workers. At sites such as Fernald, HR systems are limited to employees of the prime contractor and a few teaming partners, with no individual data available for other subcontractors. At INEEL, prior to 1994, the prime M&O contractor provided HR tracking services to some, but not all, site contractors. Assembling a roster of site remediation workers prior to this date would require obtaining records from all contractors not included in the system, and one of these had dissolved by 1999 (Zimmerman and Moore, 2000). The Savannah River Site EAFS encountered the following obstacles to remediation worker identification: a lack of requirements for subcontractors to submit detailed personnel records to the prime contractor; a lack of explicit records collection requirements in contracts; and contracting and invoicing methods which do not specify the number and/or identity of workers (Tankersley et al., 1998).

Job titles are potentially useful for identifying remediation workers. However, sites which retain an active processing component, such as Savannah River, may use the same job trade titles for both remediation and production workers, preventing differentiation of remediation workers from the general worker population. Examples at the Savannah River Site include electricians and pipefitters.

3.2.2 Departmental Data Sources for Remediation Worker Rosters

The finding that many remediation subcontractors are excluded from HR record systems at Fernald led the NIOSH Integrated Health, Work History, and Exposure Database project to investigate the feasibility of using other departmental data sources to identify remediation workers. At Fernald, the most comprehensive roster data source is the set of linked Security and Training databases. However, visitors may be indistinguishable from subcontractors in these databases due to overwriting of data and limited coding choices. For example, remediation-era subcontractors no longer employed at the site who return for medical exams may be classified as visitors, and information identifying them as workers overwritten. Health Physics, Industrial Hygiene, and Medical Department data may help to distinguish remediation workers from visitors. Individuals found to have multiple records not only in the security database, but also in the radiation exposure and medical databases, are more likely to be workers, rather than visitors.

However, at Fernald and other sites, the utility of departmental data sources for roster creation is limited by the exclusion of certain groups of subcontractors. For example, construction workers may not be covered by radiation monitoring programs because they work outside the

radiologically controlled portion of the site. A potential source for identifying these construction workers is the weekly payroll certification forms which are submitted to the prime contractor to comply with the Davis-Bacon Act regulating wage payments for Federal construction projects. However, these records fall under a two-year retention schedule, and thus will be of limited utility in constructing historical worker rosters.

In summary, both historical and current rosters identifying remediation workers appear to be absent, and retrospective reconstruction of worker rosters will be complicated by several factors. Job titles do not adequately differentiate remediation workers from those engaged in production activities. HR department data systems may not yield comprehensive rosters due to exclusion of subcontractors. While other departmental data sources may be helpful in identifying remediation workers, some subcontractors are absent from these sources as well. To comprehensively identify remediation workers on a site-wide basis over the years of interest for any specific study design, let alone across the complex, would be difficult given these constraints. Further, constructing a comprehensive, historical remediation worker roster would require identifying and locating all previous subcontractors, along with their records.

3.3 Availability of Exposure, Work history, and Medical Data for the Remediation Workforce

Data adequate to assess individual workers' occupational exposure potentials are key to epidemiologic studies and risk reduction efforts. Comprehensive individual exposure monitoring data are ideal. Where these are absent, work history information can be used to estimate

exposure potentials. Medical records can provide information about acute health events such as illnesses and accidents, as well as occupational exposures and lifestyle factors (e.g., smoking) which can impact health outcomes. Without adequate information in these areas, the ability to evaluate relationships between occupational exposures and health outcomes is compromised. Such information is particularly critical for remediation workers, who will likely face unique exposure issues.

Several factors complicate exposure assessment for DOE site remediation workers. Because of secrecy surrounding the production of nuclear weapons, including restrictions on material inventory information with "need to know" requirements, health and safety personnel may not have complete understanding of potential exposures and hence may not be able to adequately monitor remediation workers. For example, the presence of transuranics has only recently come to light at Paducah, and remediation workers there may have encountered these radionuclides during cleanup activities. At the Mound site, metal tritides present similar issues (Collas, 1999).

The use of new technologies for handling and treating existing wastes can also complicate exposure assessment for remediation workers. These technologies have the potential to reduce exposures (e.g. through remote operation) or to produce additional exposure hazards, some of which are not well characterized. For example, waste containment or reduction methods which utilize high temperatures, such as incineration, calcination, pyrolysis, ceramification, and vitrification, may emit toxic gases or particulates (Salvato, 1992). Other treatment methods, such as polyurethane grouting and neutralization, may utilize hazardous materials, including

isocyanates and caustic compounds. In some cases, the potential exposures from these cleanup technologies do not appear to have been fully evaluated or understood (Back and Stevens, 1998; Zimmerman, 1999). As a result, standard monitoring practices may not capture adequate exposure data for workers involved in these processes.

