CEDR

COMPREHENSIVE EPIDEMIOLOGIC DATA RESOURCE

U.S. Department of Energy ▪ Office of Domestic and International Health Studies ▪ Washington, D.C. 20585

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Mission Success

EHSS

Office of Environment, Health, Safety and Security

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Introduction to the DOE CEDR Program

COMPREHENSIVE EPIDEMIOLOGIC DATA RESOURCE

The Department of Energy (DOE) and its predecessor agencies have a long history of epidemiologic research programs. The main focus of these programs has been the Health and Mortality Studies of the DOE work force. These epidemiologic studies began in 1964 with a feasibility study of workers at the Hanford facility. Subsequently, worker studies were undertaken at many DOE facilities to examine possible health effects of working in these facilities. Studies of other populations exposed to radiation have also been supported by DOE, including the classic studies of radium dial painters. From a scientific perspective, this research has been productive, technically sound, and has formed the basis for many radiological protection standards.

The results of these studies have been published mainly in scientific literature and other technical reports. In the spirit of openness and transparency, DOE has made these epidemiologic data available to the general public through the Comprehensive Epidemiologic Data Resource (CEDR). This resource is free of charge to authorized users, and browsing of subsets of the data can be done without a CEDR account. In DOE's support of STEM (science, technology, engineering, and mathematics) and to aid instructors in teaching epidemiology to new students, the data are a valuable tool in advancing both of these efforts, as well as providing a means to validate the studies performed years ago.

Mission of the CEDR Program

To enhance DOE's epidemiologic research program by facilitating independent access and use of data collected during studies of the health impacts associated with working at or living near DOE facilities or operations.

To share these data through CEDR in support of the spirit of openness in government and the Secretary of Energy's initiative to make environmental, safety, and health information available to all researchers or students.

To support DOE's STEM Program and to encourage students pursuing degrees and/or careers in Science, Technology, Engineering, and Mathematics.

In its early years, CEDR primarily included data file sets that were generated from DOE's Health and Mortality Studies that had been conducted by the three DOE epidemiology centers all to be discussed later (Oak Ridge, TN, Los Alamos, NM, and Hanford, Wa). As other groups have studied DOE facilities (e.g., the National Institute for Occupational Safety and Health [NIOSH]) or the existing data in CEDR were used for a study, the results have been posted in CEDR for accessibility and use. Additionally, CEDR contains data from DOE's Radium Dial Painters Studies and from the DOE Illness and Injury Surveillance Program (closed in 2011). CEDR is a unique and unparalleled repository of data important for improving our understanding of the health effects of radiation, chemicals, and other physical agents associated with the operations at DOE facilities.

CEDR Program Goals

- To provide data from the DOE epidemiologic studies program to all interested researchers and students.
- To provide opportunities for new scientific understandings.
- To identify and document other data potentially useful for health studies.
- To create a central repository of data related to epidemiologic and health concerns.

The volume of data in CEDR will continue to increase as other researchers performing health studies, regardless of their funding source, are invited to make their data available to the public and scientific communities through CEDR. CEDR's efforts to continually refine and improve the methods of disseminating CEDR data will provide a state-of-the-art vehicle for sharing this comprehensive resource throughout the world. Inquiries or suggestions about the CEDR Program or about sharing data are always welcome and should be directed to the CEDR Program (CEDR@orau.org).

Purpose of the Catalog

This catalog is intended for use by any individual interested in obtaining information about, or access to, CEDR data. It serves as a valuable starting point by providing an introduction to the CEDR Program and to the types of data available. This catalog provides information that will help authorized users identify and obtain data file sets of interest.

Section 3 provides an overview of the data file sets available in the CEDR computer information system, as of the date of this catalog. Section 4 discusses the specific types and formats of the available data and CEDR's methodology for gathering the data. Section 5 describes the process for becoming a CEDR data user and outlines the methods for obtaining CEDR data or accessing CEDR's computer information system. Section 6 contains descriptions of major DOE sites with data available in CEDR. Appendices A, B, and C consist of listings of working and analytic data file sets and of other CEDR holdings. The glossary consists of CEDR-specific terms and abbreviations used throughout this catalog.

For the most current information on CEDR holdings

Although this catalog will be updated periodically, the most current CEDR holdings can be found on the CEDR website (https://oriseapps.orau.gov/CEDR/).

Please see Section 5 for further information about the CEDR website.

Contacts for Additional Information

To obtain further information concerning the CEDR Program and access to the CEDR information system, please contact:

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URL: https://oriseapps.orau.gov/CEDR/

Overview of CEDR Data

The CEDR Program provides a repository of data that were generated for epidemiologic or environmental health studies funded by DOE. Most of these studies were published in peer-reviewed journals; however, there are also data that were used in presentations, technical reports, and student presentations.

Types of CEDR Holdings

- DOE Worker Health and Mortality Studies
- Classic Radiation-Effects Studies
- Off-Site Dose Reconstruction Data

The data contained in CEDR are collected from various sources and researchers. The data cover different time spans; the number, type, and format of data included in studies vary considerably; and the studies may represent different groups of people or cohorts. For example, some data files will be limited to specific locations, some to specific exposures, some to certain groups of people, and some to morbidity or mortality information.

A large portion of the data file sets offered in CEDR relate to specific individuals. This is because epidemiologic studies often require the collection of detailed information for each individual in the study. Therefore, the data files developed by the original researchers who performed DOE Worker Health and Mortality Studies usually contained personal identifiers as well as many other variables that, when used in combination, might uniquely identify an individual. However, CEDR does not provide any personal identifiers, as defined in NIST 800-122, to minimize any risk of compromising an individual's identity.

As a Federal government agency, DOE has responsibilities not only to promote openness by sharing its health data, but also to maintain rights of privacy of its current and former workers. To meet these needs, a data release policy was established for CEDR. Details of the release policy can be found in Section 5. A pseudo-identification number is assigned to study cohort members to protect their identities. Personal dates, including the starting and ending dates of employment, date of birth, and date of death, are truncated leaving either year only or year and month. In addition, users of these data are required to complete access request and confidentiality forms stating that the data will be used only for research purposes.

There are other data file sets and reports in CEDR that are not linked to particular individuals. Since there are no individual privacy concerns with these data, they are presented in their entirety, and no confidentiality statements are required to use the data. Currently, this type of CEDR holding includes general descriptions and documentation for the DOE Worker Health and Mortality Studies and data that support off-site dose reconstructions, such as that for the Nevada Test Site (NTS). The following subsections describe the types of data that currently comprise the CEDR holdings.

Data from the DOE Worker Health and Mortality Studies

DOE's Worker Health and Mortality Studies began in the early 1960s, when the feasibility of using existing employee and facility records for conducting long-term epidemiologic follow-up studies was explored at three DOE facilities. Based on the promising findings from the feasibility study, a 5-year pilot study was initiated in 1964. The primary DOE sites selected for this pilot study were the Hanford Site in the State of Washington and the Oak Ridge Site, which consists of three major facilities, in the State of Tennessee. Other facilities operating at several smaller sites were also included. To obtain the information needed for a retrospective cohort study, considerable effort was expended on locating, copying, and abstracting data from various plant records located on- and off-site. When it was determined that further processing and validation of these data were necessary to ensure their proper use in epidemiologic studies, the Hanford cohort became the primary focus of the Health and Mortality Studies.

Major Centers Providing Data

- Historically, three DOE epidemiologic research centers conducted Worker Health and Mortality Studies:
- Los Alamos National Laboratory
- Oak Ridge Associated Universities
- Pacific Northwest Laboratory and the Hanford Environmental Health Foundation

In the mid-1970s, the study was expanded, and the responsibility for collecting and updating data for subsequent long-term worker studies was assigned to three epidemiologic research groups located at Oak Ridge Associated Universities (ORAU), Los Alamos National Laboratory (LANL), and Hanford, where staff from Pacific Northwest Laboratory (PNL) and Hanford Environmental Health Foundation (HEHF) formed a team.

ORAU assumed responsibility for studies of worker populations at the Oak Ridge Site, including the K-25 Facility (also known as the Gaseous Diffusion Plant), the Y-12 Facility, and the X-10 Facility (also known as the Oak Ridge National Laboratory or ORNL). In addition, ORAU was assigned the studies of workers at DOE sites that

processed, enriched, and fabricated uranium. These sites included two gaseous diffusion plants in Paducah, Kentucky, and Portsmouth, Ohio; two uranium processing facilities at the Feed Materials Production Center in Fernald, Ohio; Mallinckrodt Chemical Works in St. Louis and Weldon Springs, Missouri; and the uranium fabrication operations at the Savannah River Site (SRS) in South Carolina.

ORAU prepared a master roster of all contractor employees at each of these facilities and retrieved many of the death certificates for the three epidemiologic research groups. Each research group then extracted and coded the cause-of-death information from the death certificates for use in their respective studies. Each worker was assigned a unique identifier, a number that allowed information pertaining to that worker to be linked together, regardless of the research center that collected the data or the file in which it appeared. In total, the ORAU roster file contains unique identifiers and basic demographic data for about 600,000 workers. This includes rosters of contractor employees at the 10 sites that were the focus of long-term cohort mortality studies and partial listings of workers at about 40 other DOE facilities. It should be noted, however, that the most complete data for workers who were included in studies conducted by each epidemiologic research center are usually found in the data files that the particular research center generated and submitted to CEDR.[1]

Sites Where Cohort Mortality Studies Have Been Performed

- LANL
  - LANL and Zia (at LANL)
  - Rocky Flats Plant
  - Mound Plant
  - Pantex Plant
- ORAU
  - Oak Ridge Site
  - Fernald Facility
  - Linde Plant
  - Mallinckrodt Facility
  - Savannah River Site
- PNL and HEHF
  - Hanford Site

The epidemiologic research group at LANL assumed responsibility for studies of all workers monitored for exposure to plutonium by contractors conducting operations at the following sites: LANL and Zia Company in New Mexico; the Rocky Flats Plant in Colorado; the Mound Laboratory in Ohio; and the Pantex Plant in Texas. The LANL study population also included ORNL and SRS workers involved with plutonium operations at the site. In addition, LANL did a long-term clinical follow-up study of

1 Recent publication providing history and overview of Worker Health and Mortality Studies: Elizabeth D. Ellis, et al. (2018): Historical perspective on the Department of Energy mortality studies: focus on the collection and storage of individual worker data, International Journal of Radiation Biology, DOI: 10.1080/09553002.2018.1547851

a small group of workers exposed to high levels of plutonium at LANL during the early days of the Manhattan Project. The epidemiologic research team in Richland, Washington, with staff at HEHF and PNL, had primary responsibility for studying the operations workers who were employed by the major contractors at the Hanford Site in Washington. This research team also performed several related studies. One of the larger studies was a combined mortality study that included workers at ORNL, Rocky Flats, and Hanford. The HEHF/PNL team, along with several researchers from the other centers, also participated in an international, combined mortality study that was performed by the International Agency for Research on Cancer and included workers from these three sites. Smaller studies conducted by the Hanford team included congenital malformations that occurred in offspring of individuals who lived in communities near the Hanford Site and lung cancers among monitored Hanford workers.

Approximate number of CEDR data file sets pertaining to DOE Worker Health and Mortality Studies:

- 79 Data File Sets
- 400+ Data Files

Most of the studies included in CEDR have mortality as the end-point. One of the cornerstones of an epidemiologic cohort mortality study is a low percentage of participants with unknown vital status and low percentage of deceased individuals with unknown cause of death. As a result, a systematic multi-stage process has incorporated a variety of sources to collect vital status and cause of death information. Although the process has varied over time as new sources of data became available, the Social Security Administration (SSA), state death indexes, and the National Death Index (NDI) have been the key sources since the inception of the DOE worker studies. For each of these sources, some combination of Social Security number, name, and date of birth is matched against the source data using deterministic and probabilistic algorithms. The causes of death are coded to the International Classification of Diseases (ICD). Consistently, ascertainment of vital status is at least 90% and identification of cause of death is at 96% or greater.

Personal radiation monitoring information at the sites was collected if available. The types of monitoring data varied by site and over time as did the methods, procedures, and instruments used to collect these data.

These kinds of data were regularly collected by the three epidemiologic research centers. Each center used slightly different procedures and methodologies to merge,

document, validate, and analyze the data. However, work performed by the three centers, as well as by a number of other researchers, during their existence resulted in the collection of valuable information on a large number of workers at DOE sites and in the publication of numerous scientific papers and articles.

For the purpose of this CEDR catalog, the electronic data files generated in the course of worker studies are placed either in working data file sets or analytic data file sets, which are briefly described below. Please refer to Section 5 for more detailed information on CEDR data definitions and collection procedures.

Working Data File Sets

The working data file sets collected primarily by the three epidemiologic research centers formed the basis for cohort studies. They are data files that have minimal error checking and correction or data manipulation applied. There may be data entry and other errors in these files that have never been discovered or resolved; therefore, users should take appropriate precautions when working with these data. A researcher selects or generates variables from these more dynamic data files as a basis to form analytic data files.

Individuals using these data file sets should note that the working data file sets may include variables not carried forward to the analytic data file or used in associated studies. Because working data files may be updated during the course of a study, only the most current version is made available in CEDR.

Detailed descriptions of working data file sets currently available are presented in Appendix A. For each working data file set, this information identifies the facility to which the data pertain, describes the data available, and lists the variables found in the file.

Analytic Data File Sets

Analytic data file sets contain more refined, static data files upon which published studies are based. Analytic data files may include variables generated from, but not identical to, one or more variables found in the working data files. Also, depending on the purpose of the analysis, the analytic data file may contain additional variables not found in the working files that were collected, validated, or created by the study investigators.

Detailed descriptions of currently available analytic data files are presented in Appendix B. This information includes the name of the site or facility to which the data file sets pertain, describes the files and data comprising the data file set, provides pertinent citations, and lists the variables found in each file of the data file set.

Cause of death is coded to the ICD. Over the time period covered by the data in CEDR, the ICD has been revised numerous times. Since ICD categories are not necessarily identical from one version to another, care must be taken in interpreting the meaning of the code. Initially, all three research centers coded all death data to International Classification of Diseases, Adapted for Use in the United States (ICDA), 8th Revision (ICDA8). When coded causes of death became available from the NDI, the ICD revision at the time of death was used. Additionally, ICD codes in the 800-900 range from the three research centers should be read with an "E" prefix, i.e., accident codes, rather than as ICD8 injury codes.

Classic Radiation-Effects Study

Radium Dial Painter Data

The opportunity to study a group exposed to a potentially toxic material is rare, and it is even more rare to collect sufficient data on the group to determine the potency and effects of the material. However, such an opportunity emerged in the 1920s when skeletal lesions became associated with workers called luminizers or dial painters, who painted luminous dials on timepieces with paint containing radioactive radium as the energy source for luminosity.

Approximate number of CEDR files pertaining to radium dial painter studies:

- 1 Data File Set: RADPDW01
- 25 Data Files

Under the Internal Emitter Program conducted at DOE's Argonne National Laboratory, researchers identified about 6,000 people with significant radium exposures, including about 500 individuals, mostly women, who were dial painters. Many were located and followed until death; in these cases, the cause of death and body content of radium were determined. The files available in CEDR contain much of the data, such as demographics, measurements of radium body content, calculated doses, radium exposure history, and clinical examination results that were generated during this research.

Dose Reconstruction Studies

In an effort to assess the health impacts of DOE operations on off-site communities, DOE has funded a number of lengthy studies commonly

Approximate number of CEDR files pertaining to NTS off-site dose reconstruction:

- 1 Data File Set: NTORPW03
- 4 Data Files

referred to as historical, off-site dose reconstructions. Dose reconstructions are usually complex, multidisciplinary studies that consist of several major steps, including cumulative estimates of the amount of materials the site released to the environment, determination of the fate of those materials in the environment, and an estimate of the exposure of individuals to those materials.

One of the first comprehensive dose reconstructions to be performed was for populations downwind from the Nevada Test Site where atomic weapons were detonated. The single data file set that represents this study in CEDR contains some of the basic data upon which the results of this dose reconstruction depend.

Other CEDR Data

Complex Chemical Feasibility Study

Some workers in the DOE nuclear weapons facilities are exposed to complex mixtures of chemicals and radioactive materials, such as plutonium. It is known that exposures to such mixtures of possible carcinogens may produce adverse health effects, but it is usually difficult to measure each individual's exposure to these agents. The purpose of this study was to examine the feasibility of using existing records and information to estimate a worker's exposure to such complex mixtures of chemicals, so that the estimates would be useful for epidemiologic studies. A methodology was developed that used data found in records about chemical purchases, work areas, and plant operations, and it was applied to a small pilot population of Rocky Flats workers. Data collected include information about worker locations, operations performed, and results of samples indicating workplace exposures to various chemicals.

Approximate number of CEDR files pertaining to the Complex Chemical Study:

- 1 Data File Set: RFCHMW01
- 5 Data Files

Salmon Site Descriptive Study

Between 1964 and 1970, two nuclear and two non-nuclear bombs were detonated in a large underground salt dome in Lamar County, Mississippi, for the purpose of measuring the seismographic activity that these explosions generated in salt domes. Upon completion of the testing program, the site was deactivated and decommissioned in June 1972. Because of concerns that effluents from the tests might have

Approximate number of CEDR files pertaining to the Salmon Site Study:

- 1 Data File Set: TDBSRA01
- 1 Data File

increased cancer deaths among nearby residents, a mortality study of residents of Lamar County was conducted. The purpose of the study was to determine if there was an association between living near the salt dome and death due to cancer.

Documentation of CEDR Data

To help clarify the organization of data in CEDR, several terms have been defined. However, due to the diverse nature of the data in CEDR, these definitions are fairly broad. Some of the most commonly used CEDR terms are defined below. Other definitions can be found in the glossary.

Data Definitions and Relationships

Worker Health and Mortality Studies

A data file set is a collection of logically related files and is the term used to refer to collections of any type of CEDR data files. For the Worker Health and Mortality Studies, CEDR files are grouped into working data file sets and analytic data file sets.

A working data file set contains files of data - called working files - that were collected and updated during decades of follow-up of worker cohorts and/or DOE facilities. An analytic data file set contains files of data - called analytic files

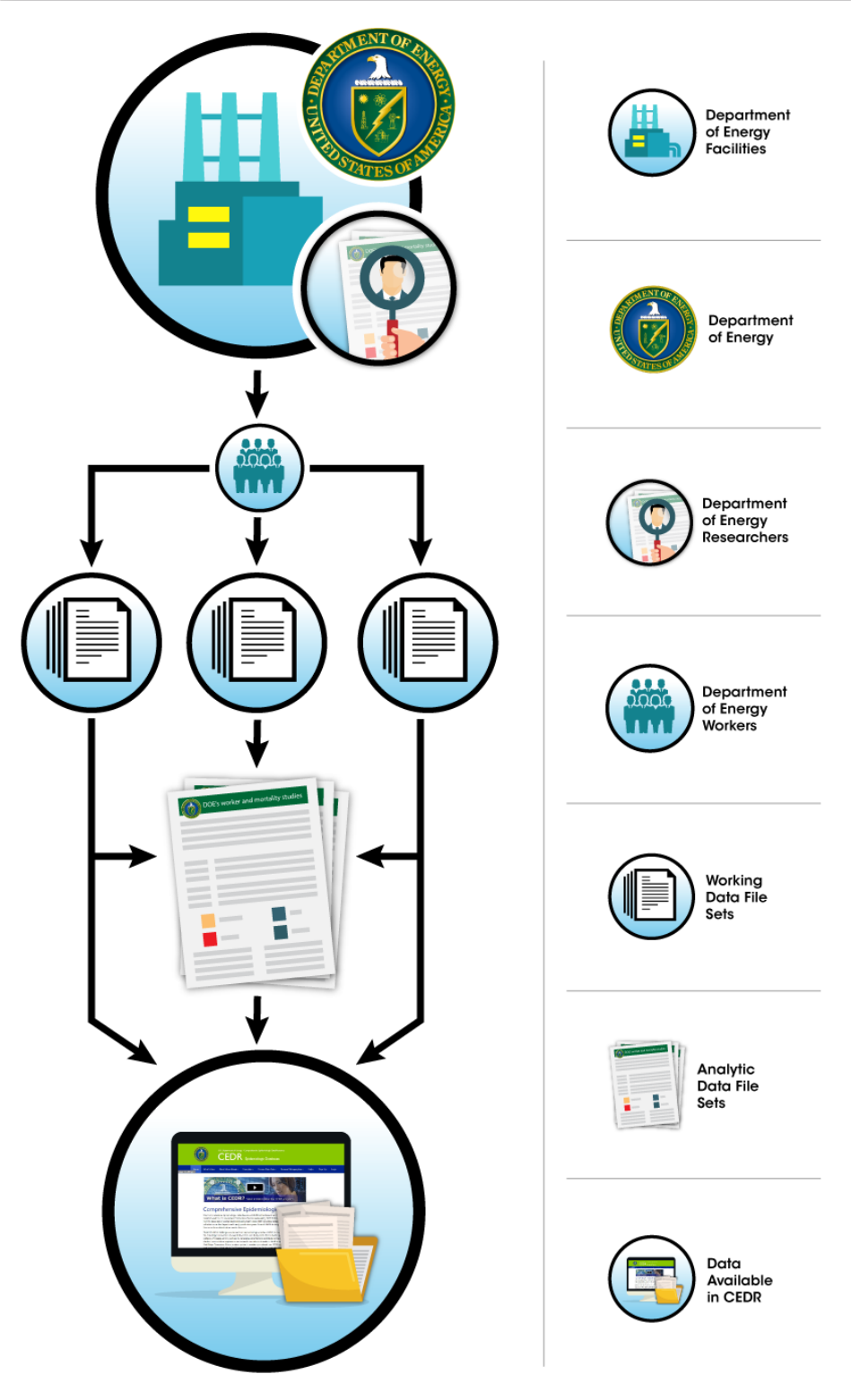


Figure 4-1. Relationship between Working and Analytic Data File Sets (for Worker Health and Mortality Studies)

- on which the analyses or results of a study are based. Researchers select data from a number of potentially diverse working files to form their initial analytic data file set. Figure 4-1 shows the relationship between working and analytic data file sets in CEDR.

Working files may contain an assortment of data, including demographic, work history, industrial hygiene, vital status, internal dosimetry, and external dosimetry data, gathered from a variety of sources. Working files are more dynamic and may be updated or corrected periodically. The level of verification and validation applied to working data will vary by site and by study. For some studies, working files have been periodically updated in CEDR; older versions of these working files have been archived.

Analytic files contain data upon which a researcher more directly bases a study's conclusions or reported findings. Typically, analytic files are composites of data (derived from working files) formulated to meet specific cohort descriptions and study needs that represent the best data available at that time. To create analytic files, researchers may subset data to form a cohort, merge data from multiple working files, validate and edit the working data, and convert the data as necessary to conduct analyses. Analytic files generally represent data that have been extensively reviewed, validated, and verified by a researcher. However, the files may also contain additional data that the researcher collected but did not use in the final analysis or publications. If the study analyzed only a subset of individuals or variables contained in an analytic file, not all variables or records in the file may have the same level of validation. Analytic files are static and are retained permanently in CEDR. If similar files with updated data are used for additional analyses, a new data file set is defined and stored in addition to the original analytic data file set.

Other Types of CEDR Holdings

Collections of electronic files pertaining to environmental dose reconstruction projects or other health effects data constitute other types of data file sets that are documented and permanently retained in CEDR. Some of these collections, such as the Radium Dial Painter Studies, contain data that are linked to particular individuals, and they are managed the same as the files relating to the Health and Mortality Studies.

Dose reconstruction data, such as the data file set pertaining to the Nevada Test Site, consist primarily of environmental or other measurement data that are not linked to particular individuals.

Structured Documentation

CEDR also includes a large volume of structured documentation that describes the files and data in CEDR. This documentation provides an overview of the study and data file sets. More detailed information is also included in the structured documentation for each file and each variable. Taken as a whole, the structured documentation provides essentially the same information normally found in a researcher's code book. This detailed documentation supplied by each data provider maximizes the usefulness of CEDR data to researchers unfamiliar with the study.

Information about CEDR's Structured Documentation

More information about the attributes of CEDR's structured documentation is contained in Guidelines for Data Documentation. Copies are available online through the CEDR website.

How CEDR Data Are Collected

As researchers near completion of their study, they compile their electronic files, including working files, analytic files, and structured documentation, into data file sets that are submitted to CEDR. Although the data files may differ considerably in content and format, the accompanying structured documentation is processed into a standard format. This standard format ensures that the structured documentation explains the data as consistently and completely as possible.

Quality assurance procedures have been implemented throughout CEDR processing to ensure the data, as presented in CEDR, are consistent with that submitted by the data provider. Various checks look for omissions and logic errors during data loading. In general, CEDR data are processed as shown in the data flow diagram provided in Figure 4-2. When CEDR data are received, the data files are examined and the structured documentation is reviewed for completeness. Data are not accepted until structured documentation requirements are satisfied. After acceptance, the data file sets and structured documentation are loaded into the CEDR system. The data and structured documentation are then reviewed by the researcher who provided the data for final verification and approval.

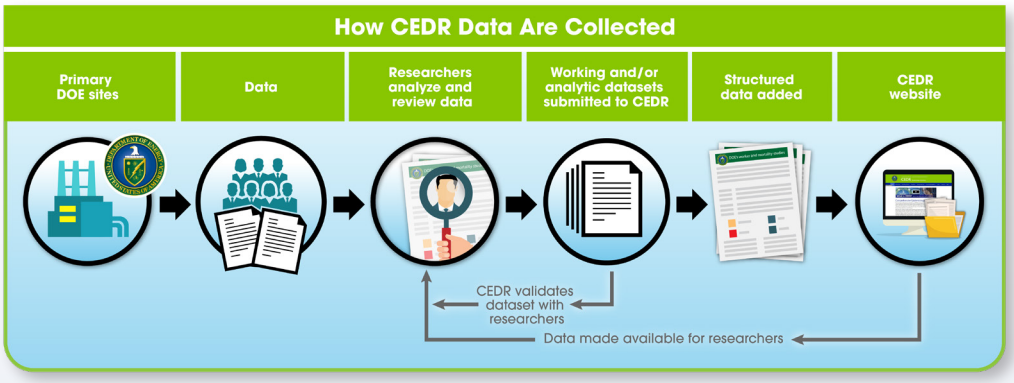


Figure 4-2. CEDR Data Flow Diagram

Considerations in Use of CEDR Data

Data Format

Because the information used by various researchers was originally generated from different DOE facilities or other sources for different purposes and needs, there is considerable variation in the format and content of data files. Terminology used to name or describe variables is also inconsistent. There has been no attempt to standardize individual variables (field names) found throughout the CEDR data. Each investigator named these variables as he/she wished. Users should pay close attention to documentation provided for each variable. Particular questions can be addressed to CEDR support staff.

Confidentiality Protection Summary

- CEDR's goal is to protect the privacy of individuals while maximizing the usefulness of the data.
- CEDR's release policy removes PII but uses a pseudo-identifier to identify a person within the study.

Confidentiality Protection

DOE recognizes the need to be compliant with protection of personal identifiable information (PII) and is compliant with the latest revision of the Privacy Act of 1974, in addition to being compliant with the Office of Management and Budget privacy protection requirements. Therefore, to ensure protection of the identities of individual w orkers, the following data release policy is in place:

- Individuals are identified only by a pseudo-identifier. Other identifying information, such as names and social security numbers, are not a part of CEDR.
- As a result of a software limitation used to calculate Standardized Mortality Ratio (SMR) at the inception of CEDR, specification of race is limited to white, black, and other.
- The dates of birth and death have been truncated to the year only.
- Other personal dates, such as date of employment, are truncated to month and year.

Cause-of-Death Data

Most DOE epidemiologic studies examined the mortality rate of the study population and ascertained the cause of death of the deceased workers. The cause-of-death information was obtained from death certificates.

Access to CEDR Information

Becoming a CEDR User

In the effort to maintain openness and transparency, CEDR has a General access level for anyone who wishes to peruse the website, allowing access to only snippets of data. A more robust access level is granted to an Authorized user, who has completed a request for an authorized account. The Authorized user can access all the data in CEDR and has the ability to download files and/or documentation.

ACCESS LEVEL	INFORMATION AVAILABLE
General	
(No registration or authorization required.)	
	Structured Documentation
	Dose Reconstruction Data
	First 10 Records of Each Data Set
Authorized	
(Confidentiality forms and registration online required.)	
	Structured Documentation
	Dose Reconstruction Data
	User may download all records in data set

Table 5-1. Summary of Information Available for each of CEDR's Levels of Access

General Access Level - Allows access to files of CEDR structured documentation, information about the CEDR Program, and various reports. These kinds of information are freely available for online access and browsing, and no registration or authorization is required. General Access also allows access to CEDR holdings that are not directly linked to an individual, such as grouped or dose reconstruction data, which do not require confidentiality protection.