3.3.1 Exposure Data

At many sites, radiation monitoring data appear to be more readily available than chemical monitoring data. This discrepancy is due in part to differences in data collection rules for the two types of exposures.

3.3.1.1 Radiation Exposure Monitoring Data

Because it is governed by legally-enforceable standards, radiation monitoring is an exception to data decentralization and exclusion of subcontractors from record systems. Radiation monitoring has been not only prescribed in DOE Order 441, but also codified under Title 10 of the Code of Federal Regulations (CFR) Part 835, Occupational Radiation Protection (Office of the Federal Register, 2000b). Because of this rule, all sites participate in standardized radiologic exposure monitoring and data collection programs. Therefore, identification of radiation-monitored workers and subcontractors is relatively straightforward (Tankersley et al., 1998; Tankersley et al., 1999).

Although external radiation monitoring systems across the DOE are comprehensive, an assessment of the INEEL Radiation Protection Program by the DOE Office of Oversight (1999b)

found that INEEL does not have an effective system for ensuring that transient radiological workers are included in appropriate bioassay programs. The assessment identified a small group of construction workers who required bioassay monitoring according to site procedures but were not in a bioassay program (Office of Oversight, 1999b).

3.3.1.2 Industrial Hygiene Monitoring Data

Across the DOE complex, industrial hygiene monitoring data are generally less complete than radiation data. The National Academy of Public Administration (Zuck et al., 1997) reported that inadequate industrial hygiene monitoring and data collection rules have led to a lack of information about chemical exposures. This is largely an administrative issue. With the recent exception of beryllium under Title 10 (Office of the Federal Register, 2000a), monitoring and data collection for non-radiologic exposures have not been codified. DOE has issued orders for many of the monitoring requirements and Permissible Exposure Limits (PELs) detailed in OSHA regulations (e.g., asbestos and noise). However, because these requirements are specified in orders, rather than rules, they have limited enforceability at DOE sites, and there are few complex-wide standard requirements for industrial hygiene monitoring (Zuck et al., 1997).

Recently, DOE has developed an exposure assessment guide which could serve as the basis for standardizing monitoring across the complex. The Exposure Assessment Implementation Guide for Order 440.1 (Office of Environment Safety and Health, 1998) outlines exposure monitoring procedures. The Guide describes the need to link hazards, exposures, and medical monitoring across departments and to individual workers, and establishes the need for complete, task-based

documentation of monitoring. This document, which focuses on hazard recognition and anticipation, is compliance-oriented, recommending the use of baseline random monitoring to determine the probability that a particular activity will exceed an occupational exposure limit. The Guide acknowledges that rapidly changing remediation activities will necessitate more frequent sampling, and encourages the use of American Industrial Hygiene Association monitoring guidelines for exposures expected to frequently exceed certain exposure limits. However, the recommendations do not include routine monitoring of individual workers, a position which may lead to incomplete data for surveillance and epidemiologic purposes. While workers exposed at low levels may be at lesser risk, evaluation of the dose-response relationships would be hindered by the decision to limit monitoring where exposures are expected to be low. The Guide's recommendations could be expanded to meet these needs. Of greater concern is that because the Guide details recommendations supporting an order, rather than a rule, its impact on exposure monitoring across the complex is likely to be limited. In the absence of DOE rules governing non-radiological monitoring and data collection and reporting, industrial hygiene data for subcontractors will continue to have large gaps.

Deficits in industrial hygiene data collection and reporting are particularly acute where responsibilities for safety and health are not clearly distributed between DOE, contractors, and subcontractors (Office of Oversight, 1998a; Office of Oversight, 1998c). The Hanford site provides an example of how organizational changes combine with a lack of codified data collection rules to create gaps in industrial hygiene data for remediation workers. In the past, the Hanford Environmental Health Foundation (HEHF) held primary responsibility for IH monitoring,

assessment, and recordkeeping. Since the advent of the Project Hanford Management Contract (PHMC) in 1996, coordination of industrial hygiene programs at the Hanford site has been the shared responsibility of the Occupational Medical Services Contractor (OMSC) at HEHF and three prime contractors on site. While these prime contractors must comply with DOE-Richland oversight, they provide their own IH monitoring and recordkeeping and are not required to submit industrial hygiene exposure monitoring reports to DOE-Richland. In turn, subcontractors have their own industrial hygiene programs and data systems, and may not be required to report data to their prime contractor in all cases. With these decentralized and potentially incomplete data collection systems, comprehensive assessments of remediation worker exposures at the site will be difficult.