Authorized Access Level - Allows access to data at the individual level, such as data included in the health and mortality data file sets (working or analytic), which require confidentiality protection. Review and approval of account request forms by DOE usually take about 1 week to complete.

Methods of Accessing CEDR Data

CEDR Website

The CEDR website is used for access and browsing of data, documentation, and related information to the studies. Listed below are some key functions within CEDR:

- Browsing Structured Documentation
- Viewing Data Files
- Keyword Searching Structured Documentation
- Downloading Structured Documentation and Data Files
- Viewing the CEDR Catalog Online
- Downloading the CEDR Catalog to a Printer
- Providing Citation Information
- Submitting a request to become an Authorized CEDR User
- Sending Comments about the Current CEDR System via CEDR@orau.org (these comments assist DOE in the evaluation and refinement of the CEDR information system)

A Brief Guide to Browsing, Searching, and Downloading

Structured Documentation

Structured Documentation is reviewable (i.e., a complete ordered listing is presented) and keyword-searchable. Documentation describing CEDR Data File Sets is structured hierarchically by Data File Set level (overview), file level, variable level, and code set levels. For example, variable level structured documentation is accessible from file level documentation, which is, in turn, accessible from the Data File Set level.

To browse through these levels of CEDR Structured Documentation:

- Browse to the CEDR website (https://oriseapps.orau.gov/CEDR)
- Select Browse Data Sets and choose to search by Analytic, Working, or Search All. See Figure 5-2.
- If you select either Analytic or Working data file sets, choose a site to view all data sets from that site. See Figure 5-3.

- If you choose Search All data sets, enter the keyword or phrase to search. See Figure 5-4.
- Click on any of the returned data file sets to find out more about the study and files that are available for viewing. See Figure 5-5.
- You can read the description of the files in the selected data set. See Figure 5-6.

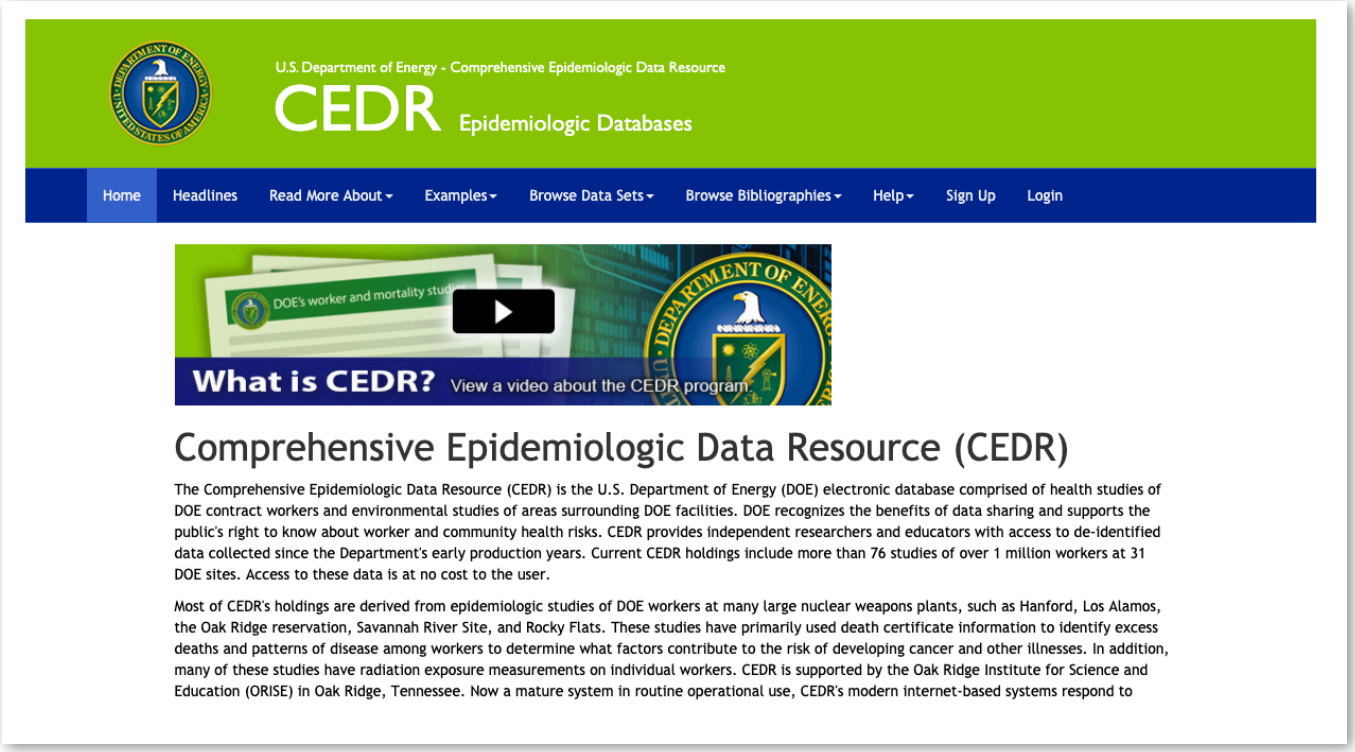


Figure 5-1. CEDR website

Figure 5-2. Browse Data Sets

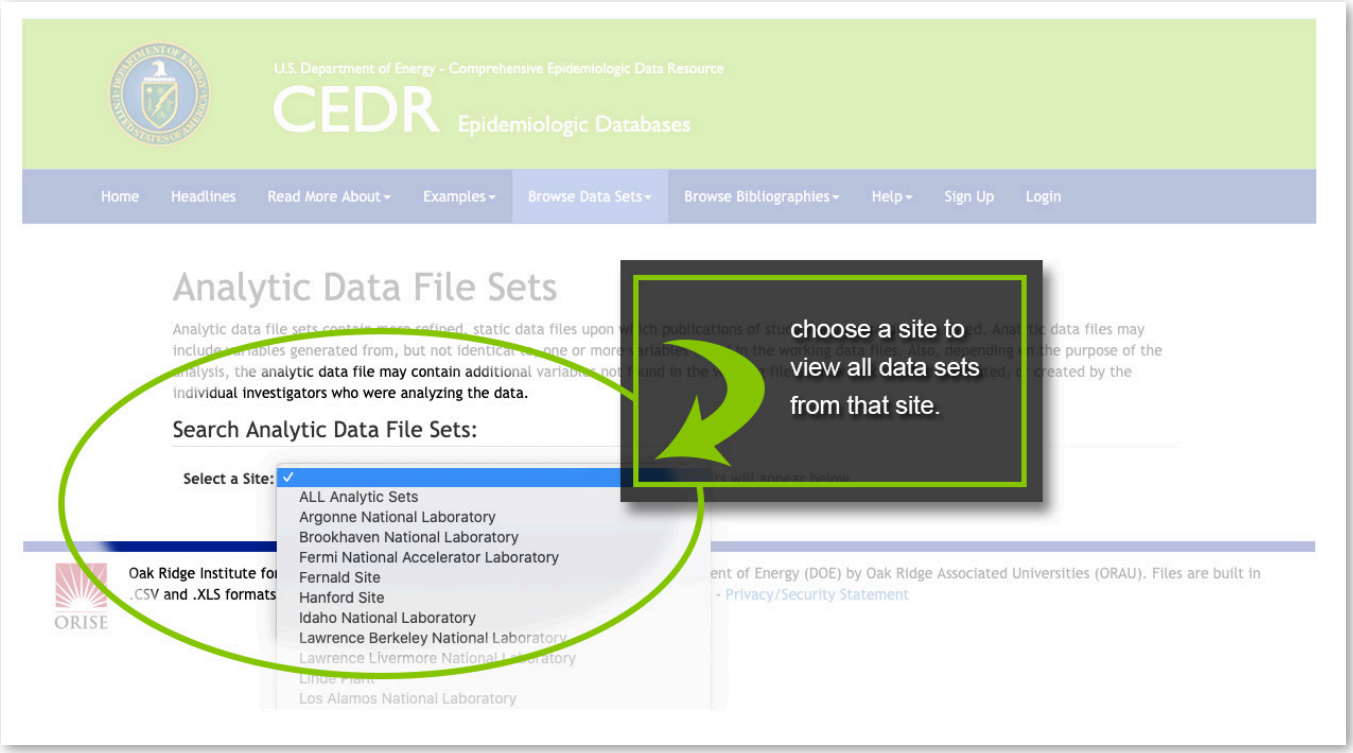


Figure 5-3. Search Analytic Data File Sets

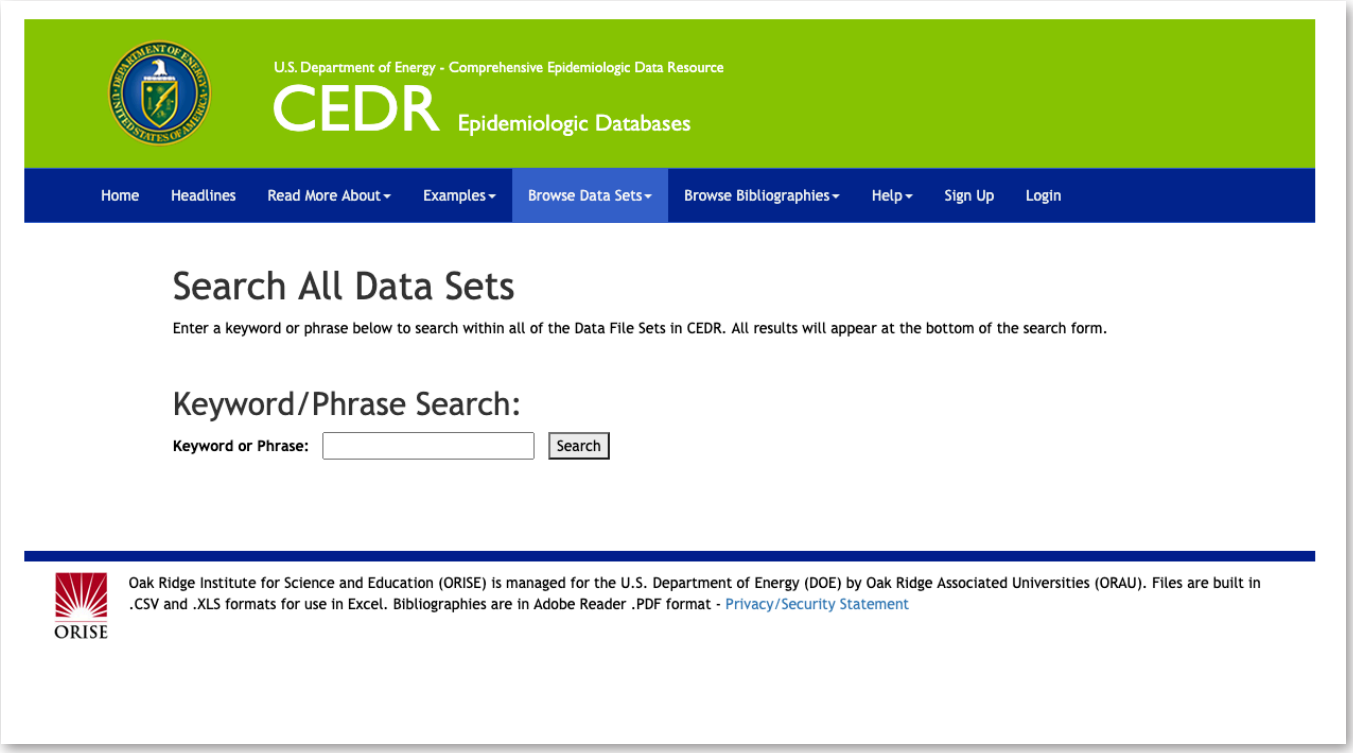


Figure 5-4. Search All Data Sets

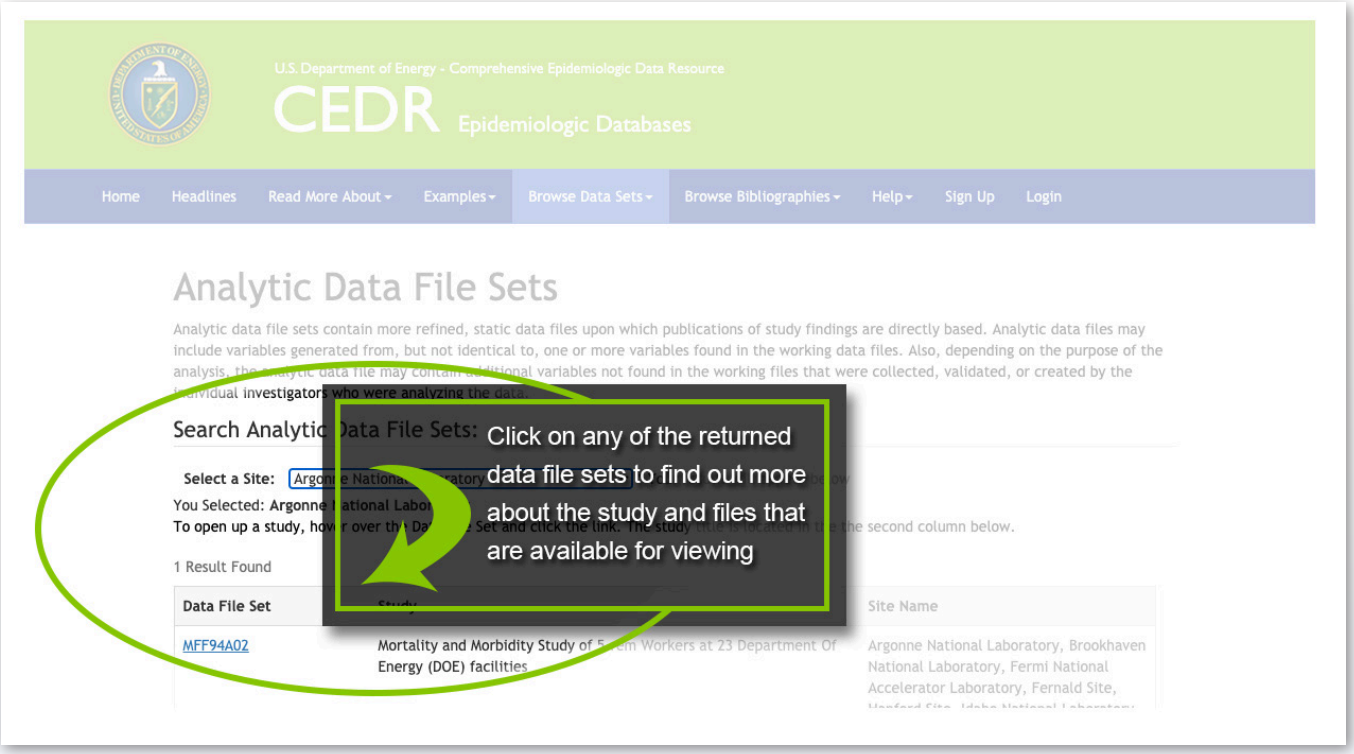


Figure 5-5. View Data Sets

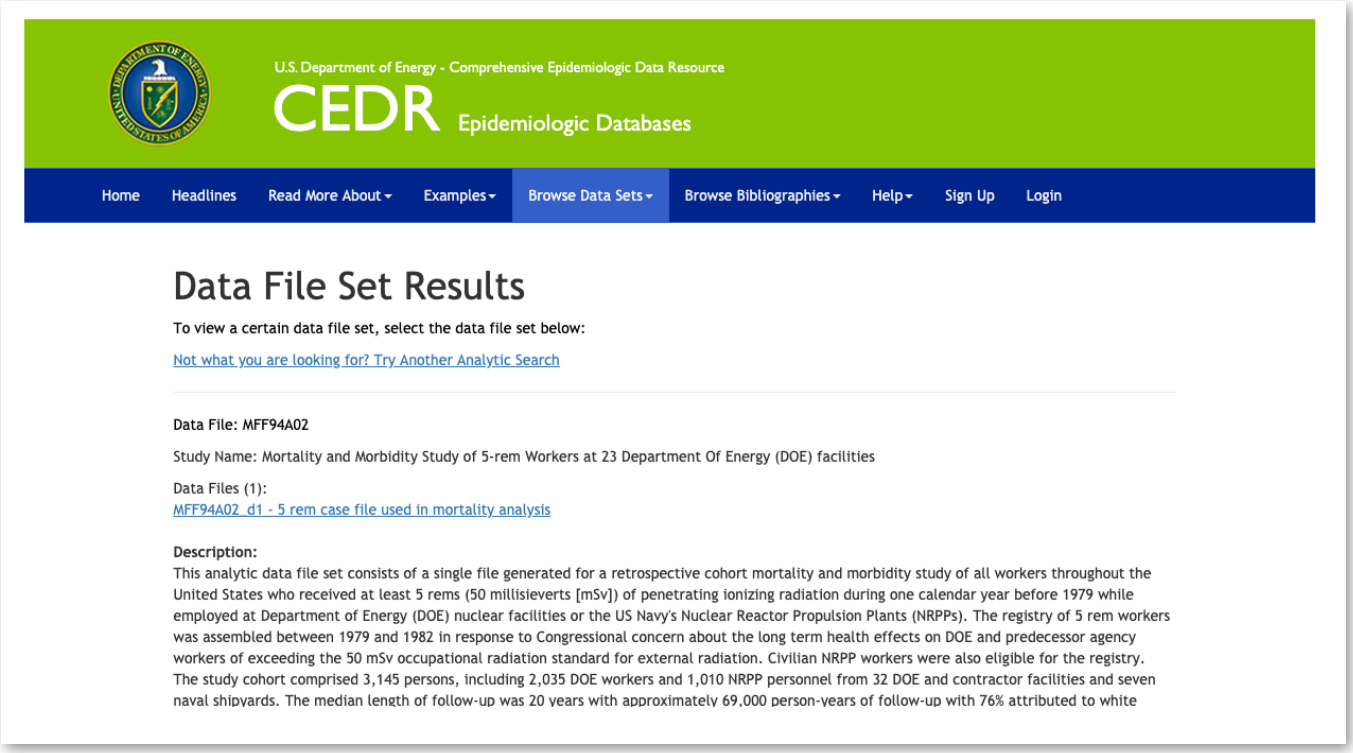
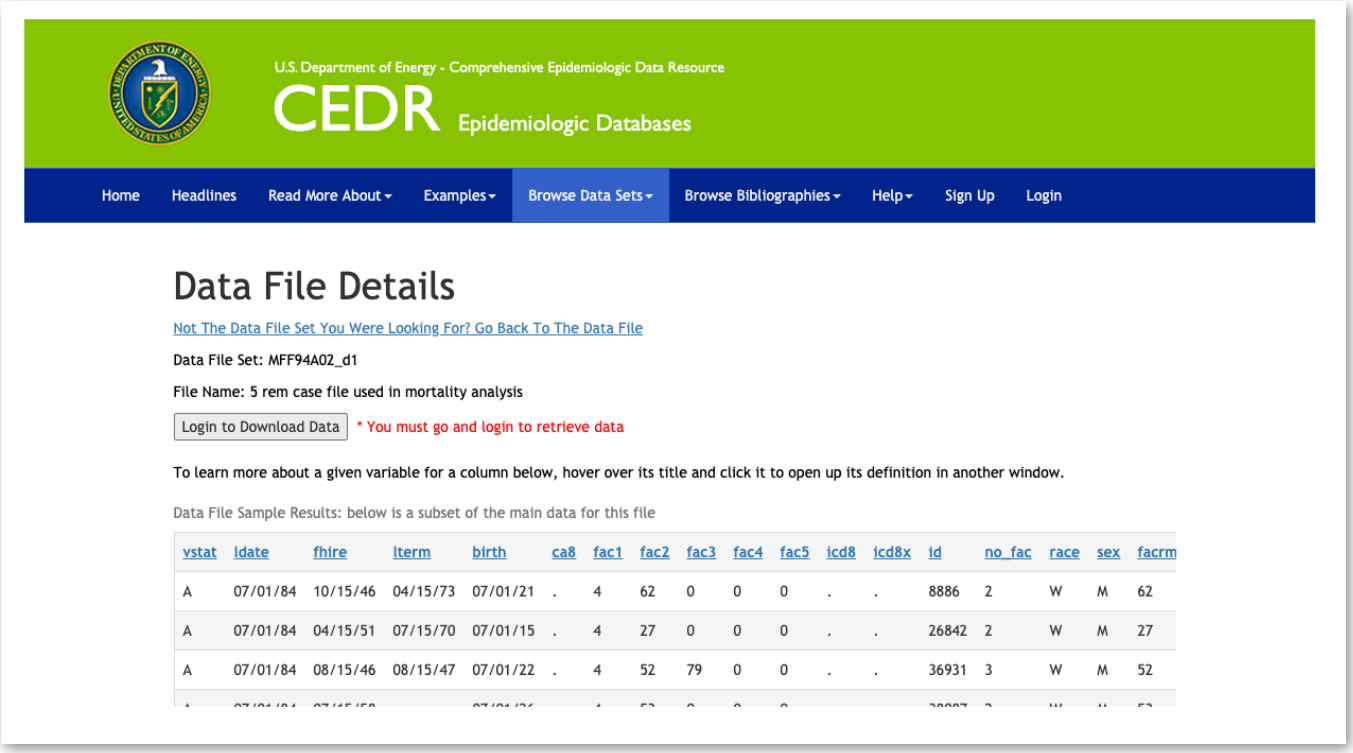


Figure 5-6. Data Set Description

From a data set description, selecting a Data File will display a list of all variables used in the file along with the first 10 records of that data file.



vstat	ldate	fhire	lterm	birth	ca8	fac1	fac2	fac3	fac4	fac5	icd8	icd8x	id	no_fac	race	sex	facrm
A	07/01/84	10/15/46	04/15/73	07/01/21	.	4	62	0	0	0	.	.	8886	2	W	M	62
A	07/01/84	04/15/51	07/15/70	07/01/15	.	4	27	0	0	0	.	.	26842	2	W	M	27
A	07/01/84	08/15/46	08/15/47	07/01/22	.	4	52	79	0	0	.	.	36931	3	W	M	52

Figure 5-7. Data File Variables

- To display a list of variables in the file, click on any of the column names on the active data set.
- The variable listing will display a table with variable names, descriptions, and links to code sets. See Figure 5-7. 1 for Variable-Level Details.

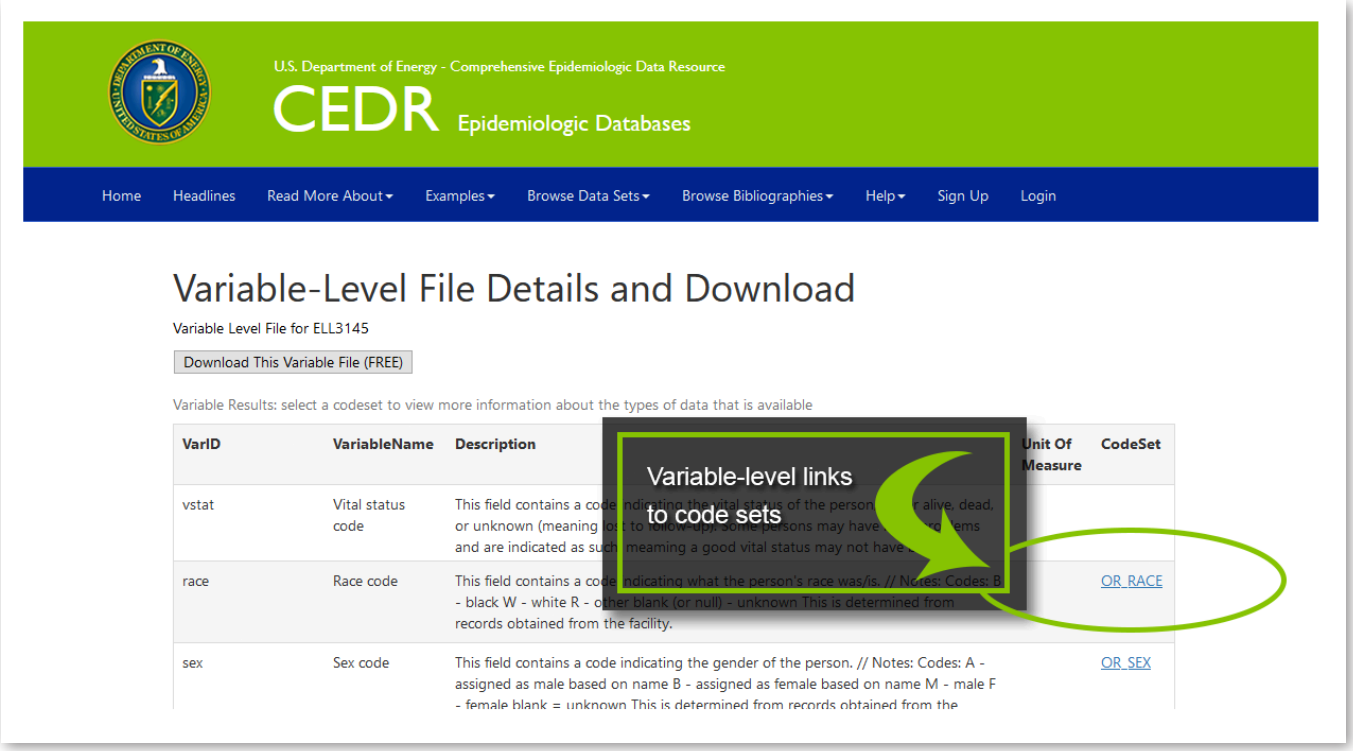


Figure 5-7. 1 Variable-Level Details

For further information about a specific variable, activate the variable name link; for a display of the code set values and their interpretations, click the code set name. See Figure 5-7. 2 for Code Set Details.

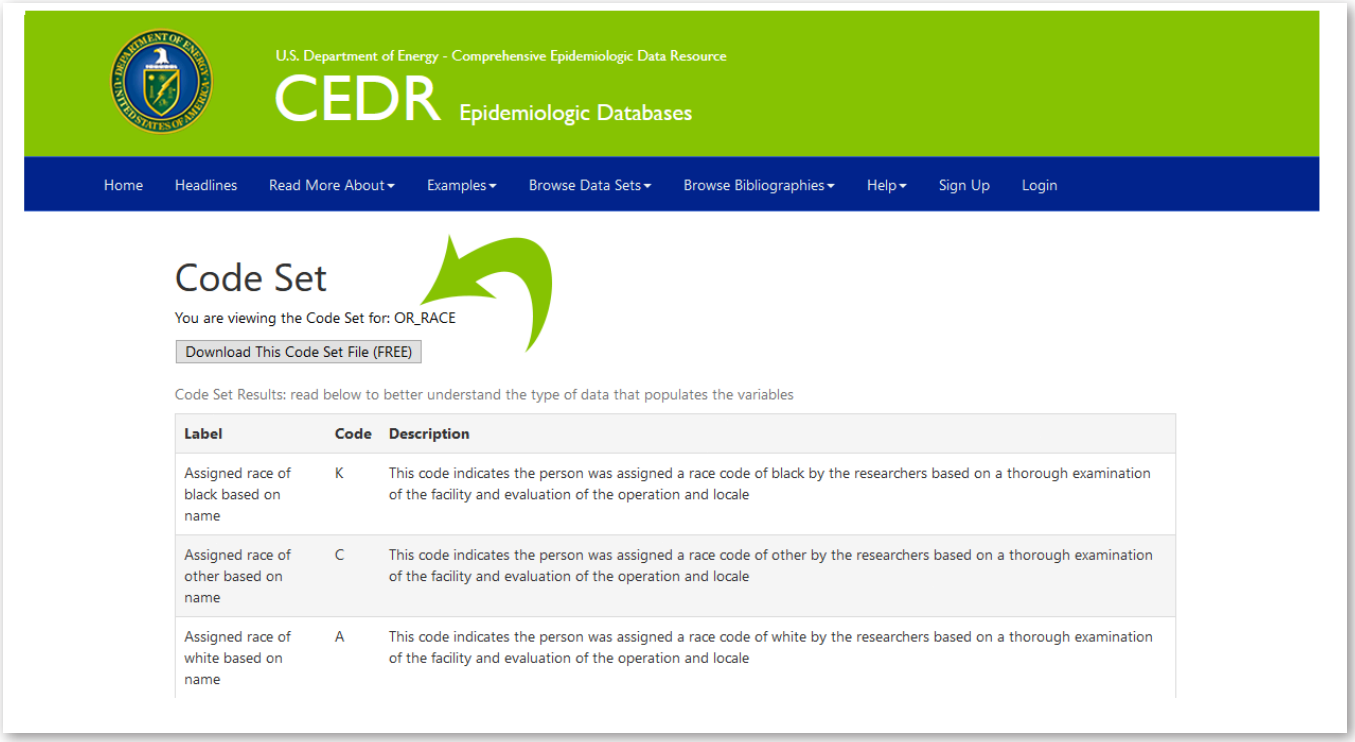


Figure 5-7. 2 Code Set Details

CEDR Data Files

CEDR Data Files are accessible via online Structured Documentation at the file level in two ways (please refer to Figure 5-7.1):

- View Data Files
  You are able to view the first 10 records of any of the data sets for free without having to log into a CEDR account.