3.3.2. Work History Data

Where personal exposure data are limited, work history data can potentially be used to link individual workers to area monitoring data, materials inventories, or other data that allow assessment of exposure potentials.

3.3.2.1 Job Titles

Job titles must be specific to be useful for assessing workers' exposure potentials. The need for specificity is heightened in the remediation era because of the increased diversity of activities. However, a number of DOE sites have moved towards increasingly broad job titles. In the worst case, completely uninformative titles such as "Team Member" are used. Some sites have adopted broad titles which encompass activities previously performed by multiple trades. Rocky Flats now

uses job titles such as “Mission Support Specialist,” which combined the Filter Technologist, Facility Remediation and Waste Technologist, and Waste Certification Inspector classifications (Back and Stevens, 1998). At Mound, bargaining unit employees were reclassified under general job titles so site contractors could use the same personnel for numerous tasks. The new agreement reclassified these workers into three groups: Maintenance, Material Handlers, and Demolition Technicians (Hekman, 1998). Exposure potentials for these generic job titles are likely to be heterogenous and, perhaps, indistinguishable.

The movement towards generic job titles or job classifications is not consistent across sites. At the Hanford site, the Craft Alignment Program (Zimmerman 1999) allows members of trades to perform a slightly broader range of activities while retaining their traditional, specific job titles and functions. With this system, exposure potentials should remain easier to define for Hanford site workers.

3.3.2.2 Worker Activity Tracking

Records which track worker activities can also be used to assess exposure potentials. At Fernald, site personnel reported that individual worker task-hours and day-to-day locations are no longer recorded, and that connecting workers to tasks is now difficult. At many sites, personnel records do not indicate a worker’s department or work location, providing instead a manager’s office location for payroll distribution. At Savannah River Site, many subcontracts do not specify the number or identity of workers contributing to invoiced worker-hours. In addition, sources at several sites indicated that in order to reduce costs, service contracts are sometimes issued for

remediation work. This practice may reduce data for worker tracking, because service work does not require collection of payroll records (in contrast to collection mandates of the Davis-Bacon Act for Federal construction projects).

3.3.2.3 Medical and Other Departmental Exposure Data

Medical records contain valuable information on injuries and illnesses, as well as providing data on factors which may impact exposure-disease relationships, such as smoking habits, occupational exposures, and occupationally-required x-rays. At several sites, the medical databases do not include all remediation workers. At INEEL, the prime contractor's Occupational Medical Surveillance System (OMSS) covers lower-tiered subcontractors only in emergency situations (Zimmerman and Moore, 2000). At Rocky Flats, subcontractors are not always included in exposure monitoring and medical screening programs provided by the site (Back and Stevens, 1998). At Fernald, medical data for subcontractors are largely in hard-copy format and data may be missing for workers opting for off-site medical exams. As with industrial hygiene data, collection and maintenance of medical data do not appear to be standardized or comprehensive

Other departmental data can also provide information on exposure potentials. For example, records of examinations or training for personal protective equipment use have similar utility, although the number of workers examined and/or trained may exceed those with real potential for exposure. Hazardous and radiation work permits can be used to select workers who have participated in specific projects if these permits contain adequate personal identifiers. Medical

databases can be used to identify workers in special health monitoring programs due to potential exposure to specific agents, such as asbestos and lead.

3.4 Data Linkage Issues

Linkages between remediation workers and their current and historical departmental data are critical for assessing relationships between occupational exposures and health outcomes. Consistent use of unique personal identifiers across departments, site-wide adoption of compatible electronic data systems, and maintenance of data in electronic, rather than hard-copy format, can facilitate these linkages. A number of DOE sites have made progress toward interdepartmental data integration, but the programs are not yet comprehensive.

3.4.1 Unique Personal identifiers

Consistent, unique personal identifiers are required to link worker rosters to their departmental data. Across the sites, these linkages are compromised by changes in identifiers over time, inconsistencies in identifiers used across departments, and reuse of identifiers. The Social Security Number (SSN) is critical for vital status follow-up for workers. However, SSNs can be incorrect or missing, and are not used by all departments across sites. Radiation badge number and payroll numbers are commonly used in place of the SSN. At several sites, including Savannah River Site and Mound, reports indicate that radiation monitoring badge numbers have sometimes been assigned to more than one worker over time. To make the badge numbers unique, employment date information could be added to the badge number, but employment dates may be difficult to obtain where subcontractors are excluded from personnel systems.