- Download Data Files
  If you are an authorized CEDR user and you log into the CEDR website, you are able to download any data file set by clicking the "Download this Data File" button (Figure 5-7. 1). When downloading a data file, users should also download the description of Data File characteristics by selecting any header in the data file set and then clicking the "Download This Variable File (Free)" at the top of the page. The variable file may also be downloaded without a CEDR account.

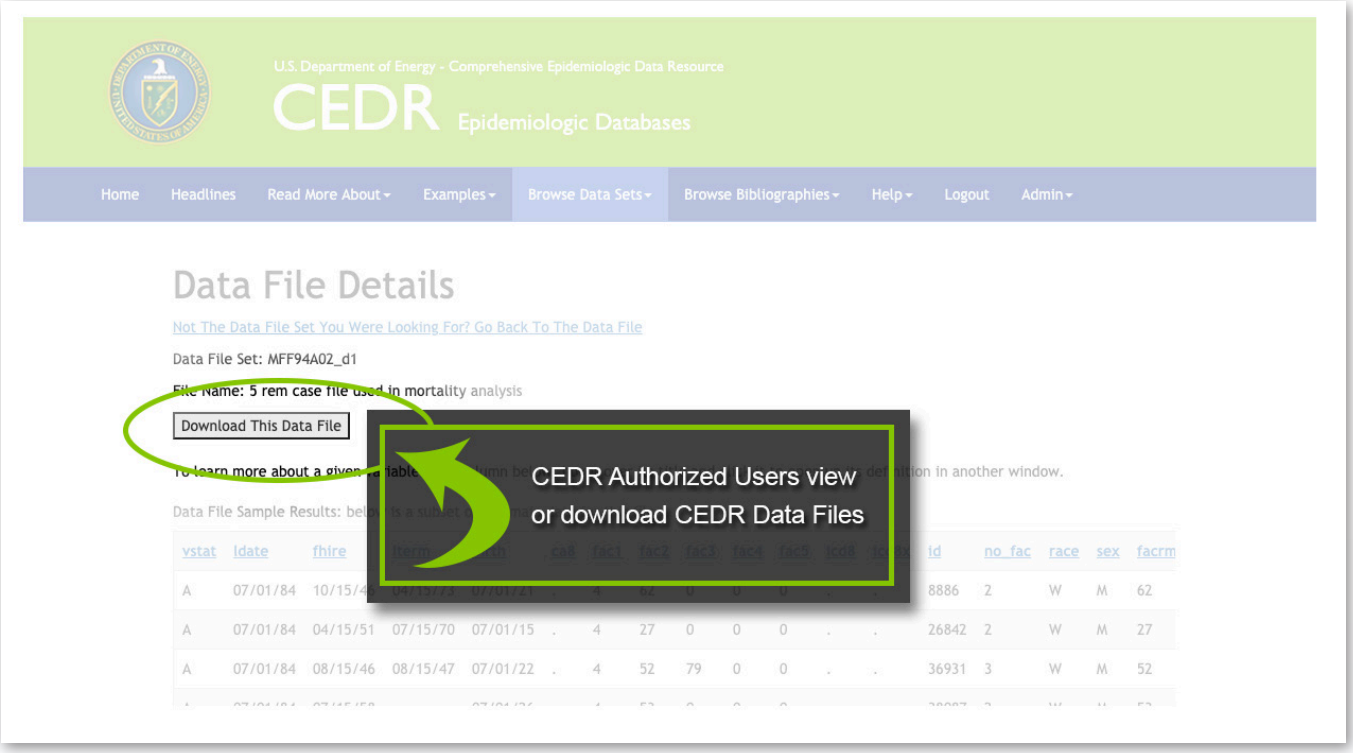


Figure 5-8. File-level Structured Documentation

Figure 5-9 illustrates a dialog box that permits CEDR Authorized Users to view or download CEDR Data Files from Health and Mortality Data Files Sets.

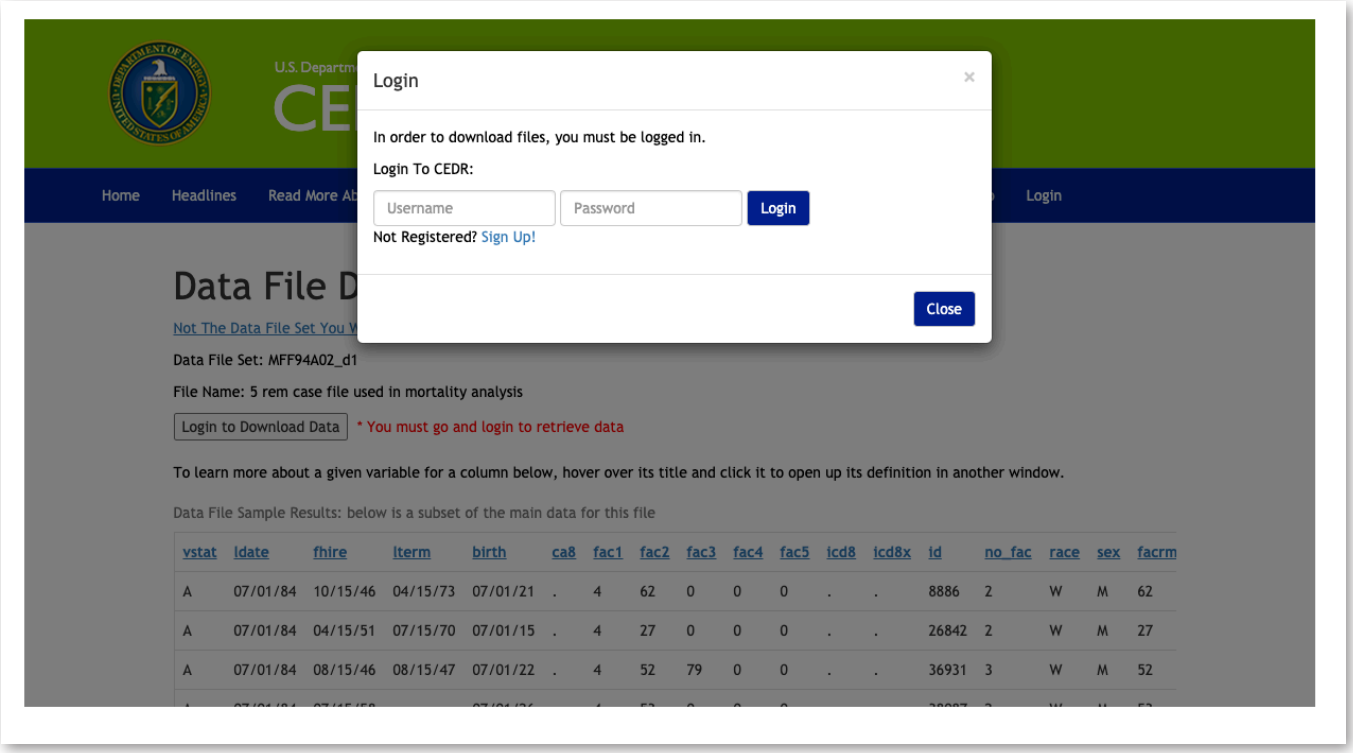


Figure 5-9. CEDR Authorized User ID and Password dialog

In all cases, assistance from CEDR project staff is available from ORAU at CEDR@orau.org (Figure 5-10).

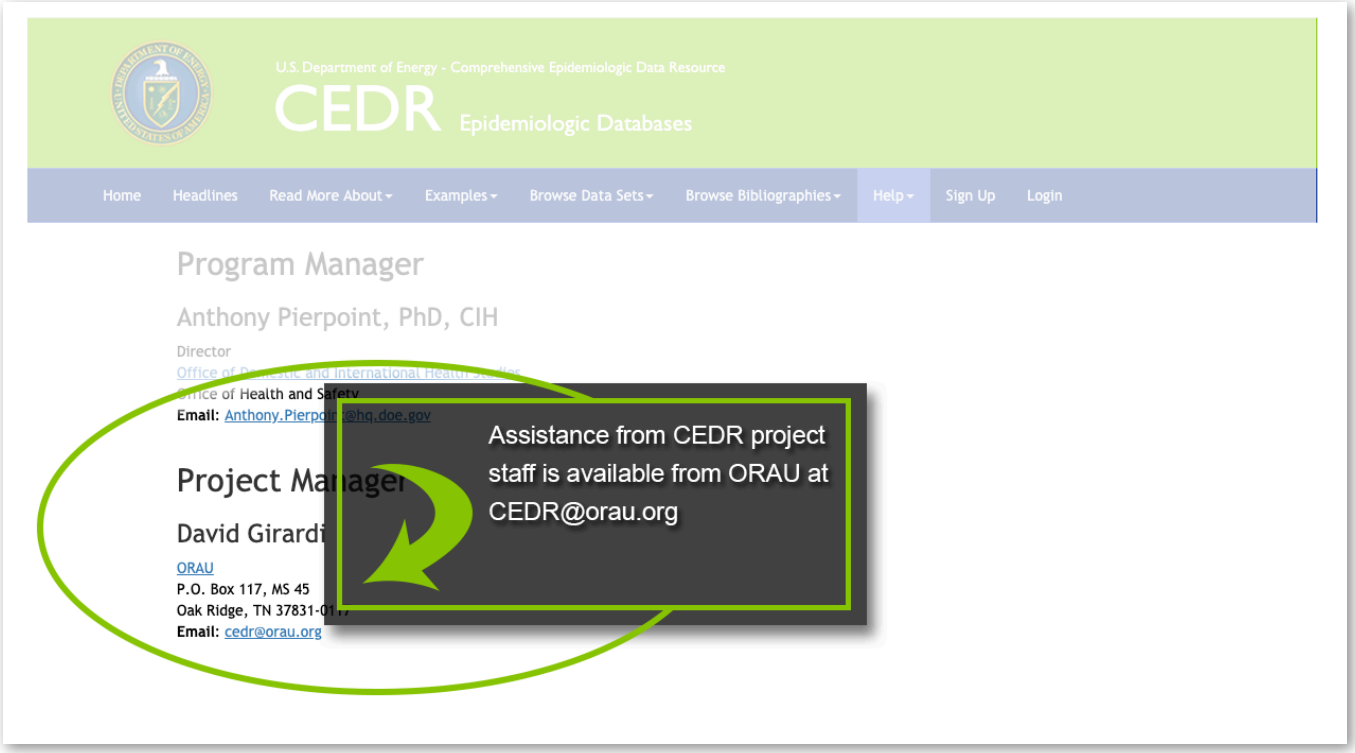


Figure 5-10.

Site Descriptions and Cross-References

This section provides a brief description, including physical location and early operations, of DOE sites for which data currently exist in CEDR. Figure 5-1 is a U.S. map that roughly indicates the locations of major DOE sites and other facilities to which CEDR data pertain.

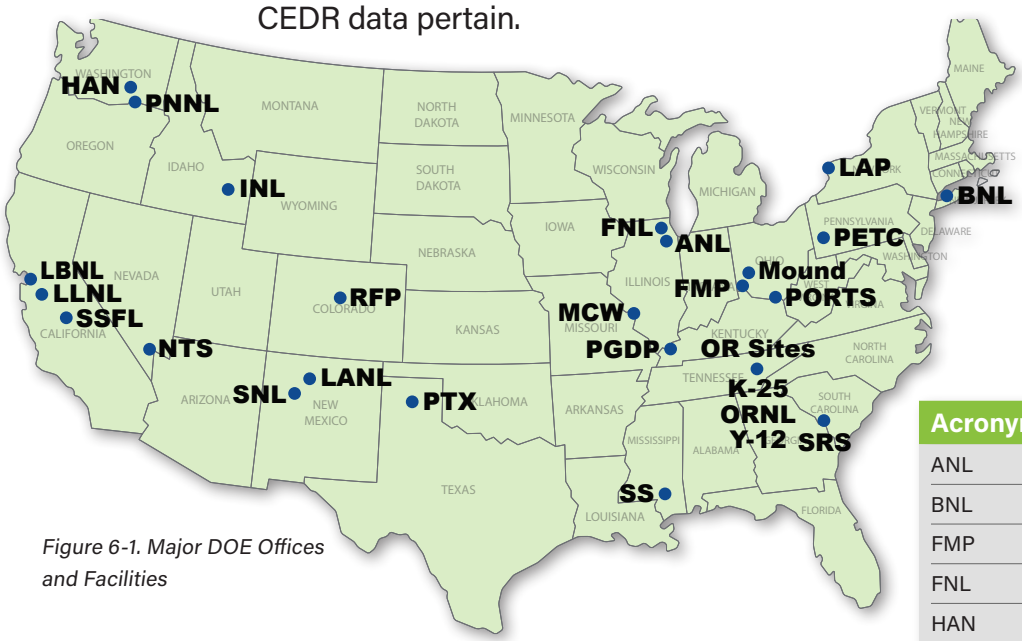
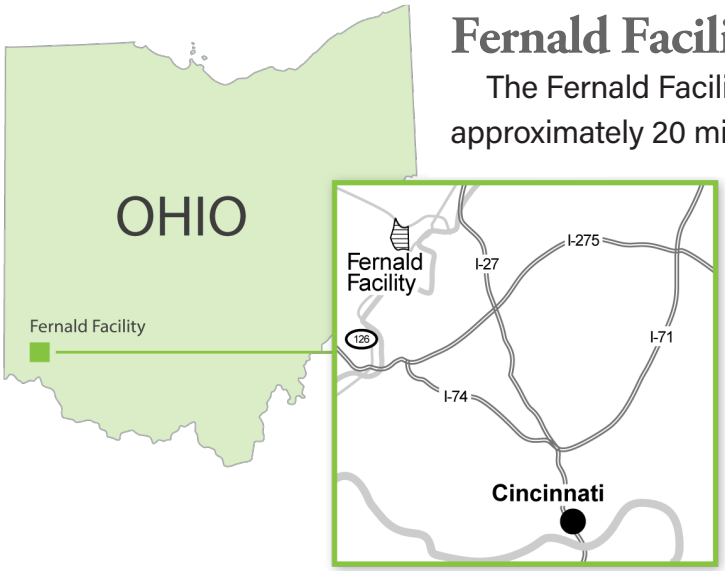


Figure 6-1. Major DOE Offices and Facilities

In addition, a summary table for each site lists the various CEDR holdings that pertain to that site. This information is particularly helpful for those sites where a number of studies were initiated or updated from time to time. A reader can quickly identify all CEDR data file sets that pertain to a particular site. The summary table for each site includes the CEDR name of each pertinent analytic and working data file set for the Worker Health and Mortality Studies, occupational studies, and community studies. Data file sets generated for studies involving multiple sites are listed and summarized at the end of this section.

Detailed descriptions of data file sets pertaining to Worker Health and Mortality Studies are provided in Appendixes A and B. Those pertaining to dose reconstructions or other types of studies that do not focus on a particular DOE site, such as the radium dial painters and the Illness and Injury Surveillance (IISP) data, are given in Appendix C.

Acronym	DOE Site Name
ANL	Argonne National Laboratory
BNL	Brookhaven National Laboratory
FMP	Feed Materials Production Center
FNL	Fermi National Accelerator Laboratory
HAN	Hanford Plant
INL	Idaho National Laboratory
K-25	K-25 Plant
LANL	Los Alamos National Laboratory
LAP	Linde Air Products
LBNL	Lawrence Berkeley National Laboratory
LLNL	Lawrence Livermore National Laboratory
MCW	Mallinckrodt Chemical Works
Mound	Mound Plant
NTS	Nevada Test Site
OR Sites	Oak Ridge Tennessee Sites
ORNL	Oak Ridge National Laboratory
PETC	Pittsburgh Energy Technology Center
PGDP	Paducah Gaseous Diffusion Plant
PNNL	Pacific Northwest National Laboratory
PORTS	Portsmouth Gaseous Diffusion Plant
PTX	Pantex Plant
RFP	Rocky Flats Plant
SNL	Sandia National Laboratory
SRS	Savannah River Site
SS	Salmon Site (Tatum Salt Dome)
SSFL	Santa Susana Field Laboratory
Y-12	Y-12 Plant



Fernald Facility

The Fernald Facility, now defunct, was located at Fernald, Ohio, approximately 20 miles northwest of Cincinnati. Operations of this complex began in 1951 with the mission to process feed materials. Early processes included receiving, sampling, and assaying foreign and domestic uranium ores; chemical processing; reduction of uranium tetrafluoride to metal; and fabrication of the metal by rolling and machining into fuel shapes. National Lead Company of Ohio (NLO), a subsidiary of National Lead Industries, was the original operating contractor of what was then called the Feed Materials Production Center. The processes changed somewhat in later years, and all plants at the facility were used for production of slightly enriched (less than 1% of U-235) metal. Employment at the facility peaked in 1956 and slowly decreased until operations halted in 1989. Westinghouse replaced NLO as the operating contractor in 1986. As production operations were discontinued, the mission of the facility has been environmental restoration. Fernald Environmental Restoration Management Company (FERMCO), a subsidiary of Fluor-Daniel, began managing the facility in 1992. Final cleanup of the facility was completed in 2006.

Working data for the Fernald Facility are included in ORISEWDS. There are two analytic data file sets in CEDR that support two cohort studies of white male workers at the Fernald Feed Materials Production Center. FRW83A01, published as a doctoral dissertation in 1983, is a cohort morbidity study of non-malignant respiratory disease. The study included 4,101 white males who were hired between 1952 and 1972. FRC94A02, completed in 1994, is a cohort mortality study of 4,014 workers with 1,064 deaths from all causes. Workers in more than one data file set retain the same identifier.

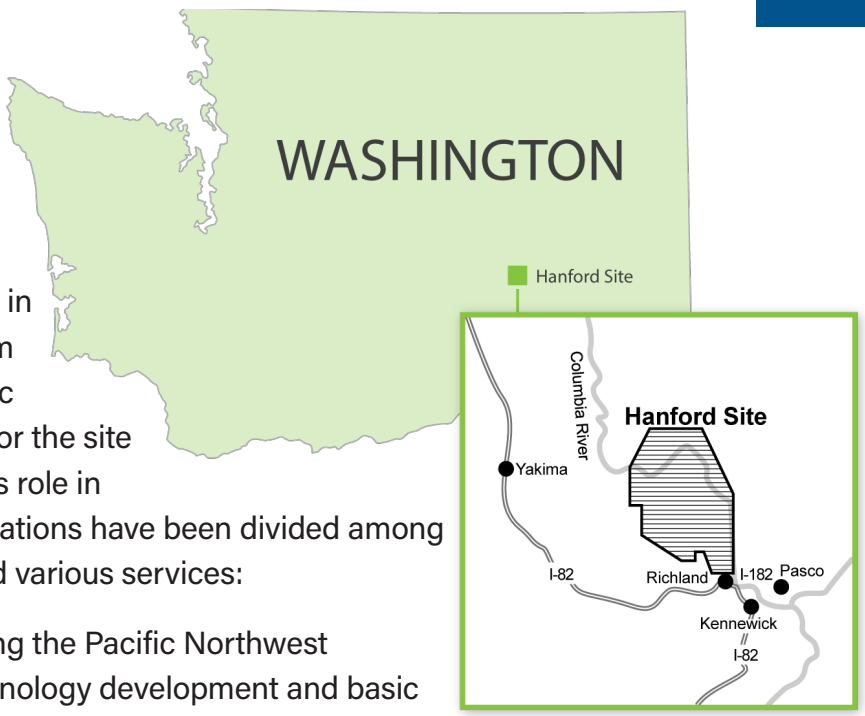
Fernald workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).

CEDR HOLDINGS PERTINENT TO THE FERNALD FACILITY*

Working Data File Set	
ORISEWDS	Three data sets
Analytic Data File Sets	
FRW83A01	One data set
FRC94A02	Three data sets
Multi-facility*	
MFD94A01	Twelve data sets
MFFEGWA1	Two data sets

**Fernald workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

Hanford Site



The Hanford Site, covering a 560-square-mile area of southeastern Washington State, is near Kennewick and Pasco and immediately north of Richland. Activities at this site, founded in 1943, initially revolved around plutonium production. DuPont was the sole Atomic Energy Commission (AEC) contractor for the site until General Electric (GE) assumed this role in 1947. After GE left in 1965, Hanford operations have been divided among a number of contractors that performed various services:

- Battelle (1965 to present) - operating the Pacific Northwest National Laboratory (PNNL) - technology development and basic research missions;
- Computer Sciences Corporation (1965-1975) and Boeing Computer Services (1975 to present) - computing services;
- Douglas United Nuclear (1966-1967), Isochem (1966-1967), Atlantic Richfield Hanford Operations (1967-1977), and Westinghouse (1970-1987) - operating the Hanford Engineering Development Laboratory;
- United Nuclear Industries (1973-1987), Rockwell Hanford Operations (1977-1987), and Westinghouse Hanford (1987 to present) - nuclear/environmental missions and support services;
- Hanford Environmental Health Foundation (1965 to present) - occupational medical services; and
- International Telephone and Telegraph (1966-1971) - support services.

Over time, major activities shifted from plutonium production to nuclear power generation, advanced reactor design, basic scientific research, and research related to the development of nuclear weapons. Waste management and environmental restoration are now the largest part of the site's activities.

CEDR HOLDINGS PERTINENT TO THE HANFORD SITE*

Working Data File Set	
HFW89W01	Seven data sets
HFSRCWOI	Seven data sets
Analytic Data File Sets	
HFC78A01	Three data sets
HFMCCA02	Three data sets
HFI89A01	Three data sets
HFS93A03	Two data sets
HFLCAA01	One data set
HFMCCA02	Five data sets
HFMPVA02	Five data sets
HFWC94A1	Three data sets
Multi-facility*	
MFCLCCA1	Four data sets
MFFEGWA1	Two data sets
MFI93A01	Fourteen data sets
MFMM98A1	Eight data sets
MFMM98W1	Seventeen data sets
MFMM98W2	Eight data sets
MFMM98W3	Six data sets

**Hanford workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

The working data file sets that contain information pertaining to these Hanford worker studies are HFW89W01 and HFSRCW01. Information on some Hanford workers may also be found in ORISEWDS.

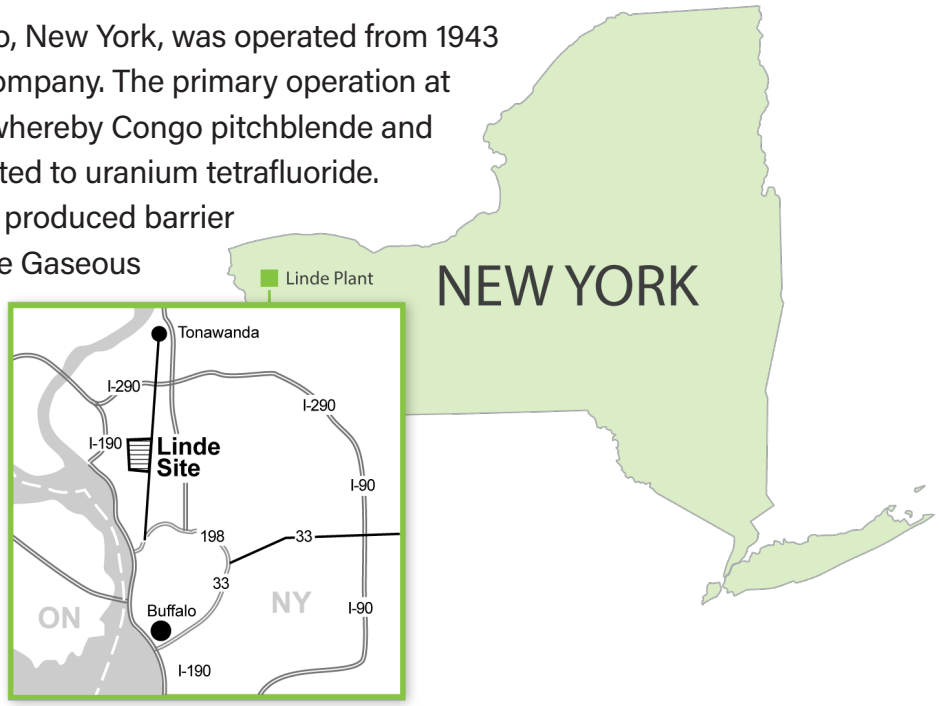
Six analytic data file sets in CEDR pertain to studies of Hanford workers and their offspring. Historical information, such as worker demographics, work histories, and radiation exposures, needed for these studies was compiled into a data base in 1979. They form the basis for three of the data file sets, HFC78A01, HFI89A01, and HFS93A03, which are similarly constructed and support cohort mortality studies conducted at various times.

In addition to the cohort mortality studies, a case-control study, HFLCAA01, of lung cancer among workers was conducted. Both a case-control and a prevalence study of congenital malformations among offspring of workers were conducted and supported by HFMCCA02 and HFMPVA02, respectively. The prevalence study also considered births in the communities near the Hanford Site. Workers in more than one data file set retain the same identifier.

The HFWC94A1 data set is a cohort mortality study completed by NIOSH that covers the production workers from 1944 to 1989 at the Hanford Site. The identifiers used are unique to this study.

Linde Plant

The Linde Plant, located in Buffalo, New York, was operated from 1943 to 1949 by the Linde Air Products Company. The primary operation at the plant was uranium processing, whereby Congo pitchblende and domestic uranium ores were converted to uranium tetrafluoride. The Linde Plant also developed and produced barrier material necessary for the Oak Ridge Gaseous Diffusion Plant (aka the K-25 Site) to use in processes to enrich uranium. The Manhattan Engineer District constructed four buildings on land owned by Union Carbide Corporation. Upon termination of the contract with the Atomic Energy Commission, ownership of the facility was transferred to Union Carbide.

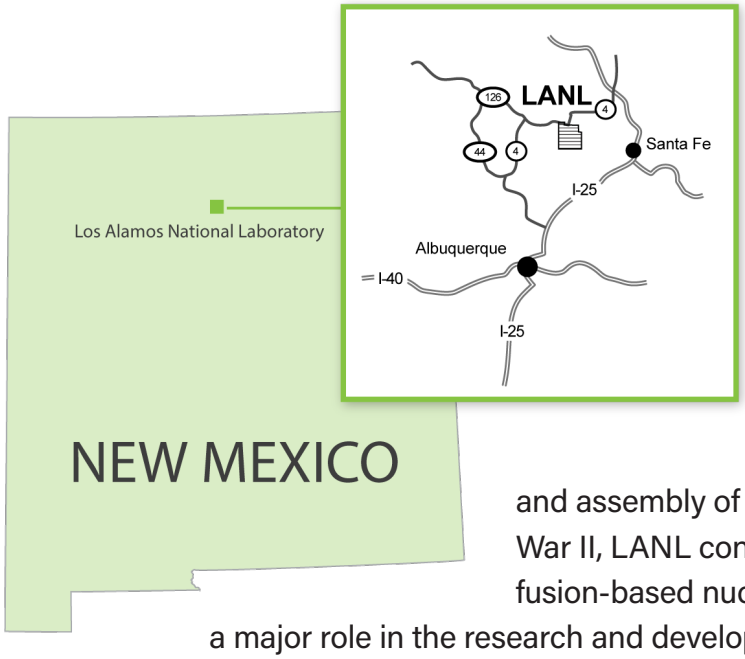


Working data for the Linde Plant are included in ORISEWDS. One analytic data file set, LND87A01, supports a cohort mortality study of workers at this plant. Workers in more than one data file set retain the same identifier.

CEDR HOLDINGS PERTINENT TO THE LINDE PLANT

Working Data File Set	
ORISEWDS	Two+ data sets
Analytic Data File Sets	
LND87A01	One data set
Multi-facility*	
MFFEGWA1	Two data sets

**Linde workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*



Los Alamos National Laboratory

LANL facilities occupy about 43 square miles (27,800 acres) on the Pajarito Plateau in Los Alamos County, New Mexico, approximately 60 miles north of Albuquerque and 25 miles northwest of Santa Fe. LANL was established in January 1943 as Project Y of the War Department's World War II Manhattan Engineer District. The mission of Project Y was the design and assembly of the first nuclear fission bomb. After World War II, LANL continued to design fission and, subsequently, fusion-based nuclear weapons. Additionally, LANL has played a major role in the research and development of nuclear reactors, and it has had a long-standing interest in nuclear fusion power generation. In the 1960s and 1970s, LANL broadened and expanded its research and development activities, and today its major activities include nuclear weapons safety, non-proliferation, and environmental restoration. The University of California (UC) began management of the laboratory in 1943. In 2005, UC teamed with Bechtel to form Los Alamos National Security, and they were awarded the contract in 2006. In 2018, the contract was awarded to Triad – a team composed of UC, Battelle, and Texas A&M University.