3.4.2 Data Accessibility and Compatibility

As many DOE sites moved from active production to remediation work, a number of former site production workers transferred to remediation work. Critical historical work history, exposure, and medical data for these workers may exist only in archived hard copy format, or in obsolete or proprietary legacy databases which can no longer be easily accessed.

3.4.2.1 Electronic Data

Historic electronic data are increasingly difficult to retrieve. Departments at a number of sites are in the process of shutting down old computer systems. Data tapes produced on older hardware platforms which no longer function cannot be read. For example, data from the old Hewlett-Packard systems in the security and radiation protection departments at Fernald may be inaccessible. Unless such data are converted to currently supported platforms while the old hardware still functions, historical data will be lost. A positive note is that many departments are moving to relational databases (frequently Oracle) which can support future data integration efforts. However, conversion of the old data to accessible formats is crucial.

3.4.2.2 Hard-Copy Data

A significant portion of important exposure monitoring and medical data across the complex exists in hard-copy formats (paper, microfilm, and microfiche) only. Hard-copy data can be linked to worker rosters, but these linkages are time consuming. At Fernald, the majority of medical records for subcontract workers are hard copy. At most sites, industrial hygiene data from the 1970s and earlier are not computerized. Fernald's Industrial Hygiene department has

recently made significant progress in automating its data. However, across the complex, some hard copy data are on unstable media, and at Fernald , some data which link workers to tasks and exposures are stored in hard-copy format on paper which is fading or on microfiche which cannot be duplicated because the original "silver" films have been lost. Exposure data will be lost unless these records are captured electronically in the near future. While staff are usually aware of the need to automate data, conversion may become a low priority when fiscal and personnel resources are limited.

3.4.3 Current Data Integration Efforts at DOE Sites

Across the complex, DOE has undertaken information integration efforts designed to reduce worker risks. A number of DOE sites have intensified advanced planning for remediation activities, including enumerating projects, defining technological approaches, and anticipating exposures, numbers of workers involved, and worker protection measures required. Initiatives such as Enhanced Work Planning (EWP) and Integrated Safety Management (ISM) involve collaboration by workers, line management, and health and safety professionals from multiple departments to identify process improvements and create feedback loops to channel information gained from exposure assessment, medical monitoring, and work experiences into future work planning efforts.

However, full integration of information systems has not yet occurred. The Office of Oversight (1999a) found gaps between site occupational medical programs and Environmental Safety and Health (ES&H) departments. Integration of radiologic control information has been more

successful. Site access control, employee qualifications, and radiation exposure monitoring have been linked together at a number of sites (Office of Oversight, 1999b). However, these systems are generally separated from industrial hygiene data and have limited ties to medical data systems. The Hanford and Fernald sites exemplify the progress and some limitations within site data integration efforts.

3.4.3.1 Hanford

At Hanford, the decentralization of industrial hygiene services which took place in the mid 1990s has impeded integration of occupational medicine and exposure data (Takaro et al. 2000). Recently, the Hanford Occupational Health Process (HOHP) was initiated as a site-wide, risk-based hazard reduction approach to occupational health. Employee Job Task Analyses (EJTA) provide individualized hazard and exposure information for both routine and special work activities and links to the individual-level Hanford Industrial Hygiene Exposure database. The Job Hazard Analysis (JHA) is used to determine the personal exposure monitoring needed for specific aspects of a project. This information is entered into a Risk Management Medical Surveillance database to determine medical qualifications and medical monitoring requirements (Zimmerman, 1999). However, the industrial hygiene and radiation exposure data of the environmental restoration contractor, Bechtel Hanford Inc, are not included in the system. In addition, JHAs had not been fully integrated into HOHP as of 1998 (Zimmerman, 1999), nor had they been required of subcontractors.