Zia Company was a second major employer associated with the operation of LANL. In April 1946, the Zia Company replaced the U.S. Army Corps of Engineers Base Post as the provider of construction, maintenance, and quasi-governmental functions for LANL. In the early 1950s, quasi-governmental activities in Los Alamos County were turned over to the local government. On July 1, 1986, Zia was replaced by Pan American World Services. The Zia Company's offices were located in Los Alamos, New Mexico, and its employees worked throughout LANL facilities to provide construction and maintenance support. Following Zia, Johnson Controls World Services Incorporated provided support services. Merrick and Company was the support contractor for Triad.

Associated with LANL is one working data file set, LAMULW02, that contains data for both LANL and Zia workers. There are five analytic data file sets in CEDR that support studies of LANL workers. LAFEMA01 supports a mortality study of 5,234 white female workers employed between 1943 and 1978. LASUIA02 supports a nested case-control study of suicide among 136 white females. LAUPUA01 contains data

supporting a follow-up study of 26 white male Manhattan Project workers exposed to plutonium during 1944 to 1945 at LANL. LAHSWA04 supports a mortality study of 7,466 white male and female workers in which 241 had a high exposure to plutonium, and LAMENA03 supports a mortality study of 15,727 male workers employed between 1943 and 1977. Workers in more than one data file set retain the same identifier.

As mentioned earlier, there is one working data file set, LAMULW02, that contains data for both LANL and Zia workers. The single analytic data file set associated with Zia, ZARADA01, supports a cohort mortality study of 5,424 radiation-monitored Zia workers employed at LANL between 1946 and 1979. Workers in more than one data file set retain the same identifier.

CEDR HOLDINGS PERTINENT TO LANL

Working Data File Set	
LAMULW02	Nine data sets
Analytic Data File Sets	
LAFEMA01	One data set
LAHSWA04	One data set
LAMENA03	One data set
LASUIA02	One data set
LAUPUA01	One data set
ZARADA01	One data set
Multi-facility*	
MFFEGWA1	Four data sets
MFMM98A1	Two data sets
MFMM98W1	Fourteen data sets
MFMM98W2	Eight data sets
MFMM98W3	Seventeen data sets

**Los Alamos National Laboratory workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

Mallinckrodt Facility

Mallinckrodt Chemical Works was one of the earliest and largest uranium-producing facilities in the United States. Headquartered in St. Louis, Missouri, the Mallinckrodt Facility was in operation from April 1942 through 1966. Its Uranium Division converted uranium ore to uranium dioxide and uranium metal. The uranium refining conducted at this facility was unique because the pitchblende ore was up to 60% pure uranium from 1946 through 1955. Uranium processing was conducted at two sites: St. Louis from April 1942 through 1957 and Weldon Spring, Missouri, from 1958 through 1966.

Working data for the Mallinckrodt Facility are included in ORISEWDS. Three retrospective cohort studies of white male workers at the Mallinckrodt Facilities were conducted. The first study followed 2,542 white males from operations who were hired beginning in 1942 to 1966 when operations ceased and who were employed at least 30 days. The vital status follow-up was through 1988. The analytic file (MCD94A01) contains vital status information including causes of death (ICD8), hire and termination dates, and number of other DOE facilities where the worker was employed. The occupational exposure variables are all categorical. They include categorical estimates of exposure to pitchblende and thorium, as well as indictors for the film badge readings, uranium urine readings, and radon breath monitoring. An update to the cohort was published in 2000 by Ellis et al. This study followed 2,514 white males employed at Mallinckrodt between 1942 and the shut down in 1966. Vital status follow-up was through 1993 with causes of death coded to ICD8. The study included 1,013 worker deaths with causes of death obtained for 1,012. Only 45 workers were deemed lost to follow-up. The analytic file set (MCD98A02) also includes external cumulative dosimetry measurements that were lagged at 0, 2, and 10 years. The most recent study was published

CEDR HOLDINGS PERTINENT TO THE MALLINCKRODT FACILITY

Working Data File Set	
ORISEWDS	Three+ data sets
MCG19W01	Two data sets
Analytic Data File Sets	
MCD94A01	One data set
MCD98A02	Four data sets
MCG19A01	Two data sets
Multi-facility*	
MFD94A01	Twelve data sets

**Mallinckrodt workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

by Golden et al. in 2019. The cohort was the same used by Ellis et al. in 2000 but with updated dosimetry and extended vital status follow-up through 2012. The vital status tracing found 1,895 deaths with cause of death obtained for all but 16 of the deaths. The analytic file set (MCG19A01) contains information for year of birth, year of hire, and pay code type. The dosimetry is provided in total dose per organ. The organs included are brain, lung, heart, kidney, red bone marrow, colon and thoracic lymph nodes. Workers in more than one data file set retain the same identifier.

Mound Plant

The Mound Plant, now defunct, was located on a 306-acre site in Montgomery County in southwestern Ohio, within the Miamisburg city limits, approximately 10 miles south of Dayton and 31 miles north of Cincinnati. This facility was operated first by the Monsanto Chemical Corporation and later by EG&G. From 1943 to 1948, the work was done under the title Dayton Project, when work was carried out at several locations within the city of Dayton. In 1948, operations were consolidated at the current central Mound Plant. In 1988, EG&G replaced Monsanto Chemical Corporation as the operating contractor. Historically, major operations included the separation, chemistry, and metallurgy of polonium-210 and the processing of plutonium-238 for heat sources. Other projects included work on explosives and tritium technology for manufacture of weapons components. Mound closed operations in 2003.

The working data file set that contains information pertaining to these Mound workers is MDFACW02. Four cohort mortality studies have been conducted of Mound workers, and data from these studies are contained in three separate analytic data file sets. MDSMRA01 consists of data used in a comparison of the mortality experience of 4,697 white male workers employed between April 1942 and December 1979. MDEXTA02 focuses on 3,229 white male workers employed between 1947 and 1979 who were monitored for external radiation, although the file contains a total of 6,904 male and female workers from Mound. The vital status follow-up was through the end

of 1979. MDPOLA03 consists of data used in a cohort mortality study of 4,402 white male workers employed during the 1944 to 1972 time period with vital status through the end of 1983. The data set files also contain the information for 6,884 workers, some of whom were not included in the study. MDB13A01 contains data for a mortality study of 7,269 workers who were employed between 1944 and 1972. Vital status follow-up was through 2009.

Workers in more than one data file set retain the same identifier.

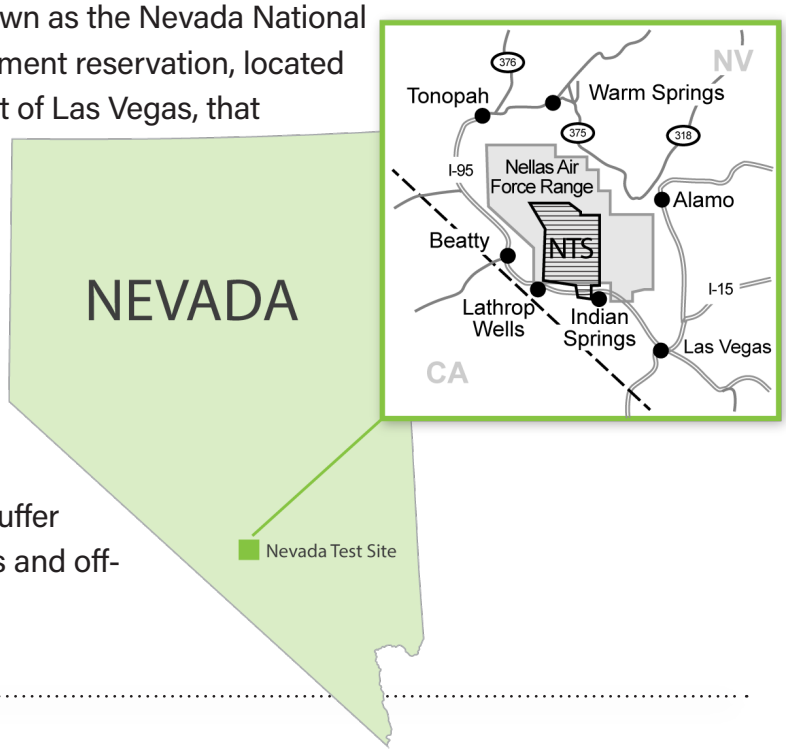
CEDR HOLDINGS PERTINENT TO THE MOUND PLANT

Working Data File Set	
ORISEWDS	Three+ data sets
Analytic Data File Sets	
MDB13A01	Two data sets
MDEXTA02	One data set
MDPOLA03	One data set
MDSMRA01	One data set
Multi-facility*	
MFFEGWA1	Two data sets

**Mound workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

Nevada Test Site

The Nevada Test Site, also known as the Nevada National Security Site (NNSS), is a government reservation, located approximately 65 miles northwest of Las Vegas, that has been used since 1951 for the testing of nuclear explosive devices. NTS, consisting of more than 1,350 square miles of Mojave and Great Basin desert terrain, is approximately the size of the State of Rhode Island. The Nellis Air Force Range surrounds NTS on three sides, acting as a buffer between nuclear testing activities and off-site communities and ranches.



Reynolds Electric and Engineering Company, Inc.; Raytheon Services Nevada; and EG&G Energy Measurements, Inc. operated NTS prior to 1996. In 1996, Bechtel Nevada (BN) and Wackenhut Services, Inc. (WSI) took over as operating contractors. Following BN, National Security Technologies was the operating contractor from 2006 until 2017, when Mission Support and Test Services, a division of Honeywell, took over this role.

During the years of atmospheric nuclear testing from 1951 through 1962, airborne radioactive debris from 74 nuclear tests was carried off-site by the winds. Subsequently, downwind residents expressed concerns regarding the health and safety of their families as a result of nuclear testing activities in Nevada. In 1979, the Off-Site Radiation Exposure Review Project (ORERP) was established to re-evaluate doses received by downwind communities from the fallout radiation. The data files generated by ORERP form the basis for the reconstruction of radiation doses to off-site populations.

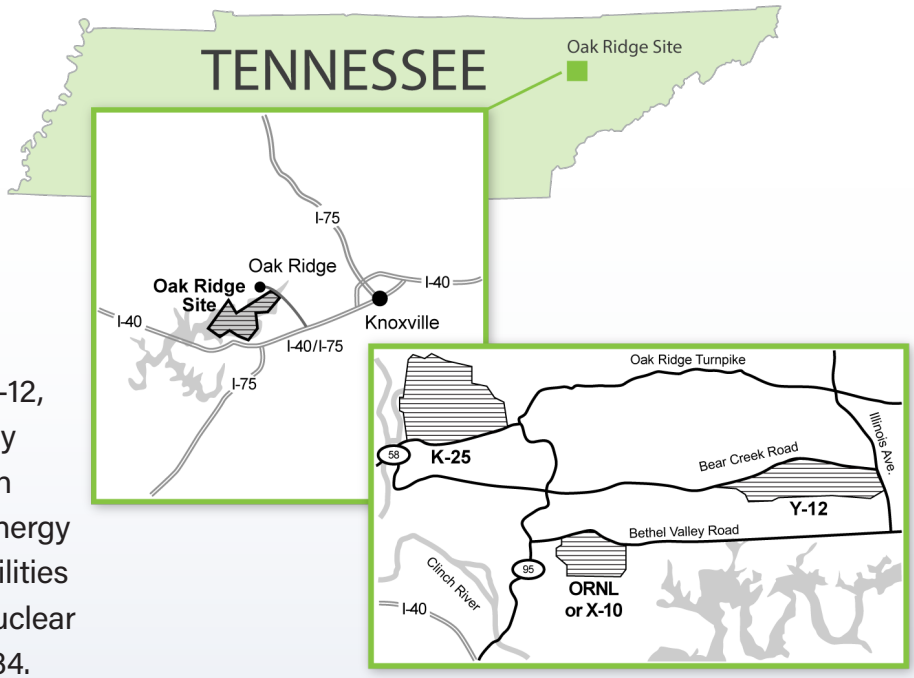
CEDR HOLDINGS PERTINENT TO THE NEVADA TEST SITE

Dose Reconstruction Data File Set	
NTORPW03	Four data sets

The NTS dose reconstruction is currently represented in CEDR by a single data file set. The four files in the data file set contain some of the basic data, primarily times of fallout arrival and exposure rates for various locations, used in the project. Additional files will become available in the future.

Oak Ridge Site

The Oak Ridge Site, located about 20 miles from Knoxville, Tennessee, consists of three major facilities near Oak Ridge, Tennessee. These facilities are X-10 (Oak Ridge National Laboratory), Y-12, and K-25 (now defunct and formerly called Oak Ridge Gaseous Diffusion Plant [ORGDP]). Martin Marietta Energy Systems, Inc. operated all three facilities after Union Carbide Corporation Nuclear Division gave up the contract in 1984.



Detailed information about the operations conducted at each facility is provided in the sections immediately following this discussion.

A number of epidemiologic studies have been conducted on the workers employed at one or more of the Oak Ridge facilities. Most of these were cohort studies that examined associations between mortality and occupational exposures to a variety of agents, including radiation, nickel, mercury, and uranium.

Various updated editions of the single working data file set, ORISEWDS, have been used to support all of the Oak Ridge worker studies, as well as studies of workers at a number of other DOE sites. The analytic data file sets supporting studies that include workers who may have worked at more than one facility at the Oak Ridge Site, or that include certain types of workers regardless of the facility at which they worked, are listed in the table below. Additional data file sets for studies concerning the Oak Ridge Site but that focus on workers at only one Oak Ridge facility are listed on the following pages.

CEDR HOLDINGS PERTINENT TO MULTIPLE FACILITIES AT OAK RIDGE*

Working Data File Set	
ORISEWDS	Fifty-eight data sets
Analytic Data File Sets	
ORMULA01	Two data sets
ORMULA02	One data set
ORMULA03	One data set
ORMULA04	One data set
ORMULA05	Six data sets

**Oak Ridge Site workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

Oak Ridge K-25 Facility

The Oak Ridge K-25 Facility, previously called the Oak Ridge Gaseous Diffusion Plant and now defunct, occupied a 1,500-acre area approximately 13 miles west of downtown Oak Ridge, Tennessee. Operated by Union Carbide Corporation Nuclear Division from 1942 until 1984 when Martin Marietta Energy Systems, Inc., became the operating contractor, the K-25 Facility originally produced enriched uranium hexafluoride for defense purposes. Due to a declining demand for enriched uranium, the enrichment process at the K-25 Facility was placed on standby in 1986 and subsequently shut down in 1987.

Working data for the K-25 Facility are included in ORISEWDS. There are two analytic data file sets that support two cohort mortality studies of K-25 workers. ORK25A01 supports a study examining the mortality experience of 8,378 white male workers exposed to nickel for at least 1 year between 1948 and 1953. ORK25A02 contains

CEDR HOLDINGS PERTINENT TO THE K-25 FACILITY

Working Data File Set	
ORISEWDS	Five+ data sets
Analytic Data File Sets	
ORK25A01	One data set
ORK25A02	One data set
ORK25A03	Seven data sets
Analytic Data File Sets	
MFCLCCA1	Four data sets
MFFEGWA1	Two data sets
MFF94A02	One data set
MFMCHMA1	Seven data sets

K-25 workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).

mortality data for 40,785 workers at K-25 between 1945 and 1990. Workers in more than one data file set retain the same identifier.

Oak Ridge X-10 Facility

The Oak Ridge X-10 Facility, also known as the Oak Ridge National Laboratory, occupies several sites and covers approximately 2,900 acres in Melton Valley and Bethel Valley, 10 miles southwest of downtown Oak Ridge, Tennessee. The site has been in use since 1943, when it was referred to as Clinton Laboratories and was operated by the Monsanto Corporation. ORNL was operated by Union Carbide Corporation Nuclear Division from 1947 to 1984 when Martin Marietta Energy Systems, Inc., became the operating contractor. Martin Marietta was the operating contractor from 1984 to 1999 when UT-Battelle assumed this role. The ORNL mission is to conduct applied research and engineering development in support of DOE programs in fusion, fission, conservation, fossil, and other energy technologies and to perform basic scientific research in selected areas of the physical and life sciences.

Working data for the X-10 Facility are included in ORISEWDS. Three analytic data file sets support three cohort mortality studies of workers at ORNL. ORX10A01 consists

of data for 8,375 white males employed at ORNL for at least 30 days between 1943 and 1972 and supports a study presenting internal comparisons of mortality between subgroups of the cohort according to radiation dose level and duration of employment in various job categories. ORX10A02 supports a mortality update study on 8,318 white

CEDR HOLDINGS PERTINENT TO THE X-10 FACILITY

Working Data File Set	
ORISEWDS	Eight data sets
Analytic Data File Sets	
ORX10A01	Four data sets
ORX10A02	Three data sets
ORX10A03	One data set
ORX10A04	Sixty-six data sets
ORX10A05	One data set
Multi-facility*	
MFCLCCA1	Four data sets
MFFEGWA1	Two data sets
MFF94A02	One data set
MFMCHMA1	Seven data sets
MFMM98W1	Seventeen data sets
MFMM98W2	Eight data sets
MFMM98W3	Six data sets

**X-10 workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

males employed at ORNL for at least 30 days between 1943 and1972 that resulted in two papers (one published in 1991 and one in 1993). ORX10A03 supports a cancer mortality study. Workers in more than one data file set retain the same identifier.

Oak Ridge Y-12 Facility

The Oak Ridge Y-12 Facility occupies an 811-acre site in the Bear Creek Valley, approximately 2 miles from Oak Ridge, Tennessee. The Y-12 Facility, built in 1943 as part of the Manhattan Project, was established to separate uranium isotopes by the electromagnetic process. The original operating contractor was Tennessee Eastman Corporation (TEC). In May 1947, Union Carbide Corporation Nuclear Division became the operating contractor. At the time of this change, the work force at the plant had a significant turnover, and the processes changed from uranium enrichment to manufacturing and developmental engineering of enriched uranium metal products.

For these reasons, two populations were identified for epidemiologic purposes. The workers employed at the plant when TEC was the operating contractor are known as the TEC population, while workers employed after May 1947 are known as the Y-12 population. After Lockheed Martin assumed the operating contractor role in 1984, BWXT-Y-12 became the operating contractor in 2000. In 2013, Consolidated Nuclear Services, LLC became the operating contractor, taking control in 2014. The Y-12 facilities have been used for treating, storing, or disposing of hazardous radioactive wastes and materials.

CEDR HOLDINGS PERTINENT TO THE Y-12 FACILITY

Working Data File Set	
ORISEWDS	Five+ data sets
Analytic Data File Sets	
ORY12A01	Three data sets
ORY12A02	One data set
ORY12A03	One data set
ORY12A04	One data set
ORY12A05	Two data sets
Multi-facility*	
MFCLCCA1	Four data sets
MFD94A01	Twelve data sets
MFFEGWA1	Two data sets
MFF94A02	One data set
MFMCHMA1	Seven data sets

**Y-12 workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

Working data for the Y-12 Facility are included in ORISEWDS. There are four analytic data file sets that support four cohort mortality studies of workers at the Y-12 Facility. ORY12A01 pertains to 6,781 white male workers who were employed for at least 30 days between 1947 and1974 and exposed to low levels of alpha and gamma radiation. ORY12A02 supports a study of the mortality experience of 5,664 white male workers who were employed for at least 4 months between 1953 and 1958 and exposed to elemental mercury and mercury vapors. ORY12A03 consists of mortality data used in a comparison study of 18,869 white male workers during 1943 to 1947. ORY12A04 supports a study of the mortality experience of 18,869 white male workers who were employed at Y-12 from 1943 to 1945 and exposed to phosgene. Workers in more than one data file set retain the same identifier.

Paducah Gaseous Diffusion Plant

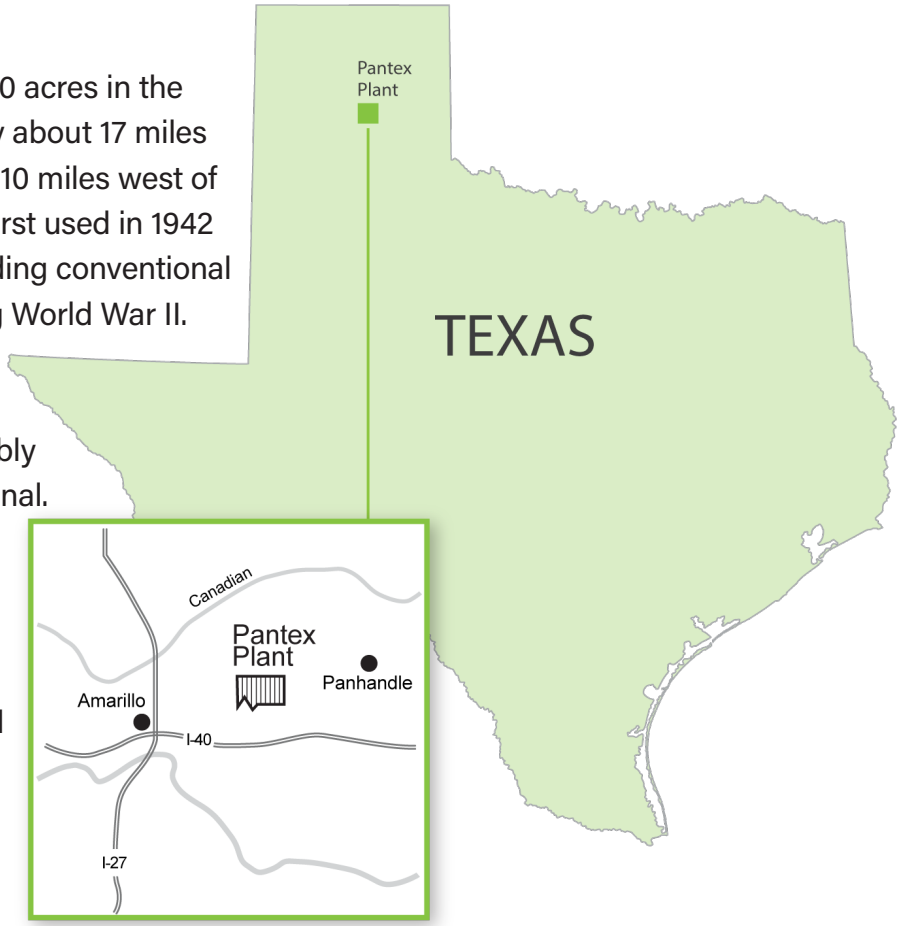
The Paducah Gaseous Diffusion Plant (PGDP) was located on 748 acres within a 3,400-acre federal reservation in McCracken County, Kentucky. Completed in 1954, PGDP was the result of efforts to expand the production of atomic weapons, which also included the expansion of the Oak Ridge and Portsmouth uranium facilities.

The primary objective of PGDP was the enrichment of uranium hexafluoride (UF6) in the U-235 isotope by the use of a gaseous diffusion (cascade) process. The diffusion plant consisted of four major process cascade buildings. There were other on-site facilities that recovered and recycled valuable metals resulting from other DOE operations. PGDP was operated by Union Carbide Corporation from 1954 until 1984. Martin Marietta Corporation operated PGDP from 1984 to 1993, when the Federal government assumed uranium enrichment activity under the Energy Policy Act. The United States Enrichment Corporation (USEC) took over operation and subcontracted to Martin Marietta Utility Services for assistance in operating PGDP. USEC and the Nuclear Regulatory Commission were involved in the operation of PGDP until operations ceased in 2013.

CEDR HOLDINGS PERTINENT TO THE PADUCAH SITE

Working Data File Set	
ORISEWDS	Fifty-eight data sets
PGDPSW02	One data set
Analytic Data File Sets	
PGDPSA02	Six data sets

Pantex Plant



The Pantex Plant is located on 9,100 acres in the panhandle of Texas in Carson County about 17 miles northeast of downtown Amarillo and 10 miles west of downtown Panhandle. The site was first used in 1942 by the Army Ordnance Corps for loading conventional ammunition shells and bombs during World War II. In 1951, new facilities for fabricating chemical high explosives used in nuclear weapons and for final assembly of nuclear weapons became operational. The Pantex Plant has been the nation's primary weapons assembly/disassembly plant. It receives conventional (non-nuclear) high-explosive materials and prefabricated nuclear weapons components to produce new nuclear weapons; maintains, modifies, and quality assurance tests nuclear weapons already in the military stockpile; and disassembles nuclear weapons for retirement. The plant also conducts research and development work on conventional high explosives to support weapons design and development programs.

The Pantex Plant was operated by Procter & Gamble from 1951 to 1956, Mason & Hanger from 1956 to 2001, and Babcock & Wilcox from 2001 to 2014. Consolidated Nuclear Security, LLC, which also operates Y-12 in Oak Ridge, was selected as operating contractor in 2013 and assumed control in 2014.

There is one working data file set, PXFACW01, associated with the study of Pantex workers. The file contains records of 7,425 workers employed

CEDR HOLDINGS PERTINENT TO THE PANTEX FACILITY

Working Data File Set	
PXFACW01	Five data sets
Analytic Data File Sets	
PXSMRA01	One data set
PXSMRA02	One data set
Multi-facility*	
MFFEGWA1	Two data sets

**Pantex workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

from 1951 to 1981. The analytic data file set, PXSMRA01, supports a cohort mortality study of 3,564 white male Pantex workers who were followed through 1980. Although not all were included in the analysis, the file contains demographic information on 5,438 male and female workers. PXSMRA02 is a revised cohort mortality study of 4,668 male and female workers at Pantex who were employed between 1951 and 1978. The vital status for the cohort was through 1995.

Portsmouth Gaseous Diffusion Plant

The Portsmouth Gaseous Diffusion Plant (PORTS) is located on 3,800 acres near Portsmouth, Ohio, aka Piketon. The site consists of two major facilities: PORTS (constructed between 1952 and 1956) and the Gas Centrifuge Enrichment Plant whose construction was halted in 1985. Previously operated by the Goodyear Tire and Rubber Company (Goodyear Atomic Corporation) from the plant's inception, PORTS was operated by Martin Marietta Energy Systems, Inc., from 1986 to 1993. At this time, the United States Enrichment Corporation (USEC) took overall responsibility for the Paducah and Portsmouth enrichment plants. USEC engaged Martin Marietta Utility Services, and in 1995, the operator became Lockheed Martin with the merger of Martin Marietta and Lockheed. In May 2001, the PORTS plant ceased operations and was placed in cold standby.

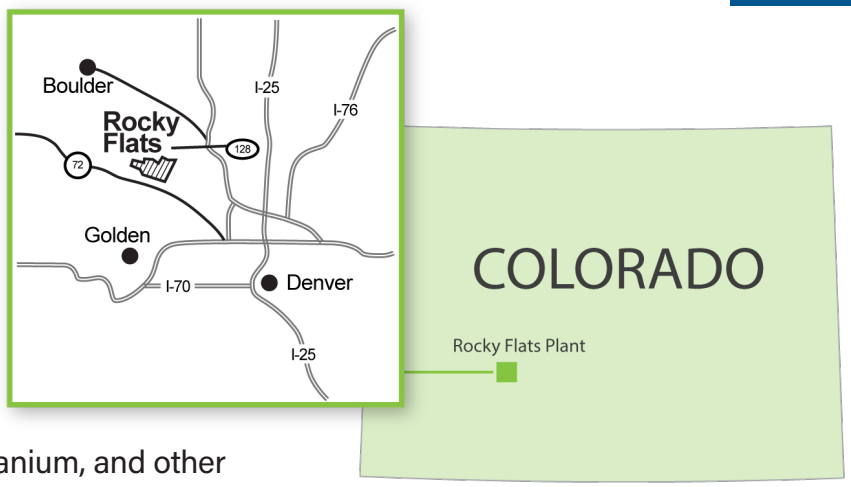
CEDR HOLDINGS PERTINENT TO THE PORTSMOUTH SITE

Analytic Data File Set	
PGDPSA01	Eighteen data sets
Multi-facility*	
MFF94A02	One data set

**Portsmouth workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

The primary objective of PORTS was the production of enriched uranium to meet private and government needs. Since production began in 1955, the PORTS site used the gaseous diffusion (cascade) process for enrichment until the cold standby order in 2001. Employment usually ran at about 2,300 workers. The one PORTS study available in CEDR is a case-control mortality study of 8,877 uranium enrichment workers who were employed between September 1954 and December 1991.