3.4.3.2 Fernald

At Fernald, one of the first sites to implement Enhanced Work Planning, several interdepartmental linkages exist, but no database completely integrates work history, medical, radiation protection, and industrial hygiene information. The medical and industrial hygiene departments are not well linked, even though each has links to other departments. For example, a site-wide Local Area Network (LAN) links the EWP database to the IH Oracle air sample database. The medical data system links to the radiological database (HIS-20), and the access control system of HIS-20 links to training records and checks worker compliance with the bioassay sampling protocol. However, the Medical Director developed a job/task/safety/hazards analysis to target medical surveillance using exposure probabilities through interviews with workers and supervisors, but had limited access to actual industrial hygiene monitoring data. Thus, some potentially useful interdepartmental linkages have yet to be developed. Moreover, a DOE review found that while the prime contractor, FDF, had made improvements in work control through the enhanced work planning process, some subcontractors did not fully understand DOE work and safety requirements and were not adequately integrated in site work and safety planning measures. These deficiencies had led to several adverse events at the site (Office of Oversight, 1998b).

4. CONCLUSIONS: THE FEASIBILITY OF CONDUCTING EPIDEMIOLOGIC, EXPOSURE ASSESSMENT, OR SURVEILLANCE STUDIES GIVEN CURRENT KNOWLEDGE

The NIOSH investigations of remediation workers described in this report indicate that comprehensive epidemiologic, exposure assessment, or hazard surveillance studies of remediation workers and their technologies cannot be conducted at this time or in the foreseeable future

without the implementation of a comprehensive information collection system for 1) remediation worker rosters, and 2) work history, exposure, and medical data. First, identification of DOE remediation workers would be difficult, resource-intensive, and incomplete, given the current decentralized and non-standardized data collection and maintenance procedures. The degree of difficulty will vary by site. Some personnel record systems exclude subcontractors, while others cannot differentiate remediation workers from visitors or from production workers. Second, work history, exposure monitoring, and medical data records appear to have similar deficiencies and are not reliably available for remediation workers. A lack of codified monitoring and reporting requirements in the area of industrial hygiene is particularly problematic. Third, while DOE has implemented a number of safety and work planning initiatives which involve sharing of information among departments, none of the sites evaluated appears to have linked information systems for all essential departments: personnel, security, training, radiation protection, industrial hygiene, and medical. Additional linkages may be hindered by inconsistent personal identifier use and failure to maintain records in easily accessible formats. No complex-wide set of core worker data elements or information system standards has been established to address these issues.

5. RECOMMENDATIONS

To be able to evaluate the health effects of remediation workers' occupational exposures, a comprehensive worker information system will be needed. Such a system could readily identify all remediation workers and their work activities, exposure potentials, and medical information in support of risk reduction efforts and future epidemiologic studies. This system would facilitate targeting of prevention and intervention efforts to work activities which increase risk of acute or

chronic disease, and could lead to increased knowledge about exposure-disease relationships.

To be comprehensive, the system will require input of essential data by all remediation contractors and subcontractors. At each site, selection of a central custodian, either DOE or a single contractor, would optimize maintenance and updating of the system. To ensure the availability of the contents as contracts at the site undergo change, the database and all related data files could be designated the property of DOE.

A comprehensive information system would include each worker who has participated in site remediation efforts, whether an employee of DOE, prime contractor, or subcontractor. Successful implementation of the information system would require integration of data from various departments at each site including Personnel, Security, Occupational Medicine, Industrial Hygiene, Radiation Safety, Record Archives, and Contracting, as well as unions. Other management offices, such as Industrial Relations, may also need to contribute information to the system.

Existing initiatives, such as DOE's Exposure Assessment Guide for Order 440.1, could serve as starting points for formulating rule-based, enforceable, complex-wide monitoring and data collection standards. Specification of required data elements, their formats, and collection frequencies and methods in an enforceable standard for the entire DOE complex would ensure the availability of comprehensive data for all remediation workers. Appendix B describes modifications which could augment current data collection and storage procedures.

Potential benefits to DOE of implementing a comprehensive remediation worker information system include an enhanced ability to limit worker risk, as well as better understanding of exposure-disease relationships. Recent attention to compensation issues highlights the value of being able to identify workers engaged in particular activities or with specific exposure potentials. DOE has experience in creating a complex-wide information system for radiation exposures (the Radiological Exposure Monitoring System, REMS), and the involvement of a core group of contractors in cleanup efforts at multiple sites (Appendix C) should also facilitate complex-wide information collection efforts. The feasibility of creating such a system for remediation workers will diminish with time, as subcontractor turnover continues and sites move towards closure.

References

Advisory Committee on Energy-Related Epidemiologic Research (ACERER) (1995), Minutes of the Seventh Meeting, Alexandria, Virginia, Centers for Disease Control and Prevention.

Advisory Committee on Energy-Related Epidemiologic Research (ACERER) (1994), Minutes of the Sixth Meeting, Alexandria, Virginia, Centers for Disease Control and Prevention.

Advisory Committee on Energy-Related Epidemiologic Research (ACERER) (1997), Minutes of the Tenth Meeting, Bar Harbor, Maine, Centers for Disease Control and Prevention.

Back, D. A. and Stevens, G. W., (1998), *Remediation Workers' Exposure Assessment Feasibility Study at the Department of Energy's Rocky Flats Site - Phase I: Report*, Contract 200-98-2006 for National Institute for Occupational Safety and Health, Cincinnati, Ohio.

Collas, A. S. (1999) Radiological Controls for Work Involving Stable Metal Tritides at Mound, *Health Physics*, vol. 76(Suppl) (6), pp. S135.

DNFSB, (1994), *Fourth Annual Report to Congress*, Defense Nuclear Facilities Safety Board, Washington D.C.

Hekman, P. (1998), Transitioning Mound laboratory into the Private Sector - Current Activities and Plans for the Future, Transitioning to an Aggressive Program for Clean-Up, Closure & Revitalization...at DOE-Fernald, Mound Lab, Cincinnati, Ohio, Exchange/Monitor Publications and Forums

Office of Environment Safety and Health, (1997), *Exposure Assessment Implementation Guide 440.1-1*, DOE Guide 430.1-1, U.S. Department of Energy, Washington D.C.

Office of Environment Safety and Health, (1995), *Enhanced Work Planning: A Team Approach to Worker Protection*, U.S. Department of Energy, Washington D.C.

Office of Environment Safety and Health, (1988), *Radioactive Waste Management*, DOE Order 5820.2A, U.S. Department of Energy, Washington D.C.

Office of Environmental Management, (1998), *Accelerating Clean-Up: Paths to Closure*, DOE/EM-0362, U.S. Department of Energy, Washington D.C.

Office of Environmental Management, (1996), *Environmental Management: 1996*, DOE/EM-0317, U.S. Department of Energy, Washington D.C.

Office of Oversight, (2000), *Phase II Independent Investigation of the Paducah Gaseous Diffusion Plant: Environment, Safety, and Health Practices 1952-1990*, U.S. Department of Energy, Washington D.C.

Office of Oversight, (1999a), *Interim Report on the Office of Oversight Review of the Effectiveness of DOE Occupational Medicine Programs*, EH2PUB/01-99/OM01, U.S. Department of Energy, Washington D.C.

Office of Oversight, (1999b), *Independent Oversight Assessment of Radiation Protection Programs Within the Department of Energy*, EH2PUB/03-99/01SR, U.S. Department of Energy, Washington D.C.

Office of Oversight, (1998a), *Oversight Analysis: Industrial Safety/Occupational Health*, U.S. Department of Energy, Washington D.C.

Office of Oversight, (1998b), *Follow-Up Review of the 1996 Integrated Safety Management Evaluation at the Fernald Environmental Management Project*, EH2PUB/10-98/04OIT, U.S. Department of Energy, Washington D.C.

Office of Oversight, (1998c), *Oversight Analysis: Subcontractor Safety*, U.S. Department of Energy, Washington D.C.

Office of Oversight, (1995), *Independent Oversight of Environment, Safety and Health Programs at the Rocky Flats Environmental Technology Site*, U.S. Department of Energy, Washington D.C.

Office of Technology Assessment, (1993), *Hazards Ahead; Managing Clean-Up, Worker Health and Safety at the Nuclear Weapons Complex*, U.S. Department of Commerce, Washington D.C.

Office of the Federal Register, (2000a), *Chronic Beryllium Disease Prevention Program*, 10 CFR Part 850, National Archives and Records Administration, Washington D.C.

Office of the Federal Register, (2000b), *Occupational Radiation Protection*, 10 CFR Part 835, National Archives and Records Administration, Washington D.C.

Stevens, G. W. and Back, D. A., (1997), *Remediation Workers' Exposure Assessment Feasibility Study at the Department of Energy's Mound Site - Phase I: Report*, Contract 200-98-2006 for National Institute for Occupational Safety and Health, Cincinnati OH.

Stevens, G. W. and Back, D. A., (1996), *Hazardous Waste, Decontamination and Decommissioning, and Clean-Up Workers Exposure Assessment Feasibility Study at the Department of Energy's Fernald Site - Phase I: Report*, Contract 200-98-2006 for National Institute for Occupational Safety and Health, Cincinnati OH.