Rocky Flats Plant



The site for the Rocky Flats Plant, now defunct, consisted of nearly 11 square miles, located near Golden, Colorado, in northern Jefferson County, about 16 miles northwest of Denver. Historically, major operations conducted at the plant in support of weapons manufacturing included fabrication and assembly of plutonium, beryllium, uranium, and other metal components; plutonium recovery, americium separation, and research and development. Construction of the plant began in 1951, and limited production operations commenced in 1952. By 1954, the plant was fully operational. In 1989, all production of nuclear weapons components ceased, and environmental restoration activities concluded in 2006. The plant was operated by four contractors beginning with Dow Chemical Company (1951), followed by Rockwell International (1975), then EG&G (1990), and Kaiser-Hill (1995).

There are two working data file sets that contain information pertaining to Rocky Flats workers. RFCHMW01 contains information on 58 workers for a small pilot study estimating an individual's chemical exposures. RFFACW02 contains the data files for the 9,537 workers who were hired between 1951 and February 1979. There are three analytic data file sets that support mortality studies at the Rocky Flats Plant. RFPLUA01 supports a cohort mortality study of 5,413 white male workers employed for 2 or more years between 1951 and 1979. However, the file contains a total of 7,616 white males who were initially hired between 1951 and 1979. RFANLA02 includes 9,490 workers employed between 1951 and

CEDR HOLDINGS PERTINENT TO THE ROCKY FLATS PLANT

Working Data File Set	
RFCHMW01	Five data sets
RFFACW02	Six data sets
Analytic Data File Sets	
RFANLA02	Two data sets
RFPLUA01	One data set
RFR04A01	One data set
Multi-facility*	
HFMULA02	Six data sets
MFF94A02	One data set
MFFEGWA1	Two data sets
MFI93A01	Fourteen data sets

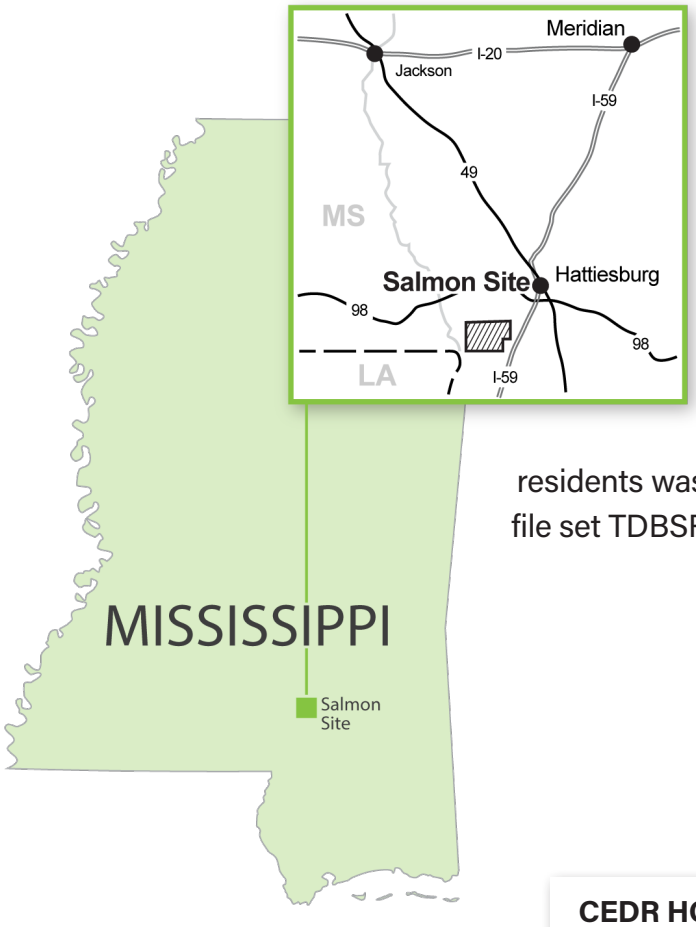
**Rocky Flats Plant workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

1979, and the vital status follow-up is through 1992. The file was created in anticipation of a cohort mortality study, but the study was never published. RFR04A01 contains the data for a nested case-control study of lung cancer mortality at Rocky Flats Plant. The final cohort included 16,248 workers who were employed for at least 6 months from 1952 to 1989. Workers in more than one data file set retain the same identifier.

Salmon Site

(previously Tatum Dome Test Site)

Lamar County, Mississippi, is the location of the Salmon Site, an underground salt dome, where two nuclear and two non-nuclear detonations occurred between the years 1964 and 1970. The Salmon Site is located in the piney woods area of the Gulf Coastal Plain, approximately 21 miles southwest of Hattiesburg, Mississippi. It is a large salt dome, about 5,000 feet in diameter and 1,500 feet below the ground surface. Upon completion of the testing program, the site was deactivated and decommissioned in June 1972.



A study of mortality among Lamar County residents was conducted and is contained in the analytic data file set TDBSRA01.

CEDR HOLDINGS PERTINENT TO THE SALMON SITE

Analytic Data File Sets	
TDBSRA01	One data set

Sandia National Laboratories

Sandia National Laboratory (SNL) headquarters and main laboratory are located near Albuquerque, New Mexico, at Kirtland Air Force Base. SNL was originally operated by the University of California until 1949, when Sandia Corporation, a subsidiary of American Telephone and Telegraph Company, took over operations. In 1993, Sandia Corporation became part of Lockheed Martin, which operated the facility. In May 2017, National Technology and Engineering Solutions of Sandia, a wholly owned subsidiary of Honeywell International, became the operating contractor.

SNL Albuquerque is the larger of the two laboratories compared with SNL Livermore (SNLL). Its major activities are in research, development, and engineering associated with the production of nuclear explosives for integrated, functional weapons used by the Department of Defense weapon delivery systems. Other areas of activities include energy efficiency research, development of technologies for remediation of contaminated sites, and technology transfer efforts. Employment usually runs at about 7,800 workers.

The smaller laboratory, SNLL, is also concerned with the design and evaluation of new and existing nuclear weapon systems. Other areas of interest are energy research, including combustion and fusion research, and research on nuclear and conventional weapons and space systems. Employment usually runs at about 1,000 workers.

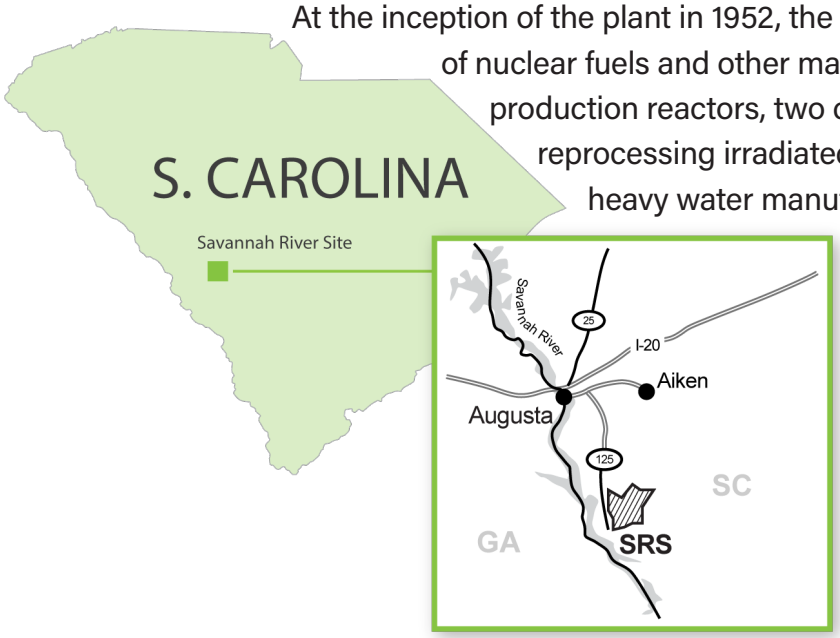
Demographic data for Sandia National Laboratories are included in ORISEWDS. SNL workers are also found in the MFF94A02 data file set, which is a multiple site study of workers with at least 5 rem of ionizing radiation within a calendar year. This study will be discussed in greater detail in the section on studies involving multiple sites.

CEDR HOLDINGS PERTINENT TO SANDIA NATIONAL LABORATORY

Multi-facility*	
MFF94A02	One data set

**Sandia National Laboratories workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

Savannah River Site



The Savannah River Site is located on 315 square miles near Aiken, South Carolina. At the inception of the plant in 1952, the primary process was the production of nuclear fuels and other materials. The facilities include five large production reactors, two chemical separation plants, plants for reprocessing irradiated nuclear fuel, a fuel fabrication plant, a heavy water manufacturing plant, and a variety of research and development laboratories. E.I. duPont de Nemours and Company was the original operating contractor until 1989, when the Westinghouse Savannah River Company assumed management of the operations. In 2008, Savannah River Nuclear Solutions was awarded the management and operation contract of Savannah River Site.

Working data for SRS are included in ORISEWDS. Two analytic data file sets support two cohort mortality studies of SRS workers. SRC88A01 supports a study that examines the overall and cause-specific mortality experience of 9,860 white males hired between 1952 and1974 and employed for at least 90 days during this time period. SRC94A02 supports an updated mortality study of the same 9,860 white male workers. Workers in more than one data file set retain the same identifier.

CEDR HOLDINGS PERTINENT TO THE SAVANNAH RIVER SITE

Working Data File Set	
ORISEWDS	Three+ data sets
Analytic Data File Sets	
SRC88A01	One data set
SRC94A02	Two data sets
Multi-facility*	
MFFEGWA1	Two data sets
MFMCHMA1	Seven data sets
MFMM98A1	Eight data sets
MFMM98W1	Seventeen data set
MFMM98W2	Eight data sets
MFMM98W3	Six data sets

**Savannah River Site workers also were included in some studies of workers at multiple DOE sites (see Page 49 for details).*

Studies Involving Multiple Sites

Some studies include workers from more than one DOE site. Nine analytic data file sets derived from such studies are included in CEDR.

- HFMULA02 supports a combined mortality study of 25,241 monitored white male workers at Hanford, Rocky Flats, and ORNL. The data file set includes the files for the original 1989 study, as well as the 1993 update.
- LAHSWA04 supports a mortality study of 7,466 white male and female workers at LANL of which 241 had a high exposure to plutonium.
- MFCLCCA1 is a case-control study with 233 participants investigating childhood leukemia and paternal radiation exposure among communities near the Hanford Site, Idaho Site, and Oak Ridge Site
- MFD94A01 consists of 12 files generated from a nested case-control study of respiratory cancer through 1982 for workers employed at three uranium processing or fabrication operations in Missouri, Ohio, and Tennessee. The DOE sites included in the study are the Y-12 facility, Mallinckrodt Chemical Works, and the Fernald Feed Materials Production facility. The data from Y-12 includes data collected from TEC and Union Carbine Corporation. These 12 analytic files contain information on 790 cancer cases and 790 matched controls.
- MFF94A02 consists of a single file generated from a retrospective cohort study of mortality and morbidity of 3,145 workers. This study cohort represents all workers throughout the United States who received at least 5 rem of penetrating ionizing radiation in one calendar year prior to 1979 while employed at DOE nuclear facilities or U.S. Navy nuclear reactor propulsion plants.
- MFFEGWA1 is a retrospective cohort mortality study of 65,984 black and white female workers at one or more DOE facilities.
- MFI93A01 consists of 14 files pertaining to the three U.S. nuclear sites included in an international study of cancer mortality among nuclear industry workers, conducted by the International Agency for Research on Cancer. The 14 files contain information on 44,106 workers included in the study from the Hanford Site, Oak Ridge X-10 Facility, and Rocky Flats Nuclear Weapons Plant.
- MFMCHMA1 supports the study evaluating the mortality experience of 6,157 male and female workers employed from 1943 to 1998 at the DOE Oak Ridge, Tennessee facilities (K-25, X-10, and Y-12) and the Savannah River Plant in South Carolina.

- MFMM98A1 is an epidemiologic case-control study of multiple myeloma among a cohort of 115,143 workers employed at the Hanford, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Savannah River sites and hired before 1979.

There are four working data file sets that used more than one DOE Facility.

- MFMM98W1 supports the Epidemiology of Multiple Myeloma at Four Department of Energy (DOE) Sites study (MFMM98A1) of workers hired prior to 1979 at Hanford, Los Alamos, Oak Ridge, and Savannah River.
- MFMM98W2 includes Los Alamos detailed external radiation data for the years 1944 to 1990, Oak Ridge film badge data, Oak Ridge neutron monitoring data, Oak Ridge results from pocket chambers, Savannah River film badge data, Savannah River external radiation data, and Savannah River results from pocket chambers.
- MFMM98W3 includes Hanford bioassay results, Los Alamos and Zia bioassay and plutonium bioassay results, Oak Ridge bioassay results, Savannah River bioassay results, and whole body counts.
- IISP18W1 is the injury data set that contains both occupational and non-occupational injuries at 16 DOE facilities. Non-occupational injuries reported to IISP were those involving an absence of 5 or more consecutive workdays or, at the discretion of the individual's supervisor, required a return-to-work (RTW) clearance from the site's occupational medicine examiner.

Analytic Data File Sets		Various DOE Sites
HFMULA02	Combined Mortality Data Study on Workers at the Hanford Site, Oak Ridge National Laboratory, and Rocky Flats Nuclear Weapons Plant	Hanford, Rocky Flats, and Oak Ridge
LAHSWA04	Analytic Health Study of Los Alamos, Zia Company, and Manhattan Project Workers, 1994	Hanford, Los Alamos National Laboratory (including Zia), Oak Ridge X-10 (Oak Ridge National Laboratory), Portsmouth Naval Shipyard
MFCLCCA1	Study of Childhood Leukemia and Paternal Radiation Exposure among Communities near Hanford Site, Idaho Site, and Oak Ridge Site	Hanford, Idaho, Oak Ridge K-25 (Gaseous Diffusion Plant), Oak Ridge X-10 (Oak Ridge National Laboratory), Oak Ridge Y-12

(Previous page's table continued below)

Analytic Data File Sets		Various DOE Sites
MFD94A01	Case-Control Study of Respiratory Cancer at Uranium Facilities at Tennessee Eastman Corporation (TEC) and Y-12 facilities in Oak Ridge; Mallinckrodt Chemical Works (MCW) in St. Louis and Weldon Springs, Missouri; and the Feed Materials Production Center (FMPC) in Fernald, Ohio	Fernald, Mallinckrodt Chemical Works, Oak Ridge Y-12, Oak Ridge Tennessee Eastman Company
MFF94A02	Mortality and Morbidity Study of 5-rem Workers at 23 Department Of Energy (DOE) facilities	Workers at various facilities with 5 rem exposure
MFFEGWA1	Mortality Study Among Female Nuclear Weapons Workers at Los Alamos National Laboratory; Zia Company; Rocky Flats; Hanford; Mound; Savannah River; Oak Ridge X-10; Y-12; and K-25; Fernald; Linde; and Pantex	Fernald, Hanford, Linde, Los Alamos, Mound, Oak Ridge K-25 (Gaseous Diffusion Plant), Oak Ridge X-10 (Oak Ridge National Laboratory), Oak Ridge Y-12, Pantex, Rocky Flats, Savannah River, Zia
MFI93A01	International Agency for Research on Cancer (IARC) Cohort Study of Nuclear Workers in the US, UK, and Canada, 1994	Oak Ridge K-25 (Gaseous Diffusion Plant), Oak Ridge X-10 (Oak Ridge National Laboratory), Oak Ridge Y-12, Savannah River
MFMCHMA1	Cohort Mortality Study of Chemical Laboratory Workers at Department of Energy Nuclear Plants	Oak Ridge K-25 (Gaseous Diffusion Plant), Oak Ridge X-10 (Oak Ridge National Laboratory), Oak Ridge Y-12, Savannah River
MFMM98A1	Epidemiologic Study of Multiple Myeloma at Hanford, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Savannah River Sites	Hanford, Los Alamos, Oak Ridge X-10 (Oak Ridge National Laboratory), Savannah River
Working Data File Sets		**Various DOE Sites**
MFMM98W1	Chemical and Physical Hazards Assessment Working Data for Hanford, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Savannah River Sites	Hanford, Los Alamos, Oak Ridge X-10 (Oak Ridge National Laboratory), Savannah River
MFMM98W2	Detailed External Radiation Monitoring Working Data for Hanford, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Savannah River Sites	Hanford, Los Alamos, Oak Ridge X-10 (Oak Ridge National Laboratory), Savannah River
MFMM98W3	Detailed Internal Radiation Monitoring Working Data for Hanford, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Savannah River Sites	Hanford, Los Alamos, Oak Ridge X-10 (Oak Ridge National Laboratory), Savannah River
IISP18W1	Illness and Injury Surveillance Program - Injury data set	Workers at 16 participating U.S. Department of Energy (DOE) sites and facilities

APPENDIX A

Working Data File Sets Health and Mortality Studies

PNL & HEHF (Hanford)

- **HFSRCW01 Data File Set**

Description

This working data file set, prepared by PNL, consists of seven working files for Hanford operations and construction workers during 1944 to 1989 and was used as data sources for the 1992 Hanford Mortality Study (HMS) database.

Job histories, external radiation data, internal deposition data, mortality information, and the 1979 master data file are provided by the Health Risk Assessment Department (HRAD) of PNL for individuals employed at Hanford. The master data file was generated by HRAD in 1979. The contents of the other working files are supplied as received from either the Operations Analysis Department of HEHF or the Health Physics Department (HPD) of PNL. These seven files are defined as source files in the PNL Technical Report No. PNL-8449, Description of the Process Used to Create the 1992 Hanford Mortality Study Database (E.S. Gilbert, et al., December 1992). Each one was a data source used by HRAD to generate the working files in the HFW89W01 data file set that were used to create the 1992 Hanford Mortality Study database.

Occupational data for Hanford employees, and mortality information for former employees, are collected, maintained, and periodically updated by HEHF. External radiation exposure data, estimated from personal dosimeters, are routinely collected and maintained by HPD. Exposure data from internal monitoring are also routinely collected and evaluated by HPD for employees who worked in locations where there was a potential for intake of radioactive material (transuranics).

- HFSRCW01_d1 (OHH88_OP) is an unedited working file of 1944 to 1988 job histories for all individuals, other than those employed only as construction workers, initially employed at Hanford from 1944 to 1983 by DOE contractors. These individuals are referred to as operations workers. This file was generated from the occupational health history (OHH) file received from HEHF in 1988. Each individual in the OHH file had one personnel identification record and usually several work history records. A work history record was created each time certain job changes occurred. HFSRCW01_d1 (OHH88_OP) has a total of 484,527 records for the 52,522 operations workers that had job histories.

- HFSRCW01_d2 (OHH88_CO) is an unedited working file of 1944 to 1988 job histories for all individuals initially employed at Hanford from 1944 to 1983, only as construction, DOE, or site service workers. This file was generated from the OHH file received from HEHF in 1988. HFSRCW01_d2 (OHH88_CO) has a total of 8,651 records for the 2,285 non-operations workers that had job histories.
- HFSRCW01_d3 (ORE_44) is an unedited working file of external dosimetry data for workers initially employed at Hanford in the years 1944 to 1982. This file of occupational radiation exposure (ORE) data, which includes off-site occupational exposures, was received from HPD in 1990. HFSRCW01_d3 (ORE_44) has a total of 333,020 records for the 33,092 workers that were monitored.
- HFSRCW01_d4 (ORE_83) is an unedited working file of external dosimetry data for workers initially employed at Hanford in the years 1983 to 1989. This file of ORE data, which includes off-site occupational exposures, was received from HPD in 1990. The type of dosimetry information provided differs from the information available for the years 1944 to 1982. HFSRCW01_d4 (ORE_83) has a total of 151,022 records for the 16,821 workers that were monitored.
- HFSRCW01_d5 (INDEP) is an unedited working file of internal deposition data for Hanford workers with confirmed internal depositions of various radionuclides, including plutonium, in the years 1944 to 1989. This file was received from HPD in 1991. HFSRCW01_d5 (INDEP) has a total of 624 records for 560 workers.
- HFSRCW01_d6 (HMO91) is an unedited working file of mortality data for former Hanford workers identified as dying in the years 1944 to 1991. This file was received from HEHF in 1991. HFSRCW01_d6 (HMO91) has one record for each of the 10,922 deceased workers.
- HFSRCW01_d7 (MST79) is the master data file consisting of merged information about job histories, external dosimetry, internal depositions, and mortality data for operations workers initially employed at Hanford in the years 1944 to 1978. A detailed account of the process used to create this file is described in Appendix A of the referenced technical report. HFSRCW01_d7 (MST79) has one record for each of the 44,101 operations workers that had job histories.

Citations

Buschbom, R.L., Gilbert, E.S., Summary of Recorded External Radiation Doses for Hanford Workers 1944-1989. October, 1993. Pacific Northwest Laboratory (PNL). Pacific Northwest Laboratory No. PNL-8909

Gilbert, Ethel S., Buchanan, Jeffrey A., Holter, N.A., Description of the Process Used to Create 1992 Hanford Mortality Study Database. 1992. Pacific Northwest Laboratory (PNL). PNL Technical Report No. PNL-8449.

HFW89W01 Data File Set
Description

- The HFW89W01 working data file set, prepared by the Epidemiology and Biometry Department (EBD) of PNNL for mortality studies of operations workers initially employed at the Hanford Facility between 1944 and 1978, consists of seven working files: three files of demographic, dosimetry, and mortality data; and four additional files for workers in the study population but excluded from study analyses.
- Data were obtained in various formats and media from the facilities where the workers were employed and from several other agencies, including the HEHF and the Social Security Administration. The files in HFW89W01 originated as part of the EBD database of information supporting their mortality studies of operations workers at Hanford, several of which were completed in 1992.
- JOB89, DOS89, and INT89 were prepared for studies of 1944 to 1989 operations workers. The three ADD89 files are for 125 operations workers excluded from the study due to questions regarding their mortality ascertainment. MORT93 includes operations and construction workers dying in the years 1944 to 1993.
- The first three files in the HFW89W01 working data set are roughly segregated by the following types of data: demographic, external radiation dosimetry, and internal monitoring results. Data pertaining to an individual that appear in one or more files may be linked together by use of the individual pseudo-identifier number that was assigned to each worker. To help ensure data integrity, similar data from various sources and files, such as those in the HFC78A01, were compared for inconsistencies. Discrepancies were resolved with assistance from the appropriate department or organization.
- HFW89W01_d1 (JOB89) is an edited working file of job histories, including demographic data, for the years 1944 to 1988. Occupational health history data for operations workers were received from HEHF in 1988. Social class was assigned by HRAD using Bureau of Census job codes modified to correct inconsistencies between recorded job descriptions and assigned codes. These modifications did not correct all inconsistencies, but they did correct those that occurred frequently. They also corrected those that were important for use in assigning social class and designating special categories of nuclear workers. Sequential entries for periods of continuous employment in which the social class code did not change were combined. Sequential entries were also combined if the time interval between the termination code and the next code was less than 1 month. HFW89W01_d1 (JOB89) contains a total of 94,176 records for the 44,408 workers that had job histories.

- HFW89W01_d2 (DOS89) is an edited working file of external dosimetry data, including demographic data, for the years 1944 to 1989. Occupational radiation exposure data for operations workers and construction workers, including off-site exposures, were received from the HPD of PNL in 1990. The HPD is responsible for radiological protection and monitoring services for the entire Hanford Site. Data for construction workers were excluded by HRAD. However, doses received by operations workers while performing construction work were retained. For each worker, whole-body dose was calculated for each year using on-site dose estimates. Comparisons were made with the master data file created in 1979 and the occupational health history data received from HEHF in 1988. Discrepancies were resolved by HPD. HFW89W01_d2 (DOS89) has a total of 429,794 records for the 45,495 workers that were monitored.

- HFW89W01_d3 (INT89) is an edited working file of internal deposition data for the years 1944 to 1989. Data on workers with confirmed internal depositions of plutonium or other radionuclides were received from HPD in 1991. These data were edited by HRAD for missing information and for workers with multiple entries. Additions and corrections were determined by HPD. Comparisons were made with the master data file created in 1979 and the key file containing identifying information for workers in the study population. Discrepancies were noted, and they were resolved by HPD. HFW89W01_d3 (INT89) has one record for each of the 560 workers with depositions.

- ADD89 consists of three edited working files: HFW89W01_d4 (ADD89_1), HFW89W01_d5 (ADD89_2), and HFW89W01_d6 (ADD89_3). Using the International Agency For Research on Cancer (IARC) protocol, these files were constructed in the same manner as IARC89_1, IARC89_2, and IARC89_3 (see HFI89A01 analytic data file set description). The 125 workers in these files were judged to be members of the study population, but they were not included in analyses of this population because there are questions about the adequacy of their mortality ascertainment. These questions involve primarily multiple social security numbers for the same worker or a worker's absence on the 1988 Occupational Health History files that serve as the basis for mortality follow-up. The study population is defined as individuals employed as operations workers prior to 1979, excluding the workers on ADD89 (HFI89A01 includes only members of this study population).

- The fourth working file, HFW89W01_d4 (add89_1), the first additional file, contains demographic, internal dosimetry, and mortality data for workers in the Hanford study population excluded from study analyses due to questions regarding the adequacy of their mortality ascertainment. This file, constructed using the IARC protocol, contains one record for each of 125 individuals initially employed at Hanford, by DOE contractors, as operations workers in the years 1944 to 1978.

- The fifth working file, HFW89W01_d5 (add89_2), the second additional file, contains external dosimetry data for workers in the Hanford study population excluded from study analyses due to questions regarding the adequacy of their mortality ascertainment. There are one or more records in this file for each of 107 individuals initially employed at Hanford, by DOE contractors, as operations workers in the years 1944 to 1978.
- The sixth working file, HFW89W01_d6 (add89_3), the third additional file, contains additional variables, not specified in the IARC protocol, for workers in the Hanford study population excluded from study analyses due to questions regarding the adequacy of their mortality ascertainment. There is one record in this file for each of 125 individuals initially employed at Hanford, by DOE contractors, as operations workers in the years 1944 to 1978.
- More detailed information about EBD's preparation of these working files can be found in the PNL report, PNL-8449.
- HFW89W01_d7 (MORT93), the seventh working file, consists of coded and edited mortality data for former Hanford operations and construction workers identified as dying in the years 1944 to 1993. This file was prepared by HEHF in 1993 and requested by HRAD in January 1995. Data discrepancies were identified by HRAD and resolved by HEHF. HFW89W01_d7 (MORT93) has one record for each of the 14,236 deceased workers (666 additional workers have been identified as dying in these years; however, cause-of-death data are not currently available for these individuals).

Citations

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LANL (Los Alamos/Zia)

▪ LAMULW02 Data File Set

Description

The LAMULW02 working data file set, prepared by LANL, consists of nine working files prepared for epidemiologic studies of workers at LANL during 1944 to 1978 and at the Zia Company (Zia), the principal subcontractor to LANL, from 1946 to 1986.

The LAMULW02 data file set consists of nine related working files that were received from the Epidemiology Section at the Los Alamos National Laboratory for mortality studies of workers employed at LANL and/or Zia. Data were obtained in various formats and media from different LANL and Zia departments and other agencies. Personnel data (through December 31, 1978) were abstracted from copies of four personnel record sources. Supplemental data were obtained from LANL's security badge book, personnel security questionnaires, and personnel records from other employers under study by LANL. Death information was abstracted from death certificates obtained from various states. Computerized external ionizing radiation data, plutonium bioassay results, and estimated plutonium body burdens were obtained from the LANL Health Physics Department, which is responsible for radiation monitoring for all subcontractor personnel at LANL.

The data files in the LAMULW02 data file set are segregated by type of data: demographic, external exposure, plutonium bioassay results, and plutonium depositions. Data pertaining to an individual that appear in one or more files may be linked by the individual identification number assigned to each worker.

- The file LAMULW02_d1 contains demographic information for LANL employees, including birth and death dates, race, sex, educational level, dates of employment, first and last job titles, coded cause of death, and other vital status information. The data in this file pertain to 23,241 workers hired between 1943 and 1977, as well as a few later hires. The file includes 6,803 females, 16,317 males, and 120 workers with unknown sex. Race was determined for 68% of the workers. Vital status was last ascertained in 1992 through the NDI, with information available from 1979 through 1990. Most death information prior to 1984 was obtained through the SSA. There are 4,170 deaths identified in this file. ICDA codes are missing for 15 records. LAMULW02_d1 contains one record per person.

- The file LAMULW02_d2 contains demographic information for Zia employees, including birth and death dates, race, sex, education, limited work histories, a flag for external monitoring as of 1985, coded cause of death, and other vital status

information. Data in this file pertain to 15,311 workers hired during the years 1946 to1978, as well as a few later hires. The file includes 469 females, 11,215 males, and 3,627 workers with unknown sex. Race was ascertained for 75% of the workers. Only the information for the radiation monitored subset of this cohort has been edited. Vital status was last ascertained in 1992 through the NDI, with information available from 1979 through 1990. Most death information prior to 1984 was obtained through the SSA. There are 5,216 deaths identified in this file. ICDA codes are missing for two records. Most fields have been edited only for the radiation monitored subset of the Zia cohort. This file contains one record per person.