Takaro TK, Ertell K, Salazar MK, Beaudet N, Stover B, Hagopian A, Omenn G, Banrhart S (2000). Barriers and solutions in the implementation of occupational health and safety services at a large USDOE nuclear weapons facility. Journal for Healthcare Quality 22(6) 29-37.

Tankersley, W. G., West, C. M. and Gray, F. E., (1999), *Hazardous Waste, Deactiviation, Dismantlement, and Cleanup Workers Exposure Assessment Feasibility Study at the Department of Energy Oak Ridge Reservation*, Contract 200-93-2695 for National Institute for Occupational Safety and Health, Cincinnati OH.

Tankersley, W. G., West, C. M. and Gray, F. E., (1998), *Hazardous Waste, Decontamination and Decommissioning and Clean-Up Workers Exposure Assessment Feasibility Study at the Department of Energy's Savannah River Site*, Contract 200-93-2695 for National Institute for Occupational Safety and Health, Cincinnati OH.

U.S. General Accounting Office, (1993), *Health and Safety: DOE's Implementation of a Comprehensive Health Surveillance Program Is Slow*, GAO/RCED-94-47, U.S. General Accounting Office, Washington D.C.

Zimmerman, T. D., (1999), *Remediation Workers Exposure Assessment Feasibility Study at the Department of Energy's Hanford Site - Phase I: Report*, Contract 200-98-2006 for National Institute for Occupational Safety and Health, Cincinnati OH.

Zimmerman, T. D. and Moore, A. M., (2000), *Remediation Workers Exposure Assessment Feasibility Study at the Department of Energy's INEEL Site - Phase I: Report*, Contract 200-98-2006 for National Institute for Occupational Safety and Health, Cincinnati OH.

Zuck, A. M., Burkhammer, S. C., Burkeimer, N. B., England, M. J., Korb, L. J., Minard, R. A., Melius, J., Sanders, E. G. and Sprinker, M., (1997), *Ensuring Worker Safety and Health Across the DOE Complex*, National Academy of Public Administration, Washington D.C.

Appendix A

U.S. Department of Energy Site and Facility Contractors				
Site	**DOE Prime Contractors/Teaming Partners**		**Lower-tiered Contractors**	**Other Contractors**
Hanford (as of 8/00)	Project Hanford Management Contract	**Fluor Hanford, Inc.**	DynCorp Tri-Cities Services, Inc. Numatec Hanford Corporation Lockheed Martin Services, Inc. Waste Management Federal Services of Hanford, Inc. DE&S Hanford, Inc. B&W Hanford Company Protection Technology Hanford COGEMA Engineering Corporation Fluor Federal Services Waste Management Technical Services, Inc. Westinghouse Safety Management Solutions Thermo Nutech CH2M Hill Hanford Group, Inc.	**Occupational Medical Services** Hanford Environmental Health Foundation **Energy Savings Performance** Johnston Controls, Inc. **Privatization Contractor** British Nuclear Fuels, LTD
	Environmental Restoration Contract	Bechtel Hanford, Inc.		
	Pacific Northwest National Laboratory	Battelle Memorial Institute		
INEEL (6/99)	Management & Operations Contract	**Lockheed Martin Idaho Technologies Company** B&W Idaho, Inc. Duke Engineering & Services Waste Management Federal Services of Idaho, Inc.	Coleman Research Corporation Parsons Infrastructure & Technology Group, Inc. Thermo Technology Ventures Numatec, Inc. Morrison Knudsen Corporation GTS Duratek Science Applications International Corporation Rocky Mountain Remediation Services, L.L.C.	**Construction Management** MK-Ferguson of Idaho **Privatization Contractor** British Nuclear Fuels, LTD
	Argonne National Laboratory-West	University of Chicago		
	Naval Reactor Facility	Westinghouse Electric Corp.		

U.S. Department of Energy Site and Facility Contractors				
Site	**DOE Prime Contractors/Teaming Partners**		**Lower-tiered Contractors**	**Other Contractors**
Rocky Flats (8/00)	Integrated Management Contract	**Kaiser-Hill Company, L.L.C.**	Rocky Mountain Remediation Services Safe Sites of Colorado DynCorp of Colorado, Inc. Rocky Flats Closure Site Services Wackenhut Services Denver West Remediation Corporation J.A. Jones	
		Manufacturing Science Corporation (Buildings 865 & 883)		
Fernald (8/00)	Fernald Environmental Restoration Management Corporation (FERMCO)	**Fluor Fernald, Inc.** Jacobs Engineering Nuclear Fuel Services	B&J Electric Babcock and Wilcox BL Payne Coleman Research Corporation Cousin Co./Debra Construction Diaz Construction Foster Wheeler GEO-Syntec IT Corporation Petro Company SEC Wise Services (Wise Construction) Wackenhut Services	**Telecommunications** Cincinnati Bell
Savannah River (8/00)	Savannah River Operations Office	**Westinghouse Savannah River Company** Bechtel Savannah River, Inc. BWXT Savannah River Company British Nuclear Fuels Limited	Numerous (including Sevenson Environmental Services, Inc., Geo-Con, Apex Environmental, Inc., Foster Wheeler Environmental Corporation, and Wackenhut Services)	
	Savannah River Ecology Laboratory	University of Georgia		

U.S. Department of Energy Site and Facility Contractors				
Site	**DOE Prime Contractors/Teaming Partners**		**Lower-tiered Contractors**	**Other Contractors**
Mound (10/97)	Miamisburg Environmental Management Project	**BWXT of Ohio** UNISYS	Los Alamos Technical Associates (LATA) Roy F. Weston, Inc. Morrison Knudsen Corporation	
Oak Ridge (8/00)	Oak Ridge National Laboratory (ORNL)	**Bechtel-Jacobs**	Numerous (includes Waste Management Federal Services, Morrison Knudsen, Tetra Tech)	
		UT-Batelle		
	East Tennessee Technology Park (ETTP, formerly K-25)	British Nuclear Fuels Limited	SAIC	
		Decon and Recovery Services		

Appendix B - Remediation Worker Data Collection Recommendations

Data collected using documented standard procedures can optimize risk reduction and epidemiologic efforts. Modifications to current data collection and storage procedures in several areas would facilitate development of a data system to support these goals.

To adequately identify remediation workers, the following procedures would be required:

1. Development and maintenance of a centralized remediation worker roster which includes information such as each worker's full name, as well as any prior names, date of birth, social security number, sex, race, and if applicable, date and causes of death; and,
2. Submission of Davis-Bacon compliance records, as well as copies of subcontractor payrolls with personal identifiers and information adequate to track worker tasks, location, and hours worked, to site personnel departments in electronic format on a regular (quarterly or semi-annual) basis.

To ensure the availability of adequate work history, exposure, and medical data for each remediation worker, the following procedures would be required:

1. Collection of historical work history data including employer, site, building, department, and location, dates in each job, and functional job titles, as well as any administrative job titles and task or activity descriptions;
2. Collection of historical data from all subcontractors engaged in remediation work at a site in the past 10 years, including individually-identified demographic, exposure, and health data on each remediation worker employed by the subcontractor;
3. Issuance of rules for routine exposure monitoring, as well as medical evaluation, including rules for data collection for all remediation workers; and,
4. Open communication between production personnel and health and safety personnel to help identify historical exposures to classified materials in order to facilitate adequate remediation worker exposure records and protection.

To facilitate linking workers to their work history, exposure, and medical data, the following would be required:

1. Allocation of additional resources for electronic entry of hard-copy data;
2. Elimination of badge number reuse and incorporation of the SSN in all databases; and,
3. Transfer of all data produced on obsolete hardware or in proprietary databases to current electronic or other archival medium on a regular basis.

Finally, designating all pertinent hard-copy records and electronic data as official systems of records for epidemiologic studies, with required retention schedules and maintained under Privacy Act Requirements, would guarantee adequate protection and maintenance of remediation worker data.

Appendix C - Contractors Involved at Multiple DOE Sites in the Remediation Phase

	Prime or Prime Team Member
	Subcontractor
	Other (Guards, direct contract to DOE)

	Total Sites	INEEL	Hanford	Rocky	Oak Ridge	Savannah	Mound	Fernald
Babcock & Wilcox	5							
Battelle	2							
Bechtel	3							
British Nuclear Fuels	5							
DynCorp	2							
Duke Engineering	2							
Fluor Daniel	2							
Jacobs Engineering	2							
Kaiser-Hill/ CH2M-Hill	3							
Lockheed-Martin	2							
Morrison-Knudsen	3							
Numatech	2							
Rocky Mountain Remediation	2							
Wackenhut	3							
Westinghouse	4							

* At Rocky Flats, Safe Sites of Colorado = Westinghouse + Babcox and Wilcox, and Rocky Mountain Remediation Services = BNFL+Morrison-Knudsen