- The file LAMULW02_d3 contains annual external radiation exposure data from 1944 through 1979 measured using film dosimeters. Data consist of annualn whole-body dose, annual penetrating gamma dose, annual non-penetrating gamma dose, beta dose, tritium dose, and fast and thermal neutron doses. Readings in centirem for all monitored Zia employees, LANL employees, other contract employees, and visitors total 175,416. LANL and Zia workers hired prior to 1978 have identification numbers consistent with other CEDR data file sets. This is not the case for most Zia or LANL workers hired after 1978 and all other contract workers and visitors. There are readings on this file through 1985, but only readings prior to 1980 should be used. Revised exposure data beyond 1979 are available in the file LAMULW02_d4. The tritium data have also been revised and are available in the file LAMULW02_ d8. The LAMULW02_d2 file contains one record per person per year of monitoring.

- The file LAMULW02_d4 contains external ionizing radiation data from the period 1980 through 1990 measured using thermoluminescent dosimeters. These data have been revised and replace the data beyond 1979 in LAMULW02_d3. There are 843,496 records in this file. Included are badge readings taken at varying time intervals (annual, semi-annual, quarterly, etc.). Data consist of whole-body dose, tritium dose, shallow dose, penetrating dose, and an albedo neutron dose. Data are available for Zia, LANL, all visitors, and other contractors working at LANL during this period. Most Zia or LANL workers hired after 1977, visitors, and other contractors do not have any identification numbers in this file. The tritium data in this file are revised and accurate, and they are duplicated for the years 1980 to 1988 in the file LAMULW02_d8.

- LAMULW02_d5 contains plutonium bioassay data from 1944 through October 1985. The file contains 43,693 records for the LANL and Zia workers monitored for internal radiation exposure. Data have been normalized from their original form.

- The file LAMULW02_d6 contains estimated plutonium whole-body burdens as of January 1, 1987. There are 16,315 records. Results are given separately for the two isotopes of plutonium (238 and 239) in units of nanocuries (nCi) and nCi- years. The computer code PUQFUA was utilized at LANL to estimate plutonium body burdens using bioassay data. Data are available for LANL, Zia, visitors, and other contract workers in this file; however, only LANL and Zia workers have individual identification numbers consistent throughout CEDR data file sets.
- The file LAMULW02_d7 contains estimated plutonium whole-body burdens as of January 1, 1985. There are 14,935 records. Results are given separately for the two isotopes of plutonium (238 and 239) in units of nCi and nCi-years. The computer code PUQFUA was used to generate these estimates using bioassay data. LANL and Zia workers have individual identification numbers consistent throughout CEDR data file sets.
- The file LAMULW02_d8 contains 6,662 revised annual tritium readings available from 1950 to 1988. These readings replace any readings available in the file LAMULW02_d3 for the years 1950 to 1988. The tritium readings for the years 1980 to 1988 are duplicated in the file LAMULW02_d4. LANL and Zia workers have individual identification numbers consistent throughout CEDR data file sets.
- The file LAMULW02_d9 contains dates of exposure to 2, 5, and 10 nCi of plutonium-238 and plutonium-239, with data available through December 31, 1986. Data were abstracted from hard copy records. Data are available for 726 workers from LANL, Zia, and other contractors in this file; however, only LANL and Zia workers have individual identification numbers consistent throughout CEDR data file sets.

Citations

No data available.

MALLINCKRODT

▪ MCG19W01 Data File Set

Description

Mallinckrodt Chemical Works was the earliest uranium processing facility in the United States, and in 1942 produced the uranium oxide used for the first sustained and controlled nuclear fission chain-reaction at the University of Chicago. A vital status follow-up through 2012 was conducted of 2,514 white male workers employed 1942 to 1966 at the MCW for dose-response analyses for selected causes of death. The cohort was the same as used in the first analysis with follow-up through 1993 (Ellis 2000). Organ/tissue-specific dose reconstruction included both external (12,686 MCW film badge records, 210 other facility film badge records, and 31,297 occupational chest x-rays) and internal sources of uranium and radium (39,451 urine bioassays, 2,341 breath radon measurements, and 6,846 ambient radon measurements). Dust measurements from pitchblende facilitated quantitative risk estimates for non-radiogenic effects on the lung and kidney. Vital status was determined from multiple sources including the National Death Index and the Social Security Administration.

Vital status was determined for 99% of the workers, of whom 75% had died. The mean lung dose from all sources of external and internal radiation combined was 69.9 milligray (mGy) (maximum 885 mGy; percent workers >100 mGy, 10%), and there was no evidence for a dose response for lung cancer (Hazard Ratio [HR] of 0.95 [95% confidence interval (CI) 0.81–1.12] at 100 mGy). A significant association with radiation was found for kidney cancer (HR of 1.73 [95% CI 1.04–2.79] at 100 mGy) and suggested for non-malignant kidney diseases (HR of 1.30 [95% CI 0.96–1.76] at 100 mGy). A non-radiation etiology could not be discounted, however, because of the possible renal toxicities of uranium, a heavy metal, and silica, a component of pitchblende dust. Non-significant HRs at 100 mGy for other sites of a priori interest were 0.36 (0.06–2.03) for leukemia other than chronic lymphatic leukemia (CLL), 0.68 (0.17–2.77) for liver cancer, and 1.23 (0.79–1.90) for non-Hodgkin lymphoma. The HR at 100 mGy was 1.09 (0.99–1.20) for ischemic heart disease. An association was seen between dust and combined malignant and non-malignant lung disease, HR at 10mgm^-3year^-1 of 1.01 (1.00–1.02).

A positive radiation dose response was observed for malignant and non-malignant kidney disease, and a negative dose response for malignant and non-malignant lung disease. Cumulative measures of dust were significantly associated with malignant and non-malignant lung disease and suggested for malignant and non-malignant kidney disease. Small numbers preclude definitive interpretations, which will await the combination with similar studies of early uranium processing workers.

- The file Deconstructed doses (MCG19W01_d1) contains 121,375 records and covers 1942 through 1968 exposures. Dosimetry data are separated by organ and by external radiation, high linear energy transfer (LET) internal radiation, and low LET internal radiation. Organs and tissues included in the dosimetry are brain, heart, lung, kidney, colon, and red bone marrow. The Person Data (MCG19W01_d2) has 2,514 people and contains information on their date of birth, vital status and underlying cause of death for select outcomes, year of hire, and pay code for first job title.

Citations

No data available.

LANL (Mound)

MDFACW02 Data File Set

Description

This working data file set, prepared by the Epidemiology Section at the Los Alamos National Laboratory, Occupational Medicine Group, consists of four working files prepared for epidemiologic studies of workers at the Mound Plant in Ohio during 1941 to 1979.

Data were obtained in various formats and media from Mound departments and other agencies. Demographic data were abstracted from employment record cards and employee information sheets provided by the Personnel Department at Mound. Supplemental data were obtained from the SSA 941A forms, Mound medical records, and Mound health physics records. Death information was abstracted from death certificates obtained from various states. External ionizing radiation exposure and polonium bioassay data, in hard copy, were provided by the Health Physics Department at Mound.

The four files in the MDFACW02 data file set are segregated by type of data: demographic, work history, external exposure, and polonium bioassay results. Data pertaining to an individual that appear in one or more files may be linked by the individual identification number assigned to each worker.

- The first working file, MDFACW02_d1, contains demographic information, including race, sex, and birth date; education; employment period; and death information, such as underlying cause-of-death (ICDA8), date of death, and state of death, for 6,881 male and female workers hired between 1941 and 1979. The file includes 1,692 females, 5,182 males, and 7 with unknown sex. Race was determined for 88%

of the workers. Death information was last obtained in 1992 using a submission to the NDI, which provided the death records from 1979 through 1990. There are 1,730 deaths identified in this working file. Cause-of-death information (ICDA8) is not available for three deaths. The last effort to obtain confirmed vital status information for the entire cohort was also conducted in 1992 with a submission to the TRAX service followed by mail and phone tracing. Vital status was confirmed for 90% of the cohort through January 1, 1989.

- The second working file, MDFACW02_d2, contains occupational histories from 1941 through 1981 for 6,771 employees. There are 20,977 records in the file. The file includes dates started on the job, the verbatim job title used by Mound, and an alphanumeric job code used by Mound that was associated with each job title. For approximately one-third of the cohort, some single employment intervals were mistakenly coded as two distinct periods of employment. This information has never been used in any studies and should be revised before use.
- The third working file, MDFACW02_d3, contains the external ionizing radiation exposure data. There are 32,351 records for 4,081 identified individuals and 438 records for individuals not assigned an identification number. The years covered by this file are 1947 through 1979. The variables include annual neutron, tritium, and whole-body dose in millirem (mrem) incurred while working at the Mound Plant and those received prior to employment at Mound.
- The fourth working file, MDFACW02_d4, contains results of polonium urine bioassays between March 30, 1944, and June 5, 1984. There are 201,652 records for 2,788 individuals. The data include the date of the sample, polonium activity in the sample (count per minute), volume of urine in the sample (milliliters), and any comments about the particular sample or its results.

Citations

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Wiggs, L. D., Cox-DeVore, C. A., Voelz, G. L. Mortality Among a Cohort of Workers Monitored for Po-210 Exposure: 1944-1972 (polonium 210). 1991. Health Physics. 61(1):71-76

Wiggs, Laurie D., Cox-DeVore, Carol A., Wilkinson, Gregg S., Reyes, Michele -- Los Alamos National Laboratory (LANL). Mortality Among Workers Exposed to External Ionizing. Radiation at a Nuclear Facility in Ohio. May, 1991. Journal of Occupational Medicine. 33(5):632-637

MULTIPLE MYELOMA

▪ MFMM98W1 Data File Set

Description

This working data file set, prepared by the University of North Carolina at Chapel Hill, consists of 17 files (MFMM98W1_d1 through MFMM98W1_d17) that support the Epidemiology of Multiple Myeloma at Four Department of Energy (DOE) Sites study (MFMM98A1) of workers hired prior to 1979 at Hanford, Los Alamos, Oak Ridge National Laboratory, and Savannah River. MFMM98W1 was used in conjunction with MFMM98W2 and MFMM98W3 for the multiple myeloma study.

For each of the four sites included in the study, there are three files: inventory of chemical and physical agents, building lists, and industrial hygiene data. In addition, there is one file of references used for exposure assessment (MFMM98W1_d13) and another file listing chemicals by name and Chemical Abstract Service (CAS) number (MFMM98W1_d1).

Citations

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Case Control Study of Multiple Myeloma Among Workers Exposed to Ionizing Radiation and Other Physical and Chemical Agents, Final Technical Report. March 26, 1997 (rev. January 15, 1998). Department of Epidemiology, School of Public Health, University of North Carolina, National Institute for Occupational Safety and Health (NIOSH). 200-93-2628

▪ MFMM98W2 Data File Set

Description

This working data file set, prepared by the University of North Carolina at Chapel Hill, consists of 8 files that support the Epidemiology of Multiple Myeloma at Four Department of Energy (DOE) Sites study (MFMM98A1) of workers hired prior to 1979 at Hanford, Los Alamos, Oak Ridge National Laboratory, and Savannah River. MFMM98W2 was used in conjunction with MFMM98W1 and MFMM98W3 for the multiple myeloma study.

These files include Los Alamos detailed external radiation data for the years 1944 to 1990 (MFMM98W2_d1 and MFMM98W2_d2), Oak Ridge National Laboratory film badge data (MFMM98W2_d3), Oak Ridge National Laboratory neutron monitoring data (MFMM98W2_d4), Oak Ridge National Laboratory results from pocket chambers (MFMM98W2_d5), Savannah River film badge data (MFMM98W2_d6), Savannah River external radiation data (MFMM98W2_d7), and Savannah River results from pocket chambers (MFMM98W2_d8).

Citations

No data available.

▪ MFMM98W3 Data File Set

Description

This working data file set, prepared by University of North Carolina at Chapel Hill, consists of six files that support the Epidemiology of Multiple Myeloma at Four Department of Energy (DOE) Sites study (MFMM98A1) of workers hired prior to 1979 at Hanford, Los Alamos, Oak Ridge National Laboratory, and Savannah River. MFMM98W3 was used in conjunction with MFMM98W1 and MFMM98W2 for the multiple myeloma study.

These files include Hanford bioassay results (MFMM98W3_d1), Los Alamos and Zia bioassay results (MFMM98W3_d2), LANL and Zia bioassay results for plutonium only (MFMM98W3_d3), Oak Ridge National Laboratory bioassay results (MFMM98W3_d4), Savannah River bioassay results (MFMM98W3_d5), and whole-body counts from each site (MFMM98W3_d6).

Citations
No data available.

NEVADA TEST SITE

▪ NTORPW03 Data File Set

Description

This working data file set, prepared by Desert Research Institute, consists of four files generated for a 1951 to 1975 dose reconstruction called the Off-Site Radiation Exposure Review Project (ORERP) at the NTS.

The Department of Energy began ORERP in 1979 with two major objectives. The first objective was to collect and organize at one central location all available documents and data pertaining to off-site fallout from weapons testing and make this information accessible to the public. This was achieved by the establishment of the Center for Information and Coordination.

The second objective was to reevaluate the radiation dose that off-site residents received from nuclear testing at the NTS, based on their age, occupation, and place of residence. This required the development of computer models for the transport of radionuclides from their deposition on the ground or vegetation to the ingestion by humans through food and for organ doses resulting from ingestion, inhalation, or deposition on the skin. Also, the models required various data relating to fallout transport and population demographics as input. Four of the basic data files used as input to these dose estimation models were the Town Data Base file NTORPW03_d1

(TOWNDB), the County Data Base file NTORPW03_d2 (CNTYDB), and the Lifestyle Survey Data Base files NTORPW03_d3 and NTORPW03_d4 (LFSDEMOG and LFSFARM).

The Town and County Data Bases provided the models with estimates of exposure rate (mR/hr) at 12 hours after each detonation or event (H+12) and time (hr) of arrival of the fallout cloud. Each record represents the estimates made at a given location for a given nuclear event where there was significant deposition from NTS. The estimates from these data bases were used in dose reconstruction based on the residence history. The data bases differ in the region covered, the resolution of the locations for which estimates were made, and the type of data available for making the estimates. The record format for the data bases is basically identical.

ORERP divided its study area into two phases. The Phase I region covered the area closest to NTS and included Clark, Esmeralda, Lincoln, and Nye Counties in Nevada and Washington County in Utah. The Phase II region covered Arizona, New Mexico, Nevada, Utah, western Colorado, southwestern Wyoming, southern Idaho, southeastern Oregon, and southeastern California, excluding any counties in the Phase I region.

The estimates in the Town Data Base file were based primarily on post-shot monitoring measurements made with survey meter instruments and on fallout patterns. There are 1,910 records covering 353 locations in Arizona, California, Nevada, and Utah and 74 events. There are 1,575 records that fall in the Phase I region covering 173 locations that were used directly in making dose estimates. The remaining 335 records fall into Phase II, which is also covered by the County Data Base.

The County Data Base file contained estimates for each of 142 counties or county segments for 55 nuclear events. The data sets used as input for developing these estimates included, but were not limited to, the gummed-film data, the Town Data Base, fallout patterns, air sampling data, air-mass trajectories, precipitation data, thermoluminescent dosimeters, measurements in bricks, and historical and contemporary soil analyses.

Information about lifestyles and agricultural practices in affected areas for the period in question was also important for the dose reconstruction. These data were collected to estimate lifestyle parameters when not specifically available and to help understand the relationships between variables in the models' development. These data were based on personal surveys taken in 10 counties in Nevada, Utah, and Arizona with most of the surveys taken in the Phase I region, specifically in Lincoln, Nye, and Washington Counties.

The Lifestyle Survey data consists of two data files: NTORPW03_d3 and NTORPW03_d4 (LFSDEMOG and LFSFARM). NTORPW03_d3 (LFSDEMOG) contains surveys of 910 unnamed individuals who lived in these 10 counties during the 1951 to 1962 period. It includes demographic data, as well as daily consumption for 15 food types. NTORPW03_d4 (LFSFARM) contains data for 267 of these individuals, representing 226 farms, who had direct information about agricultural practices at that time. The data describe the planting, harvesting, and consumption practices for crops, as well as the feeding, slaughtering, and distribution practices for various animals and animal products.

Citations

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ORISE (Multiple Facilities)

▪ ORISEWDS Data File Set

Description

The ORISEWDS working data file set is comprised of a collection of working files that were developed by the Center for Epidemiologic Research (CER), Medical Sciences Division, Oak Ridge Institute for Science and Education (ORISE). CER obtained these data in various formats and media from the K-25, X-10, Y-12, Linde, Savannah River, Mallinckrodt, and Fernald facilities, where the workers were employed, and from several other agencies, such as the Social Security Administration. To ensure the integrity of the data in the transcription from hard copy to electronic media, a double-entry method was used whereby one person entered the data and a second person entered the same data for verification purposes.

The files in the ORISEWDS working data set originated as part of CER's data model, a relational database of epidemiologic data. Most of the files contain a large volume of data, which usually pertain to more than one site or facility, and are maintained in a relational database management system. This design provides efficient data storage and facilitates the frequent addition of new or corrected data. The dynamic nature of the data model means that the working files comprising the ORISEWDS data file set are

a snapshot of the files at CER and that subsequent updates that will be placed in CEDR may be different from the current working files in the ORISEWDS data file set.

The files in the ORISEWDS are roughly segregated by type of data rather than by facility. Each worker has been assigned a unique pseudo-identification number that can be used to relate data that may appear in a number of files. This allows users to compile all data for a given individual or cohort.

There are 11 files in the ORISEWDS data file set that primarily contain demographic and work history data.

They are:

- ORISEWDS_d1 (MR),
- ORISEWDS_d2 (EMP),
- ORISEWDS_d3 (PAYCD),
- ORISEWDS_d4 (JOB),
- ORISEWDS_d5 (DEPTCD),
- ORISEWDS_d6 (MVITAL),
- ORISEWDS_d7 (DEATH),
- ORISEWDS_d70 (DEATH_OTHER_CAUSES),
- ORISEWDS_d8 (ERROR),
- ORISEWDS_d9 (FIXED), and
- ORISEWDS_d10 (MERGED).

The MR (master roster) file contains one record per person. All other files may have multiple records, or no records, for an individual, depending on the type and availability of the data. The remaining working files in the ORISEWDS data file set contain data relating to personal radiation monitoring information that were obtained from various facilities at which the individual worked. Due to the volume and nature of these data, they are segregated by facility and by type of monitoring, such as external monitoring, whole-body counting, and urinalysis results. The individual identification numbers in these files allow these data to be linked to pertinent data that may appear in other files in the ORISEWDS data file set. Therefore, the proper combination of files will provide a complete picture of data for an individual or for a particular cohort of interest. More

detailed information about each of the working files in the ORISEWDS data file set is provided in the file-level structured documentation.

These working data include three files concerning the Fernald site.

- File ORISEWDS_d11 (FMPCFB) contains Fernald film badge data,
- File ORISEWDS_d12 (FMPCWBC) contains whole-body count data, and
- File ORISEWDS_d13 (FMPCURIN) contains urinalysis data.

Similarly, three working data files each are included concerning the K25 site and the X10 site.

- File ORISEWDS_d14 (K25EXT) contains external monitoring data,
- File ORISEWDS_d15 (K25WBC) contains whole-body count data, and
- File ORISEWDS_d16 (K25URIN) contains urinalysis data.
- File ORISEWDS_d17 (X10EXT) contains external monitoring data,
- File ORISEWDS_d18 (X10WBC) contains whole-body count data, and
- File ORISEWDS_d19 (X10URIN) contains urinalysis data.

The Y12 site is described by five files:

- ORISEWDS_d20 (Y12EXT5080) contains external monitoring data for 1950 to 1980,
- ORISEWDS_d21 (Y12EXT8184) contains external monitoring data for 1981 to 1984,
- ORISEWDS_d22 (Y12EXT8588) contains external monitoring data for 1985 to 1988,
- File ORISEWDS_d23 (Y12WBC) contains whole-body count data,
- File ORISEWDS_d24 (Y12URIN) contains urinalysis data, and
- File ORISEWDS_d25 (LINDEFB) contains external monitoring data.

Four working data files are included concerning the Savannah River site.

- File ORISEWDS_d26 (SRABSTRACTED) is a subset of SRS exposure/monitoring data.
- ORISEWDS_d28 (SRHPAREA1) and
- ORISEWDS_d29 (SRHPAREA2) contain Savannah River monitoring data.
- File ORISEWDS_d27 (SRFAYERWETHER) contains additional dosimetry data.

Four working data files are included concerning the Mallinckrodt Chemical Works site.

- File ORISEWDS_d30 (MCW_FB) includes film badge data,
- ORISEWDS_d31 (MCW_URIN) is a urinalysis file,
- ORISEWDS_d32 (MCW_X-RAY) has X-ray data, and
- ORISEWDS_d33 (MCW_BRTHRADON) has radon breathing zone data.

16 working data files ORISEWDS_d34 through ORISEWDS_d49 contain information as reflected by the file name.

- ORISEWDS_d34 - K25 TLD 1989 - 1991,
- ORISEWDS_d35 - K25 TLD 1991 - 1998,
- ORISEWDS_d36 - tblK25 Urinalysis 1991-1993,
- ORISEWDS_d37 - tblK25 Bioassay 1994-1998,
- ORISEWDS_d38 - tblK25 WBC 1989-1991,
- ORISEWDS_d39 - tblK25 Invivo 1991-1993,
- ORISEWDS_d40 - tblORNL TLD 1989-1991,
- ORISEWDS_d41 - tblORNL TLD 1992-1998,
- ORISEWDS_d42 - tblORNL Urinalysis 1992-1998,
- ORISEWDS_d43 - tblORNL WBC 1989-1991,
- ORISEWDS_d44 - tblORNL WBC 1992-1998,

- ORISEWDS_d45 - tblY12 Bioassay1 1992-1998,
- ORISEWDS_d46 - tblY12 Bioassay2 1992-1998,
- ORISEWDS_d47 - tblY12 TLD 1989-1991,
- ORISEWDS_d48 - tblY12 TLD 1992-1998, and
- ORISEWDS_d49 - tblY12 WBC 1989-1991

Citations

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Pantex

PXFACW01 Data File Set

Description

This working data file set, prepared by the Los Alamos National Laboratory Occupational Medicine Group, consists of five working files of demographic, vital status, and exposure data for workers employed at the Pantex Plant located near Amarillo, Texas, during 1951 to 1981.

- The first file, PXFACW01_d1, contains basic demographic data on 7,425 male and female workers employed either by the prime contractor or by a subcontractor. The hire and termination data cover the period from the start of plant operations in 1951 through late 1981, with some dates beyond. These data were abstracted by project staff primarily from personnel records microfilmed at the Pantex Plant. The cohort roster was assembled from employee record cards, employment information sheets, SSA 941A forms, and health physics records. Vital status was assessed from a number of sources including the SSA, the Pantex Plant records, the Texas Department of Motor Vehicles, and telephone tracing. Vital status tracing was

through 1993. Death certificates were obtained from state vital registrars. Death certificates were coded by trained nosologists according to the Eighth Revision of the International Classification of Diseases, adapted for use in the United States. The file was extracted from the Los Alamos National Laboratory Epidemiology Section's Pantex database in October 1993 and reflects all demographic and death information present in the database at that time.

- The second file, PXFACW01_d2, contains exposure data on 209 male and female workers employed at the Pantex Plant. The file consists of each individual's identification number and the date his/her exposure reached or exceeded 1 rem. File PXFACW01_d2 was extracted from Pantex health physics records. The records of individuals having exposures were examined to determine when that individual's exposure reached or exceeded 1 rem. The file contains one record per person.

The other three files (PXFACW01_d3, PXFACW01_d4, and PXFACW01_d5) were received from the Pantex Plant in the early 1980s and have not been used or altered. The variable definitions for these files are limited to what was included in the sparse documentation from Pantex. Except for the addition of identification numbers and the CEDR-mandated data truncation, these data are included exactly as they were received from Pantex.

- The third file, PXFACW01_d3, consists of 209 records containing identification and radiation exposure data on terminated male and female workers at Pantex. The personnel exposure data are whole-body, internal, organ, skin, extremity, and other exposures by current year. Whole-body, internal, skin, extremity, and other exposure measurements are recorded in millirem.

- The fourth file, PXFACW01_d4, consists of 705 records containing identification and radiation exposure data on inactive male and female workers or buildings at Pantex. The exposure data are whole-body, internal, organ, skin, extremity, and other exposures by current year. Whole-body, internal, skin, extremity, and other exposure measurements are recorded in millirem.

- The fifth file, PXFACW01_d5, consists of 897 records containing identification and radiation exposure data on active male and female workers or buildings at Pantex. The exposure data are more detailed than those in the PXFACW01_d3 and PXFACW01_d4 files. The whole-body, internal, organ, skin, extremity, and other exposures are included for the current year, prior to the current year, and monthly for the current year. Whole-body, internal, skin, extremity, and other exposure measurements are recorded in millirem.

Citations

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Rocky Flats

▪ RFCHMW01 Data File Set

Description

This working data file set, prepared by LANL, consists of five files that include information about worker locations, operations performed, and results of samples indicating workplace exposures to various chemicals at the Rocky Flats Plant.

Rocky Flats workers were exposed to complex mixtures of chemicals and radioactive materials, such as plutonium. The exposure to such a mixture of possible carcinogens may produce adverse health effects. The purpose of the Complex Chemical study was to examine the feasibility of estimating individual worker exposures to such complex mixtures of chemicals, so that the estimated exposures would be useful for epidemiologic studies. The study attempted to use information found in records about chemical purchases, work areas, and plant operations to assess individual chemical exposures. A general methodology was developed and applied to a small pilot population of 58 Rocky Flats workers. The pilot study gathered exposures from 1956 to 1989 for those in the pilot.

This data file set is comprised of an agent dictionary file (RFCHMW01_d1), a detailed sample file (RFCHMW01_d2), a general sample results file (RFCHMW01_d3), a linking file for persons exposed (RFCHMW01_d4), and a sample results file (RFCHMW01_d5).

Citations
No data available.

RFFACW02 Data File Set

Description

The RFFACW02 data file set consists of six working files that were generated by the Epidemiology Section at LANL for mortality studies of workers employed at Rocky Flats Plant (RFP) in the years 1951 to 1979. Data were obtained in various formats and media from RFP departments and other agencies. Demographic data were collected from two primary sources of records provided by the Personnel Department at RFP. Supplemental data were obtained from RFP health physics records. Death information was abstracted from death certificates obtained from various states. External ionizing radiation exposure and plutonium bioassay data were provided by the Health Physics Department at RFP. The external ionizing radiation data from hard-copy records through 1978 were computerized by the Epidemiology Section at LANL.

The six files in the RFFACW02 data file set are segregated by type of data: demographic, external ionizing radiation exposure, and plutonium-239 bioassay results. Data pertaining to an individual that appear in one or more files may be linked by the individual identification number assigned to each worker.

- The first working file (RFFACW02_d1) contains demographic information, including race, sex, birth date, education level, employment dates, and death information, such as cause of death, date of death, and state of death, for 9,537 males and females hired between 1951 and February 1979. The file includes 1,563 females, 7,973 males, and 1 with unknown sex. Race was determined for 99% of the workers. Death information was last obtained in 1992 from NDI. Mortality data were available from the NDI for the period 1979 through 1990. Earlier death information was obtained from the SSA and other sources, including the Colorado Department of Motor Vehicles and active tracing. There are 1,423 deaths identified in this working file. Cause-of-death information (ICDA8) is not available for six deaths. This file also includes dosimetry data from 1981 that have been superseded by the data in the other four files of this working data file set.

- The second working file (RFFACW02_d2) contains results of urine bioassay measurements for gross alpha, uranium, enriched uranium, depleted uranium, plutonium-239, and americium-241 through 1989. The file contains 300,261 records for contractor personnel and hires after 1979. Data include the date of the sample, type of analysis, activity of each isotope, and estimated body burdens for plutonium-239 and americium-241. These data were not edited by LANL.

- The third working file (RFFACW02_d3) contains external ionizing radiation exposure data. There are 62,375 records for 9,015 workers for the years 1951 through 1978. The variables include year of monitoring and annual whole-body penetrating dose (in mrem) incurred while working at RFP. These data have been edited extensively with the help of the health physics staff at RFP.
- The fourth file (RFFACW02_d4) contains values recorded at RFP for "lifetime accumulated other" external ionizing radiation exposure received from a facility other than RFP. There are 9,015 readings reported in millirem for 9,015 individuals. These data were coded from hard-copy records provided by RFP and are available for 1965 through 1978. These data have been edited with the help of the staff at RFP.
- The fifth file (RFFACW02_d5) contains 360,388 records of badge readings for external radiation for the last quarter of 1976 through 1989. The exposure values are reported in millirem for neutron, gamma, penetrating, skin, hand, and forearm. Two background exposure variables are included as well. In addition to records for RFP workers, readings are present for contractor employees and workers hired at RFP after 1979. These data were provided in computerized form by RFP in 1990 and have not been edited.
- The sixth file (RFFACW02_d6) contains americium and plutonium whole-body counts. The file contains 79,761 records for contract employees and workers hired after 1979. These data were never used by the LANL Epidemiology Section in any analyses, and no documentation exists at LANL on the units or meaning of data in this file.

Citations

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APPENDIX B – Part 1

Analytic Data File Sets Single Facilities Health and Mortality Studies

FERNALD

- **FRC94A02 Data File Set**

Description

This analytic data file set consists of three files generated for a retrospective cohort mortality study of white males employed during 1951 to 1989 at the FMPC in Fernald, Ohio by Donna Cragle.

This study of white males employed between 1951 and 1989 had a total of 121,000 person-years of follow-up. Results for the combined cohort showed statistically significantly elevated standardized mortality ratios (SMRs) for all cancers combined (1.15) and prostate cancer (1.58). Investigating SMRs separately for salaried and non-salaried workers, there were notable differences between the mortality patterns of the two groups. Salaried workers had a statistically significantly increased SMR only for stomach cancer (2.61), as contrasted with all cancers combined (1.21), lung cancer (1.26), and motor vehicle accidents (1.59) for non-salaried workers. No deaths from bone sarcomas were found in either group. The healthy worker effect was evident in the statistically significant all-causes SMR of 0.71 for salaried workers. The corresponding SMR for non-salaried workers was 0.95 with an upper confidence bound of 1.01. Dose-response relationships were found only for cumulative external dose and lung cancer and for cumulative internal dose and non-malignant respiratory diseases.

The demographic and work history analytic file (FRC94A02_d1) contains a record that includes vital status as of January 1, 1990, for each of the 4,014 members of the cohort. There are two exposure files. FRC94A02_d2 contains annual deep doses in cGy (rads) from external radiation sources, while FRC94A02_d3 contains annual calculated lung doses in cGy from internal radiation sources.

The last SSA submission for this population provided “alive” status as of January 1, 1985. The “alive” category is no longer obtainable from SSA.

However, NDI provides a record of all deaths occurring since January 1, 1979. If not identified as deceased by SSA or NDI, individuals last known to be alive before January 1, 1979, were considered lost to follow-up on the last date known alive. Those classified as unknown after January 1, 1979, were considered alive at the end of the study. There

were 1,064 deaths from all causes with death certificates available for 99.0% of these individuals. The underlying causes of death were coded for ICDA8.

The FMPC was involved in processing uranium ore concentrate and uranium of low grade enrichment into fabricated uranium metal products and in the production of thorium metal. Operations began in late 1951 with 85% of the cohort being hired before 1960. Employment at the facility reached its peak in 1956 and slowly decreased until operations halted in July of 1989. In addition to radiation and thorium, potential exposures included kerosene, tributyl phosphate, and other solvents.

Citations

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▪ FRW83A01 Data File Set

Description

This analytic data file set consists of one file generated for a 1983 dissertation that involved a cohort morbidity study of non-malignant respiratory disease among 4,101 white males employed during 1952 to 1972 at the Fernald Facility.

This study investigated the relationship between exposure to uranium and the development of non-malignant respiratory disease. Diagnosis was based on physician diagnoses as recorded on medical insurance claims. An examination of these data, along with exposure associated with job title, suggested that exposure to uranium dust was the principal exposure at Fernald that contributed to the development of non-malignant respiratory disease. No statistically significant association was demonstrated for non-radioactive chemical exposures.

The single analytic file, FRW83A01_d1, in this data file set contains 13,196 records, with one or more records for each person. Data in the file include date of birth, dates of employment, job title, job code, pay code, vital status, cumulative exposure for internal and external radiation (categorical), and smoking history data (on a 17.4% sample). Chemical exposure indicator variables for trichloroethylene exposure (TCE), tributyl phosphate (TBP), cutting fluid, kerosene, lime, ammonia, carbon, nitric acid, and sodium hydroxide are also available. The study cohort was defined as 4,101 white males who were first hired at Fernald between January 1, 1952, and December 31, 1972, and

who had at least 3 months of continued employment. Internal and external exposures were obtained through urine bioassay, film badges, and air sampling data. Smoking data were potentially available for workers employed on or after January 1, 1968.The chemicals used in the processes at the facility, along with job title and plant area, were analyzed by plant experts to determine exposure risk classes. Four exposure risk classes ranging from none to heavy were developed. A similar scale that ranged from no exposure above background to regular exposure at low levels was developed for radiation exposures.

Citations

Wilson, J. 1983. An epidemiologic investigation of nonmalignant respiratory disease among workers at a uranium mill. Ph.D. diss., University of North Carolina, Chapel Hill.

HANFORD

▪ HFC78A01 Data File Set

Description

This analytic data file set consists of three files generated for the cohort mortality study of operations workers initially employed during 1944 to 1978 at the Hanford Site by Ethel Gilbert, et al., published in Health Physics in 1989.

The study evaluated the relationship of occupational radiation exposure and mortality from several specific causes. The study showed that Hanford workers exhibited a strong healthy worker effect, having death rates substantially below those of the general U.S. population. Comparisons by level of exposure within the Hanford worker population provided no evidence of a positive correlation between exposure and mortality from all cancers combined or between exposure and mortality from leukemia.

The three analytic files in the HFC78A01 data file set, constructed using the IARC protocol, pertain to 44,101 Hanford workers initially employed at Hanford between 1944 and 1978.

- The first file, HFC78A01_d1 (CEDR78_1), contains demographic, work history, and vital status data and indicators of internal depositions. Mortality data are provided for deaths occurring outside the state of Washington between 1944 and 1981, as well as for deaths occurring in Washington between 1944 and 1985. Internal deposition data include the radionuclide symbol and the year of first plutonium deposition. There is one record per individual.

- The second file, HFC78A01_d2 (CEDR78_2), contains annual external whole-body doses that were compiled from external monitoring data for operations workers. These data include doses received while the worker was employed at other sites, but, unlike another Hanford data set (HFI89A01), they do not include doses received while performing construction work at Hanford. There is one record for each year of exposure data for each of the 35,869 workers who were monitored.
- The third file, HFC78A01_d3 (CEDR78_3), contains additional data related to on-site exposure and cause of death. There is one record for each worker.

The discussions in the published paper focus on monitored workers of both sexes. Dose-response analyses (internal comparison) included 35,869 workers who were monitored for external radiation. Vital status was ascertained through December 31, 1981, the study end date. There were 4,846 deaths identified, and death certificates were obtained for 4,797 (99.0%) of these deaths. Comparisons with the U.S. general population included 42,291 white workers. There were 7,249 deaths identified, and death certificates were obtained for 7,155 (98.7%) of these deaths. Internal exposures were also examined.

Workers at the Hanford Site were involved in a variety of activities that resulted in their exposure to radiation, including reactor operations, chemical separation of reactor fuel to obtain plutonium, treatment and storage of hazardous waste, and biological and engineering research. Personal dosimeters (film or thermoluminescent) have been used since 1944. Also, bioassay programs to detect exposures to internally deposited radionuclides, primarily transuranics, were initiated in 1944. Dose estimates resulting from these monitoring programs appear in this analytic data file set. Annual whole-body doses to penetrating external radiation are presented in units of millisieverts. Quality factors of 10 for fast neutrons, 3 for slow neutrons, and 1 for photons and electrons were used in the conversion of exposure to dose. Internal exposure data were collected and evaluated for all individuals who worked in locations where there was a potential for exposure to radioactive material (transuranics).

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Tolley, H. D., Marks, S., Buchanan, J. A., Gilbert, E. S. A Further update of the Analysis of mortality of workers in a nuclear facility. 1983. Radiation Research. 95:211-213

HFI89A01 Data File Set

Description

This analytical data file set consists of three files for the updated cohort mortality study of operations workers initially employed during 1944to 1978 at the Hanford Site by Ethel Gilbert, et al., published in Health Physics in 1993.

This study continues to examine the relationship between occupational radiation exposure among Hanford workers and mortality from specific causes. The files used for this paper have been updated and refined since the 1989 publication. The study showed that both male and female workers continue to exhibit a strong healthy worker effect, with death rates from most causes substantially below those of the general U.S. population. Comparisons by level of radiation exposure within the Hanford worker population provided little evidence of a positive correlation between cumulative radiation exposure and mortality from leukemia or from all other cancers combined.

The three analytic files in the HFI89A01 data file set, constructed using the IARC protocol, pertain to 44,156 Hanford operations workers initially employed at Hanford between 1944 and 1978.

- The first file, HFI89A01_d1 (IARC89_1), with one record per individual, contains demographic, work history, vital status, external dosimetry, and internal deposition data. Mortality data are provided for deaths occurring outside Washington State between 1944 and 1986 and deaths occurring in Washington between 1944 and 1989, inclusive. Internal deposition data include the radionuclide symbol and the year of first plutonium deposition.
- The second file, HFI89A01_d2 (IARC89_2), contains external exposure data for the years 1944 through 1989. The dosimetry data include doses received while performing construction work at Hanford, as well as occupational doses received off-site at other facilities. There is one record for each year of exposure data for each of the 37,012 monitored workers.
- The third file, HFI89A01_d3 (IARC89_3), contains additional data related to internal exposures, off-site exposures, and cause of death. There is one record for each worker.

Comparisons with the U.S. general population included a cohort of 42,070 white workers. There were 9,452 deaths identified, and death certificates were obtained for 9,285 (98.2%) of these deaths. Dose-response analyses included 32,643 workers (24,672 males and 7,971 females) who were monitored for external radiation and

employed for at least 6 months between 1944 and 1985. Vital status was ascertained through 1986, the study end date. There were 6,286 deaths identified, and death certificates were obtained for 6,200 (98.6%) of these deaths. Both types of analyses included deaths through December 31, 1986.

Workers at the Hanford Site were involved in a variety of activities that resulted in their exposure to radiation, including reactor operations, chemical separation of reactor fuel to obtain plutonium, treatment and storage of hazardous waste, and biological and engineering research. Personal dosimeters (film or thermoluminescent) have been used since 1944. Bioassay programs to detect exposures to internally deposited radionuclides, primarily transuranics, also were initiated in 1944. Dose estimates resulting from these monitoring programs appear in this data file set. Annual whole-body doses to penetrating external radiation are presented in units of millisieverts. Quality factors of 10 for fast neutrons, 3 for slow neutrons, and 1 for photons and electrons were used in the conversion of exposure to dose. Internal exposure data were collected and evaluated for all individuals who worked in locations where there was a potential for intake of radioactive material (transuranics).

Citations

Gilbert, E. S. Issues in Analyzing the Effects of Occupational Exposure to Low Levels of Radiation. 1989. Statistics in Medicine. 8:173-187

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1988

Gilbert, E., Fix, J. J., Baumgartner, V. W. -- Battelle Pacific Northwest Laboratories. An approach to evaluating bias and uncertainty in estimates of external dose obtained from personal dosimeters. 1996. Health Physics. Volume 70(3):336-345

Gilbert, Ethel S., Buchanan, Jeffrey A., Holter, N.A. Description of the Process Used to Create 1992 Hanford Mortality Study Database. 1992. Pacific Northwest Laboratory (PNL). PNL Technical Report No. PNL-8449

Gilbert, Ethel S., Omohundro, Ellen, Buchanan, Jeffrey A., Holter, Nancy A. Mortality of Workers at the Hanford Site: 1945-1986. 1993. Health Physics. 64:577-590

▪ HFLCAA01 Data File Set

Description

This analytic data file set consists of one file generated for a lung cancer case-control study of monitored white males employed at the Hanford Site by Gerald Petersen, et al., published in Health Physics in 1990.

The purpose of the study was to investigate the association between lung cancer risk and occupational radiation exposure with appropriate adjustment for tobacco use. Data were analyzed using methods that took into account both the case-cohort

design and the changes over time in the quality of the tobacco-use information that was collected. Tobacco use was not strongly related to the level of radiation exposure and adjustment for tobacco use did not greatly modify results of analyses assessing the association between lung cancer risk and cumulative dose equivalent. With or without adjustment for tobacco use, the estimated risks per unit of cumulative dose equivalent were negative, but the 95% confidence intervals were wide and included values several times those estimated from populations with high levels of irradiation.

The single analytic file, HFLCAA01_d1 (HFLUNGCA), contains one record for each of the study years 1965 through 1980 (or year of death if earlier) for each of the workers qualifying as a lung cancer case or selected as a subcohort member from a stratified random sample of cohort members. White male operations workers who died of lung cancer qualified as cases if they were monitored for external radiation for at least 3 years and terminated employment on or after January 1, 1965. Questions about tobacco use became a routine part of the periodic medical examination in 1965. Termination in or after this year allowed most workers to have at least one examination during the study period. The criteria for cohort members were identical except for the diagnosis of lung cancer, although this did not exclude their selection. The lung cancer cases were stratified into year-of-birth groups in 5-year intervals. These intervals were used as strata for identifying eligible persons for the subcohort. For each stratum, at least five times as many subcohort members as cases were randomly selected.

Eighty-six workers qualified as lung cancer cases. This resulted in the random selection of 445 subcohort members from a total of 5,445 eligible workers. Thirteen of those selected also qualified as lung cancer cases. One of the 86 cases and three of the 445 subcohort members were excluded from the analyses because their medical records could not be located. Vital status was ascertained through December 31, 1980, the study end date. Of the 442 subcohort members, 344 remained alive through the end of the study. Internal as well as external radiation exposures were examined.

Workers at the Hanford Site were involved in a variety of activities that resulted in their exposure to radiation, including reactor operations, chemical separation of reactor fuel to obtain plutonium, treatment and storage of hazardous waste, and biological and engineering research. Personal dosimeters (film or thermoluminescent) have been used since 1944. Annual whole-body doses to penetrating external radiation are presented in units of millisieverts. Quality factors of 10 for fast neutrons, 3 for slow neutrons, and 1 for photons and electrons were used in the conversion of exposure to dose. Bioassay programs to detect exposures to internally deposited radionuclides, primarily transuranics, were also initiated in 1944. The potential for inhalation of uranium

in this study was evaluated by reviewing each worker's uranium bioassay records. It was assumed that the number of bioassay measurements provided a rough indication of potential for exposure. Bioassay programs for uranium were primarily concerned with monitoring for uptake by the kidney and did not directly provide indications of lung dose.

Citations

Gilbert, E., Fix, J. J., Baumgartner, V. W. -- Battelle Pacific Northwest Laboratories. An approach to evaluating bias and uncertainty in estimates of external dose obtained from personal dosimeters. 1996. Health Physics. Volume 70(3):336-345

Petersen, Gerald R., Gilbert, Ethel S., Buchanan, Jeffrey A., Stevens, Richard G. A Case-Cohort Study of Lung Cancer, Ionizing Radiation, and Tobacco Smoking Among Males at the Hanford Site. 1990. Health Physics. 58:3-11

▪ HFMCCA02 Data File Set

Description

This analytic data file set consists of five analytic files used to support a case-control study by Lowell Sever, et al. of congenital malformations among births in two counties adjacent to the Hanford Site during 1957 to 1980, published in the American Journal of Epidemiology in 1988.

The purpose of the study was to investigate the association of parental occupational exposure to low-level external whole-body penetrating ionizing radiation and risk of congenital malformations in their offspring. Cases and controls were ascertained from births in two counties in southeastern Washington State, where the Hanford Site has been a major employer. Twelve specific malformation types were analyzed for evidence of association with employment of the parents at Hanford and with occupational exposure to ionizing radiation. Two defects, congenital dislocation of the hip and tracheoesophageal fistula, showed statistically significant associations with employment of the parents at Hanford but not with parental radiation exposure. Neural tube defects showed a significant association with parental preconception exposure, on the basis of a small number of cases. Eleven other defects, including Down syndrome, for which an association with radiation was considered most likely, showed no evidence of such an association. When all malformations were analyzed as a group, there was no evidence of an association with employment of the parents at Hanford but the relation of parental exposure to radiation before conception was in the positive direction. Given the number of statistical tests conducted, some or all of the observed positive correlations are likely to represent false-positive findings.

In view of strong contradictory evidence, based on no demonstrated effects in genetic studies of atomic bomb survivors in Hiroshima and Nagasaki, it is unlikely that these correlations result from a cause-and-effect association with parental radiation exposure.

The HFMCCA02 data file set is comprised of five analytic files with information on 672 malformation cases and 978 matched controls.

- The first file, HFMCCA02_d1 (MALCCA_1), contains demographic data for the parents and the reproductive history of the mother.
- The second file, HFMCCA02_d2 (MALCCA_2), contains birth data for the infant.
- The third file, HFMCCA02_d3 (MALCCA_3), contains malformation data for cases and additional medical data for the infant and mother.

If the parents worked at Hanford prior to the infant's date of birth,

- the fourth file, HFMCCA02_d4 (MALCCA_4), contains employment data, and
- the fifth file, HFMCCA02_d5 (MALCCA_5), contains radiation exposure data.

There is one record in each file for each of the cases and controls.

A unique feature of this study was the linking of quantitative individual measurement of external radiation exposures of Hanford employees and the disease outcome, congenital malformations. The population at risk, from which cases and controls were ascertained, consisted of live births and fetal deaths occurring in three local hospitals during 1957 through 1980, the study ending date. Of the 672 cases, 146 fathers and 48 mothers were employed at Hanford prior to conception. Twenty-two mothers of cases were employed at Hanford during gestation. Of these cases, 125 fathers and 28 mothers had positive recorded doses prior to conception. Only one mother of a case received more than 1 millisievert (mSv) during gestation. Information on internal radionuclide depositions was also obtained. However, only one father of a case had evidence of a deposition, and it was determined to be less than 1% of the applicable maximum permissible body burden.

Radiation exposure data routinely collected at Hanford include the doses from external sources to the whole body, the skin of the whole body, and the extremities, for each employee working with or near radiation sources. Because exposure to the gonads was the primary interest of this study, analyses were limited to consideration of

exposure to external whole-body penetrating radiation. Dose estimates, presented in units of millisieverts, were obtained primarily from personal dosimeter measurements. A sievert is numerically equivalent to the absorbed dose in gray multiplied by a quality factor expressing the biological effectiveness of the radiation type. Factors of 10 for fast neutrons, 3 for slow neutrons, and 1 for photons were used to convert external exposure measurements to dose estimates. Workers who are considered at risk for internal depositions also undergo routine bioassays and in vivo tests to determine such radiation exposure.

Citations

Gilbert, E., Fix, J. J., Baumgartner, V. W. -- Battelle Pacific Northwest Laboratories. An approach to evaluating bias and uncertainty in estimates of external dose obtained from personal dosimeters. 1996. Health Physics. Volume 70(3):336-345

Sever, Lowell E. -- Centers for Disease Control (CDC). Gilbert, Ethel S. -- Pacific Northwest Laboratory (PNL). Hessol, Nancy A. -- Hanford Environmental Health Foundation
McIntyre, James M. -- Pacific Northwest Laboratory (PNL). A Case-Control Study of Congenital Malformations and Occupational Exposure to Low-Level Ionizing Radiation. 1988. American Journal of Epidemiology. 127(2):226-242

▪ HFMPVA02 Data File Set

Description

This analytic data file set consists of five analytic files that support a prevalence study by Lowell Sever, et al. of congenital malformations among births in two counties adjacent to the Hanford Site during 1958 to 1980, published in the American Journal of Epidemiology in 1988.

The purpose of this study was to investigate the prevalence of congenital malformations among births in two southeastern Washington State counties where the Hanford Nuclear Site is a major employer. Various agriculturally and chemically related activities take place in this area as well. The rates of specific malformations ascertained during the first year of life were compared with combined rates from the Birth Defects Monitoring Program (BDMP) for the states of Washington, Oregon, and Idaho. Among defects that would be expected to be comparably ascertained, a statistically significant elevated rate of neural tube defects was observed in the two counties, while rates of cleft lip were significantly lower. For congenital heart defects, pyloric stenosis, and Down syndrome (defects often not diagnosed during the newborn period), BDMP data did not offer appropriate comparisons. However, the rates of these defects did not appear to be elevated in relation to rates found in other relevant populations. When rates of neural tube defects were compared with populations other than those in the BDMP, the bi-county rates were still considered elevated. The increased rate cannot be explained by employment of the parents at Hanford or by the impact of Hanford plant emissions on the local population.

The HFMPVA02 data file set is comprised of five analytic files with information on 454 malformation cases.

- The first file, HFMPVA02_d1 (MALPVA_1), contains demographic data for the parents and the reproductive history of the mother.
- The second file, HFMPVA02_d2 (MALPVA_2), contains birth data for the infant.
- The third file, HFMPVA02_d3 (MALPVA_3), contains malformation data and additional medical data for the infant and mother.

If the parents worked at Hanford prior to the infant's date of birth,

- the fourth file, HFMPVA02_d4 (MALPVA_4), contains employment data, and
- the fifth file, HFMPVA02_d5 (MALPVA_5), contains radiation exposure data.

There is one record in each file for each of the cases.

The population at risk consists of 23,076 live births and 243 fetal deaths occurring in three of the bi-county hospitals from the beginning of the study in 1968 through the end of the study in 1980. Thus, the denominator for prevalence rates is 23,319. A total of 454 malformation cases were identified, for a congenital malformation rate in the newborn population of 19.6 per 1,000, or about 2% of all births. For the bi-county general public, a maximally exposed individual could not have received more than 10 millisieverts (mSv) from Hanford nuclear activities during 1957 to 1984. This is about one-third of the exposure received from natural background over the same period. At the time of this study, more than 65,000 individuals had been employed at Hanford since it began operations in 1944, and about 15,000 of these people were still employed there. On the basis of a companion case-control study (HFMCCA02), it is estimated that 23% of all infants born during the 1968 to 1980 study period would have one or more parents employed at Hanford, and about 6% of these infants would have a parent with cumulative Hanford ionizing radiation exposure exceeding 10 millisieverts.

Radiation exposure data routinely collected at Hanford include the doses from external sources to the whole body, the skin of the whole body, and the extremities, for each employee working with or near radiation sources. Dose estimates, presented in units of millisieverts, were obtained primarily from personal dosimeter measurements. A sievert is numerically equivalent to the absorbed dose in gray multiplied by a quality factor expressing the biological effectiveness of the radiation type. Factors of 10 for fast neutrons, 3 for slow neutrons, and 1 for photons were used to convert external

exposure measurements to dose estimates. Workers who are considered at risk for internal depositions also undergo routine bioassays and in vivo tests to determine such radiation exposure.

Citations

Sever, Lowell E. -- Centers for Disease Control (CDC). Hessol, Nancy A. -- Hanford Environmental Health Foundation. Gilbert, Ethel S., McIntyre, James M. -- Pacific Northwest Laboratory (PNL). The Prevalence at Birth of Congenital Malformations in Communities near the Hanford Site. 1988. American Journal of Epidemiology. 127(2):243-254

Sever, Lowell E. Parental radiation exposure and children's health: Are there effects on the second generation? 1991. Occupational Medicine: State of the Art Reviews 1991. 6:613-627

▪ HFMULA02 Data File Set

Description

This analytic data file set consists of three files supporting the 1989 combined cohort mortality study by Ethel Gilbert, et al. of white males employed at the Hanford, Oak Ridge, and Rocky Flats sites and three additional files supporting the updated 1993 study of workers at these sites.

An important objective of studies of workers exposed occupationally to chronic low doses of ionizing radiation is to provide a direct assessment of health risks resulting from this exposure. This objective is most effectively accomplished by conducting analyses that allow evaluation of the totality of evidence from multiple study populations.

The 1989 combined study of males employed at Hanford, Oak Ridge, and Rocky Flats provides no evidence of a correlation between external radiation exposure and mortality from all cancers or from leukemia. Of 11 other specific types of cancer analyzed, multiple myeloma was the only cancer found to exhibit a statistically significant correlation with exposure. Estimates of the excess risk of all cancers and of leukemia, based on the combined data, were negative. Upper confidence limits based on the combined data were lower than for any single population and were similar to estimates obtained from recent analyses of A-bomb survivor data. These results strengthen support for the conclusion that estimates obtained through extrapolation from high-dose data do not seriously underestimate risks of low-dose exposure but leave open the possibility that extrapolation may overestimate risks.

Each of the 1989 study files in the HFMULA02 data file set represent a particular site. The study population at each site consists of white males monitored for external radiation and employed for at least 6 months.

- HFMULA02_d1 (HFMUL_HF) has one record for each of 25,241 white male candidates in the study period of 1944 to 1981. This file contains demographic, work history, vital status, and external dosimetry data.
- HFMULA02_d2 (HFMUL_OR) has one record for each of 8,375 white male candidates in the study period of 1943 to 1977. This file contains demographic, work history, vital status, and external dosimetry data.
- HFMULA02_d3 (HFMUL_RF) has one record for each of 7,616 white male candidates in the study period of 1952 to 1979. This file contains demographic, work history, vital status, external dosimetry, and internal deposition data.

Updated 1993 analyses of mortality data on workers at the Hanford Site, ORNL, and Rocky Flats Weapons Plant were performed with the objective of providing a direct assessment of health risks resulting from protracted low-dose exposure to ionizing radiation. For leukemia, the combined excess relative risk estimate was negative (-1.0 per Sv), and confidence limits excluded risks that were more than slightly larger than those forming the basis of International Commission on Radiological Protection (ICRP) recommendations. For all cancers except leukemia, the excess relative risk estimate was 0.0 per Sv, but confidence limits indicated consistency with estimates several times those forming the basis of ICRP recommendations. Of 24 cancer types tested, 12 showed positive correlations with radiation dose and 12 showed negative correlations, as would be expected by chance fluctuation. Cancer of the esophagus, cancer of the larynx, and Hodgkin's disease showed statistically significant correlations with radiation dose ($P < 0.05$), but these correlations were interpreted as likely to have resulted from bias or chance fluctuation. Evidence of an increase in the excessive relative risk with increasing age was found for all cancers at both Hanford and ORNL, and both populations showed significant correlations of all cancers with radiation dose among those 75 years and older. Although this age effect may have resulted from bias in the data, its presence suggests that risk estimates based on nuclear worker data be interpreted cautiously.

Each of the three updated 1993 study files in the HFMULA02 data file set represents a particular site. The study population at each site includes white males monitored for external radiation and employed for at least 6 months. In addition, female workers and a small number of non-white workers are included in the Hanford study population.

- HFMULA02_d4 (HFMUP_HF) has one record for each of 44,156 candidates in the study period of 1944 to 1986. This file contains demographic, work history, vital status, internal deposition, and external radiation exposure data. External radiation estimates are provided by type of work: on-site operations, on-site construction, or off-site.
- HFMULA02_d5 (HFMUP_OR) has one record for each of 8,318 white male candidates in the study period of 1943 to 1984. This file contains demographic, work history, vital status, internal deposition, and external dosimetry data.
- HFMULA02_d6 (HFMUP_RF) has one record for each of 7,616 white male candidates in the study period of 1952 to 1983. This file contains demographic, work history, vital status, external dosimetry, and internal deposition data.

Workers at the Hanford Site were involved in a variety of activities that resulted in their exposure to radiation, including reactor operations, chemical separation of reactor fuel to obtain plutonium, treatment and storage of hazardous waste, and biological and engineering research.

Personal dosimeters (film or thermoluminescent) have been used at Hanford since 1944. Annual whole-body doses from penetrating external radiation are presented in units of millisieverts. Quality factors of 10 for fast neutrons, 3 for slow neutrons, and 1 for photons and electrons were used in the conversion of exposure to dose.

ORNL began monitoring personnel for exposure to external penetrating radiation, primarily gamma rays, in 1943. Pocket chambers were used until June of 1944. At this time, film dosimeters (film badges) became the primary type of dosimeter. In 1975, film badges were replaced with thermoluminescent dosimeters (TLDs).

Until the early 1950s, the usual practice at ORNL was to provide personal dosimeters to only those workers entering designated areas where there was a potential for exposure. After that time, all workers were monitored.

The Rocky Flats Plant has been a weapons facility since 1952. Sources of occupational exposure include external radiation, both gamma and neutron, and potential for internal deposition of plutonium-239. Personal film dosimeters and subsequently TLDs were used to monitor external exposure to workers. Formal bioassay programs to monitor for internal radiation were initiated in 1952. Results of both types of monitoring programs reflect technological improvements and changes in concepts and models over time.

Citations

Gilbert, E. S., Fry, S. A., Wiggs, L. D., Voelz, G. L., Cragle, D. L., Petersen, G. R. Analyses of Combined Mortality Data on Workers at the Hanford Site, Oak Ridge National Laboratory, and Rocky Flats Nuclear Weapons Plant. 1989. Radiation Research. 120:19-35

Gilbert, Ethel S., Buchanan, Jeffrey A., Holter, N.A. Description of the Process Used to Create. 1992 Hanford Mortality Study Database. 1992. Pacific Northwest Laboratory (PNL). PNL. Technical Report No. PNL-8449

Gilbert, Ethel S. -- Pacific Northwest Laboratory. Cragle, Donna L. -- Center for Epidemiologic Research (CER), Oak Ridge Institute for Science and Education (ORISE). Wiggs, Laurie D. -- Los Alamos National Laboratory (LANL). Updated Analyses of Combined Mortality Data for Workers at the Hanford Site, Oak Ridge National Laboratory, and Rocky Flats Weapons Plant. 1993. Radiation Research. 136:408-421

▪ HFS93A03 Data File Set

Description

This analytic data file set consists of two files constructed for another analysis, operations workers initially employed during 1944 to 1978 at the Hanford Site, published in the American Journal of Industrial Medicine in 1993. This study by George Kneale and Alice Stewart examined the relationship between low-level occupational radiation doses among Hanford workers and mortality from specific causes. The approach taken in this study made new use of standard epidemiologic procedures and revealed evidence of increased cancer risk at low dose levels.

The reanalysis does not indicate that radiation is more likely to cause leukemia than solid tumors or that there is a reduced cancer effectiveness of radiation at low dose levels. However, the estimated proportion of radiogenic cancers was much higher for the 175 non-fatal cancers than for the 1,732 fatal cases.

There is one record in each of the two analytic files corresponding to each of the 44,101 workers. The cohort was restricted to individuals who worked at Hanford between 1944 and 1978. The follow-up period for this reanalysis runs from January 1944 through December 1986.

- The first file, HFS93A03_d1 (HFS93A03_1), contains demographic data, off-site doses, internal exposure data, annual external doses, work history, and vital status data.
- The second file, HFS93A03_d2 (HFS93A03_2), contains work history and internal exposure data.

Due to the many job titles at Hanford, six job categories were established: professional, managerial, clerical, crafts, blue collar, other, and not specified. Data include the date on which a worker was first monitored (by urinalysis) for internal

deposition, as well as the dates on which the result was first greater than zero (i.e., measurable), the result was greater than the standard error, and the result was greater than twice the standard error. Results of in vivo counting include the years at which depositions of one, two, or three nuclides were detected. There were 9,443 deaths identified through the follow-up period of December 31, 1986.

Workers at Hanford were involved in a variety of activities resulting in exposure to radiation, including reactor operations, chemical separation processes, treatment and storage of hazardous waste, and biological and engineering research. Personal dosimeters were first used in 1944. The doses contained in the file are expressed in centirad. Internal exposure data were collected and evaluated for all individuals who worked in locations where there was a potential for intake of radioactive materials.

Citations

Gilbert, E., Fix, J. J., Baumgartner, V. W. -- Battelle Pacific Northwest Laboratories. An approach to evaluating bias and uncertainty in estimates of external dose obtained from personal dosimeters. 1996. Health Physics. Volume 70(3):336-345

Gilbert, Ethel S., Buchanan, Jeffrey A., Holter, N.A. Description of the Process Used to Create. 1992 Hanford Mortality Study Database. 1992. Pacific Northwest Laboratory (PNL). PNL. Technical Report No. PNL-8449

Kneale, George W., Ph.D., Stewart, Alice M., MD -- Department of Public Health and Epidemiology, University of Birmingham. Reanalysis of Hanford Data: 1944-1986 Deaths. 1993. American Journal of Industrial Medicine. 23:371-389. Further Results of a 1993 Analysis of Data from Five Nuclear Facilities

U.S. Bureau of the Census. 1970 Census of Population. Alphabetical Index of Industries and Occupations, 1970 Census of Population. The Classified Index of Industries and Occupations

▪ HFWC94A1 Data File Set

Description

This analytic data file set consists of three files constructed for a cohort mortality study of production workers at the Hanford Site in Richland, Washington for NIOSH by Steve Wing et al., University of North Carolina at Chapel Hill.

The Hanford Site was constructed along the Columbia River in South Central Washington State during World War II as a plutonium production facility. After the war, the Hanford Site continued to produce plutonium for the U.S. weapons arsenal and also conducted research and development in reactor design, fuel fabrication, chemical separations, and biological effects of plutonium.

- The first file is a general analysis file, HFWC94A1_d1 (hfan2g01). This file consists of a single record for each worker who met the criteria for inclusion in the study. It contains demographic, vital status, cause of death, and essential work history information. Records are identified by the research staff at the University of North Carolina at Chapel Hill (UNCID).

- The second file contains annual external doses, HFWC94A1_d2 (hfan2a01). This single record file consists of a record for each worker in the study. Records are identified by UNCID. The file contains information on both recorded and estimated annual whole-body doses for each year from 1944 to 1989. Annual whole-body doses include cumulated gamma, x-ray, neutron, and tritium doses. Doses are recorded in mSv.
- The third file contains plutonium exposure data, HFWC94A1_d3 (hfan2p01). This file consists of a single record for each worker in the study. Records are identified by UNCID. The file contains information on the number of days in each work year in routine plutonium exposed jobs, the number of days in each work year in non-routine plutonium exposed jobs, and information about workers with confirmed internal depositions of radioactive materials.

A study cohort of Hanford workers who were hired between 1944 and 1978 was defined. Workers had at least one annual external dosimetry record and had been employed at least 180 days by a prime contractor. Four workers were excluded due to involvement in radiation accidents and/or unusually high annual external radiation dose estimates (>250 mSv). In order to minimize problems of missing or incomplete radiation exposure information, workers known to have been employed at other Department of Energy sites and workers with dose records from nuclear sites, if doses were available only as cumulative doses, were excluded. In order to minimize potential bias due to long periods of worker selection prior to start of follow-up, workers who were first hired by construction contractors and those who were hired at Hanford 2 or more years prior to achieving eligibility for the study were excluded.

Follow-up of vital status was conducted through 1994 using information from Social Security Administration searches, records of the Health Care Financing Agency, the NDI, and the Washington State Department of Licensing (driver's license bureau). Workers who were confirmed alive as of January 1, 1979, were assumed to be alive December 31, 1994, if there was no indication of death through NDI or other sources. Workers who could not be identified as dead or alive at the end of 1994 were censored as of their date of last observation. Death certificates were obtained from state departments of vital statistics. Underlying and contributory causes of death were coded to the ninth revision of the International Classification of Diseases (ICD9).

A detailed work history file indicating dates of employment, as well as job titles and areas/departments, was constructed. External radiation dose was estimated via a nearby procedure for any year that a worker was employed at the Hanford Site but an

external radiation dose record was not available. In addition, the potential for plutonium exposure via a simple job exposure matrix was estimated. The matrix had three dimensions: job title, area/process (reactor, separations, research and development, other), and time period (1944 to 1967 and 1968 to 1989). An industrial hygienist classified each cell in the table in the following categories: 0 = minimal potential for exposure to plutonium, 1 = non-routine or limited potential for exposure to plutonium, or 2 = routine potential for exposure to plutonium.

The number of days a worker spent in jobs with routine and non-routine potential for plutonium exposure was calculated.

Citations

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Wing, Steven B. -- Department of Epidemiology, School of Public Health, University of North Carolina. Grant Application: Ionizing Radiation and Mortality among Hanford Workers. July 1, 1996

IDAHO

▪ INELCMA1 Data File Set

Description

This analytic data file set consists of one file generated for a cohort study published as a NIOSH report in 2005 of workers at the Idaho National Laboratory (INL) (formerly Idaho National Engineering and Environmental Laboratory) in Idaho Falls, Idaho.

The Idaho National Laboratory is a large DOE facility near Idaho Falls, Idaho. Since its construction in 1949, INL has conducted a wide variety of activities, including engineering and basic scientific research, nuclear reactor design and testing, nuclear material chemical processing, and the construction, servicing, and demolition of large-scale facilities. In addition, the U.S. Navy maintains its Naval Reactors Facility (NRF) at INL, where research and testing of Navy ship reactors occurs, as well as training of military and civilian personnel involved in the naval nuclear surface ship and submarine

program. An epidemiologic cohort mortality study was initiated by researchers at the National Institute for Occupational Safety and Health to evaluate hazards associated with ionizing radiation and other exposures among workers at the INL facility. This report refers to the Idaho National Engineering and Environmental Laboratory (INEEL). On February 1, 2005, the Idaho National Engineering and Environmental Laboratory and Argonne National Laboratory-West became the Idaho National Laboratory.

This cohort study included 63,561 civilian workers ever employed by DOE, its contractors, or the Naval Reactors Facility (NRF) at INL at any time between 1949 and 1991. Vital status and causes of death if deceased were ascertained for each worker through 1999. Exposures were estimated to external ionizing radiation using site records available through 1998. Potential exposure to internal radiation was also categorized. The INL cohort was predominantly white (96%) and male (81%). The median year of birth was 1942. The median length of follow-up for the cohort was 21 years, and the median year of hire for white males (WM) was 1973.

The mortality of workers who were badged for ionizing radiation exposure was compared with that of unbadged workers. Workers receiving higher external radiation doses were compared with those receiving lower doses. The cohort was also divided into subcohorts for the evaluation of non-radiological hazards and other factors at INL. Subcohorts that could be identified include construction and maintenance/service workers, asbestos workers, painters, reactor workers, chemists and chemical operators, security workers, and drivers. Mortality patterns were also evaluated for cohort members by the type of employer they worked for (prime contractors, subcontractors, or multiple types of contractors).

The statistical analysis consisted of SMRs, standardized rate ratios (SRRs), and Poisson regression analysis. SMRs were calculated for the cohort by comparing mortality with both the U.S. population and to a regional population consisting of the states of Idaho, Montana, and Wyoming, while standardizing on sex, race (white or non-white), age in 5-year intervals, and calendar year in 5-year intervals. SRRs were calculated based on a comparison of the baseline categories with the regional population and on internal comparisons for exposed subcohorts. Poisson regression was used to evaluate associations between external radiation and cancers by estimating the risk of death per unit of dose for several groups of interest, as described in the report.

Although no smoking information was available for the cohort, two surrogates for smoking behavior were evaluated: socioeconomic status (SES), as defined by the

worker's first job title at INL, and state of origin as Utah, Idaho, Montana, or Wyoming, which was used as an indicator of possible membership in the Latter Day Saints religion (which is associated with lower rates of smoking and alcohol consumption). Smoking-related cancers were also analyzed separately as part of the Poisson regression analysis to determine whether they were related differently to radiation than non-smoking-related cancers.

The median duration of employment was just over 3 years. About 57% of the cohort was ever monitored for exposure to external radiation. The average cumulative external dose among the monitored workers was about 13 mSv. The highest average doses for workers, as well as collective doses across the site, occurred during the 1960s. About 47% of the cohort was classified as ever having been a construction or maintenance service worker. Smaller groups were identified as asbestos workers, painters, reactor workers, chemical workers, security workers, or drivers. About half the cohort came from the states of Utah, Idaho, Montana, and Wyoming. The cohort consisted of many professional (16%) and administrative/technical (15%) workers but also had a large percentage who were skilled manual or non-manual (33%) and partly skilled or unskilled (15%) workers. About 21% were of unknown SES.

When compared with the regional population, INL workers exhibited slightly lower mortality rates (overall SMR: 0.96, 95% confidence interval [CI] 0.94-0.97, 10,788 deaths), but cancer rates were elevated (all-cancer SMR: 1.07, 95% CI: 1.03-1.11, 2,873 deaths). Workers monitored internally and externally for ionizing radiation exposures showed lower mortality than non-monitored workers for most causes of death.

Mortality rates for certain cancers were elevated among the INL cohort or among individual subcohorts. Non-Hodgkin lymphoma (NHL) was elevated in the overall cohort, particularly among painters and female construction workers. Brain tumor mortality rates were elevated among male chemical workers and security workers. Construction and maintenance service workers showed elevated mortality rates from asbestosis and cancers likely to be mesotheliomas. Mortality rates for these causes were particularly high among those identified as asbestos workers. Bus and truck drivers showed elevated rates of death from transportation accidents, and security workers exhibited higher mortality rates from accidental falls and other non-transportation accidents compared with other workers.

An inverse external radiation dose-response relation was observed for emphysema, heart disease, and smoking-related cancers, suggesting negative confounding by smoking (that is, those receiving higher doses may have smoked with lower frequency or at a lower rate than those receiving lower doses). The excess relative risk (ERR) per

10 mSv (1 rem) of cumulative exposure was -0.0023, with an upper 95% confidence limit (CL) of 0.0459. Positive, but non-significant, associations were detected for brain tumors, leukemia, and lymphatic cancers, particularly when off-site dose was included in the model. At a 20-year dose lag, the ERR per 10 mSv for all brain tumors combined was 0.087 (95% CI: -0.0037 to 0.338). At a 7-year lag, the ERR per 10 mSv for non-CLL leukemia was 0.054 (95% CI: -0.011 to 0.24). The ERR per 10 mSv for CLL was negative, even when a longer lag period was used. For NHL, the ERR per 10 mSv was 0.020 (upper 95% CL: 0.10) and for multiple myeloma was 0.064 (95% CI: -0.015 to 0.35).

The INELCMA1_d1 (INEL2CEDR) file contains the following variables, where available: sex, race (white/non-white), date of birth (DOB), date of death (DOD), date last observed, vital status (VS), underlying cause of death, first hire date, last termination date, first monitoring date, date of first positive dose, annual cumulative on-site dose (1950 to 1998), annual cumulative on-site + off-site dose (1950 to 1998), SES, and indicator variables for migrant, construction, asbestos, painter, reactor, chemical, security, and driver worker status.

Citations

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An Epidemiologic Study of Mortality and Radiation-Related Risk of Cancer Among Workers at the Idaho National Engineering and Environmental Laboratory (INEEL), a U.S. Department of Energy Facility, January, 2005

HEALTH-RELATED ENERGY RESEARCH BRANCH, National Institute for Occupational Safety and Health, HHS (NIOSH) Publication No. 2005-131

Utterback, David F., Mills, Paul K., Glover, Sam, Cardarelli, John, Nowlin, Sue -- National Institute for Occupational Safety and Health (NIOSH), Protocol for an epidemiologic study of workers at the Idaho National Engineering Laboratory, May 16, 1994

LOS ALAMOS

▪ LAFEMA01 Data File Set

Description

The LAFEMA01 data file set contains one analytic file used in a cohort mortality study of the 6,573 white female workers at LANL, published as a doctoral dissertation by Laurie Wiggs in 1987.

The analysis sought to determine whether mortality among these workers differed significantly from the general population of females in the United States and whether the subgroup of this cohort that was exposed to radiation was at an increased risk of dying from cancer when compared with the unexposed group. The analysis focused on 6,573 white (those with race unknown were assumed to be white) females who were employed at LANL between 1943 and 1978, inclusive. Most analyses were further limited to the 5,234 white workers employed at least 6 months. The study found a SMR for suicide that was significantly elevated. Rate ratios for cancers of the ovary and pancreas were also significantly elevated for radiation-monitored members of the cohort. Due to the elevated risk of suicide, an elevated rate ratio for deaths due to all causes was also observed for the radiation workers in this cohort.

The single analytic file, LAFEMA01_d1, contains data for 6,790 females of all races employed at LANL and represents a complete roster of females hired through December 31, 1978. Some later hires are included in the file but not in the analysis. External exposure data in the file consist of dates (given in decimalized notation) on which the worker was first monitored, first received a positive exposure, first accumulated 1 rem whole-body dose, first accumulated 5 rem whole-body dose, and first received 10 rem whole-body dose. Whole-body dose was defined as the sum of all tritium, neutron, and penetrating gamma readings. External readings were available through 1981. Data pertaining to internal plutonium exposure include isotope, dates (in decimalized notation) of first and last samples, and estimated body burdens (in units of both nCi and nCi-years) of plutonium. Cumulative whole-body burdens for external radiation were reported in centirem. The latest date shown for either date of first and last sample was January 1, 1985. Estimated body burdens were calculated. The computer code PUQFUA was used to estimate plutonium body burdens incurred by workers through 1984. Demographic data were extracted from a number of sources, including LANL personnel and other records, and were computerized in 1982 and 1983 by the LANL Epidemiology Section.

Vital status was ascertained for 87% of the 6,790 females through December 31, 1981, the study end date. There were 430 deaths identified in this cohort. Causes of

death were coded to ICDA8. Other demographic information included race, ethnicity, education level, first and last job titles, and employment dates.

LANL has been a center for research in nuclear physics and weapons development since the 1940s. Sources of occupational exposures include external radiation, primarily gamma, and potential internal deposition of plutonium-238 and plutonium-239. Film dosimeters were used for personnel monitoring until 1980, when they were replaced with thermoluminescent dosimeters. Formal bioassay programs to monitor for internal exposures were begun in 1945. Results of both types of monitoring programs reflect technological improvements and changes in concepts and models.

Citations

Lawrence, J.N.P., PUQFUA, an IBM 704 Code for Computing Plutonium Body Burdens. 1962. Health Physics. 8:61-66

Wiggs, L. D., Mortality Among Females Employed by the Los Alamos National Laboratory: An Epidemiologic Investigation. 1987. Ph.D. Dissertation. University of Oklahoma

▪ LAHSWA04 Data File Set

Description

This data file set contains one analytic file prepared for a case-control cohort mortality study of 241 LANL workers exposed to plutonium by George Voelz, et al.

This file, LAHSWA04_d1, was generated in 1993 to 1994 for a historical cohort analysis of 241 plutonium-exposed workers employed at LANL, the Zia Company (Zia), or the Manhattan Project. The acronym HSW used in the file's name means Health Study of Workers as indicated in the report. Data for 7,225 controls from the Zia and LANL populations are also included. The analysis sought to determine whether mortality among these workers differed significantly from the general population of males and females in the United States and whether the males were at an increased risk of dying from cancer than the group of unexposed 7,225 male controls selected from the LANL and Zia cohorts.

This file contains demographic and exposure data for 224 white males and 17 females who were employed at the Los Alamos site during World War II and who represented the most highly exposed group of plutonium workers at LANL as of December 31, 1974. Also included is information for 6,452 white male controls selected from the LANL cohort matching the 224 plutonium-exposed males on race, age, and hire date. There is also information for 773 male Hispanic controls selected from the radiation monitored subgroup from the Zia cohort (the only Zia group with sufficient demographic information) to approximate the ratio of Hispanic to non-Hispanic males in the 241-member cohort as closely as possible in the controls. None of the males in the

control population had significant depositions of plutonium. Demographic information was abstracted from personnel records available for hires through December 31, 1977, for the LANL and Manhattan Project workers and through December 31, 1978, for the Zia workers. These data were supplemented with information from death certificates. Employment histories have not been updated since December 31, 1977, for the LANL workers and December 31, 1978, for the Zia workers. Demographic variables included date of birth, hire and term dates, ethnicity, race, sex, and education level.

Death information for the controls was last obtained in 1992 with a submission to NDI. Data were available from 1979 through 1990. Pre-1979 death information was available from earlier submissions to SSA. The 241-member cohort was actively traced in June of 1990 and vital status was ascertained for all members of the cohort. A study end date of June 1990 was assigned based on the death information provided by the NDI and the tracing effort for the 241-member cohort. Some deaths after the study end date were recorded but death information after end of study is not complete. Causes of death were coded to ICDA8.

The sources of occupational radiation exposures were external radiation, primarily gamma, and internal deposition of plutonium-238 and plutonium-239. Pocket chambers or film dosimeters were used for personnel monitoring from 1944 through the end of 1979, when they were replaced with thermoluminescent dosimeters. Formal bioassay programs to monitor for internal exposures were begun in 1944. Both external and internal radiation exposure data are available for all controls and the 241-member cohort. These are given as three arrays representing annual exposures in centirem for the years 1943 to 1990 for plutonium-239, plutonium-238, and external ionizing radiation. For all plutonium-monitored workers, first sample dates for plutonium-239 and plutonium-238 are included. For some plutonium-monitored workers, insufficient data were available to allow an estimate of their plutonium deposition or their deposition is known to be less than 0.3 nCi but cannot be determined exactly using available techniques. These workers are flagged but have no information available for their actual plutonium depositions. Values for external ionizing radiation are given as annual whole-body penetrating doses that are computed as the sum of penetrating gamma, tritium, and neutron components. All radiation exposure values are reported in centirem.

Citations

Report Health Study of Workers 241. HSW 241

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LAMENA03 Data File Set

Description

This data file set contains one analytic file used in a cohort mortality study of male workers at LANL by Laurie Wiggs et al.

This file was prepared for a historical cohort analysis of males at LANL in 1993. The analysis sought to determine whether mortality among these workers differed significantly from the general population of males in the United States and whether the subgroup of this cohort exposed to external ionizing radiation or plutonium exhibited an increased cancer death rate when compared with the unexposed group. Analyses focused on 15,727 white (unknown race assumed to be white) males whose birth and hire dates were available on their records and who were hired before January 1, 1978. No cause of death was elevated among the plutonium-exposed workers when compared with their unexposed co-workers. Significant dose-response relationships with whole-body dose from external ionizing radiation and tritium were observed for cancers of the brain/central nervous system, the esophagus, and Hodgkin's disease. A suggestive relationship was also observed for cancers of the kidney. An osteosarcoma was observed among the plutonium-monitored workers.

This file, LAMENA03_d1, contains demographic and exposure data for 16,438 males of all races employed at LANL from 1943 through December 31, 1977. Of these, 324 are non-white, 14,981 are known to be white, and 1,133 have an unknown designation for race. Demographic information was abstracted from personnel records available for hires through December 31, 1977. These data were supplemented with information from death certificates and some later LANL information. Employment histories have not been updated since December 31, 1977. Demographic variables include date of birth, race, ethnicity, education level, hire and term dates, and an indicator if the time at LANL was a military appointment.

Death information was last obtained in 1992 with a submission to NDI. NDI data were available from 1979 through 1990. Pre-1979 death information was obtained through earlier submissions to SSA. An end of study date of December 31, 1990, was assigned based on the death information provided by NDI. Some information on deaths after the study end date are included, but all workers identified as dead after the study end date were treated as alive for purposes of the study. There are a total of 3,319 deaths in the file with 3,239 of them occurring on or before December 31, 1990 (end of study). Causes of death were coded to ICDA8.

The sources of occupational radiation exposures were external radiation, primarily gamma, and internal deposition of plutonium-238 and plutonium-239. Pocket chambers or film dosimeters were used for personnel monitoring from 1944 through 1980, when they were replaced with thermoluminescent dosimeters. Formal bioassay programs to monitor for internal exposures were begun in 1944. External data consist of dates (given in decimalized notation) at which the worker was first monitored, first received a positive exposure, first received 1 rem whole-body dose, first received 5 rem whole-body dose, and first received 10 rem whole-body dose. Whole-body dose was defined as the sum of all tritium, neutron, and penetrating gamma readings. External readings (centirem) were available through December 31, 1990. Plutonium data include isotope type, first sample date (in decimalized notation), last sample date (decimalized), and estimated whole-body burdens (both nCi and nCi years) as of December 31, 1984.

Citations

Lawrence, J.N.P. PUQFUA, an IBM 704 Code for Computing Plutonium Body Burdens. 1962. Health Physics. 8:61-66

Voelz, G. L., Johnson, E. R., Lawrence, J. N. P. Mortality of 244 male workers exposed to plutonium. 1993 (unpublished). Los Alamos National Laboratory

Wiggs, L.D., Johnson, E. R., Cox-DeVore, C. A., Voelz, G. L. Mortality through 1990 among white male workers at the Los Alamos National Laboratory - considering exposures to plutonium and external ionizing radiation. 1994. Health Physics. 67(6):577-588

▪ LASUIA02 Data File Set

Description

This data file set contains one analytic file that was used in a nested case-control study of deaths from suicide among female workers at LANL by Laurie Wiggs et al. in 1988.

A study was undertaken to identify characteristics distinguishing white females dying from suicide from white females dying from all other types of injuries and those dying from non-injury causes. Two separate analyses were presented: one contrasting the 19 suicide deaths and the 41 other injury deaths, and one contrasting the 19 suicide deaths and 76 non-injury deaths. External radiation monitoring status and job classification both showed an association with risk of suicide when suicide deaths were compared with non-injury deaths. An association was also found between suicide and external radiation monitoring status when comparing suicide with deaths from all other injuries. No significant associations were found between risk of suicide and duration of employment, plutonium monitoring status, or marital status. Education was controlled in all comparisons.

The single analytic file, LASUIA02_d1, pertains to 136 white females employed at LANL. This number includes all suicide, all other injury deaths, and a 4:1 random sample of all other deaths. These 136 known-dead workers were selected from the file used in a 1987 LANL female cohort study (LAFEMA01). External monitoring data consist of dates (in decimalized notation) on which the worker was first monitored, first received a positive exposure, first received 1 rem cumulative whole-body dose, first received 5 rem cumulative whole-body dose, and first received 10 rem cumulative whole-body dose. Whole-body dose (centirem) was defined as the sum of all tritium, neutron, and penetrating gamma readings. External readings were available through December 31, 1981.

Only eight of the females in this file were monitored for plutonium. Internal exposure data consist of plutonium-239 body burdens that were calculated by the PUQFUA computer code, the official code used at LANL to estimate body burdens (nCi) from bioassay data. The date of first positive uptake of plutonium was hand-abstracted from data valid through 1986. Plutonium monitoring data include isotope type.

LANL has been a center for research in nuclear physics and weapons development since the 1940s. Sources of occupational exposures include external radiation, primarily gamma, and potential internal deposition of plutonium-238 and plutonium-239. Pocket chambers or film dosimeters were used for personnel monitoring until 1980, when they were replaced with thermoluminescent dosimeters. Formal bioassay programs to monitor for internal exposures were begun in 1945. Results of both types of monitoring programs reflect technological improvements and changes in concepts and models.

Citations

Lawrence, J.N.P. PUQFUA, an IBM 704 Code for Computing Plutonium Body Burdens. 1962. Health Physics. 8:61-66

Wiggs, L. D. Mortality Among Females Employed by the Los Alamos National Laboratory: An Epidemiologic Investigation. 1987. Ph.D. Dissertation. University of Oklahoma

Wiggs, L.D., Weber, C. A., Lee, E. T. 116th Annual Meeting of the American Public Health Association. Proceedings of the 116th Annual Meeting of the American Public Health Association. Suicide Mortality Among Female Nuclear Industry Workers (abstract). The American Public Health Association. Boston, MA. November 13-17, 1988. p. 46

▪ LAUPUA01 Data File Set

Description

The purpose of this study was to maintain long-term surveillance of a group of workers exposed to plutonium-239, in order to estimate the plutonium deposition throughout their lifetime and to maintain detailed medical records. The information can then be compared with existing plutonium dosimetry models, radiobiological information, and human epidemiologic studies of plutonium workers. This data file set,

prepared for studies by George Voelz, et al., consists of a single analytic file containing data taken from personnel records of 26 white males who were employed by the Manhattan Project (Los Alamos, New Mexico, now Los Alamos National Laboratory) during World War II. These data were used in this surveillance study of plutonium workers. These subjects were exposed to plutonium-239 from 1944 through 1945 during chemical and metallurgical research dealing with plutonium, as well as the fabrication of plutonium parts.

The plutonium work in 1944 to 1945 was partly done in chemical fume hoods, but some operations were performed in open rooms. Contamination of the work rooms with plutonium resulted from these operations. Inhalation of plutonium particles was the principal mode of exposure for this group of workers. These plutonium-exposed workers have had medical examinations approximately every 5 years since 1952. This data file was developed for the 1986 to 1987 examination records, at which time four of the subjects had died. There were three additional deaths before the data were submitted to CEDR. The information was obtained from personnel records and from continued personal contact with each of the 26 study subjects.

This file, LAUPUA01_d1, was developed for the fourth study in a series of studies documenting the health experience and possible effects of exposure for the 26 subjects. The selection of the 26 subjects was based on the history of individual job assignments, work conditions, and the results of plutonium measurements in urine samples taken during that period. The variables available include date of birth, date of death, cause of death (ICDA8), and hire and term dates.

Citations

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Topical Meeting: Epidemiology Applied to Health Physics. Mortality Study of Los Alamos Workers with Higher Exposures to Plutonium. Albuquerque, NM, Springfield, VA. 1983. 1983:318-327

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Voelz, George L., Hempelmann, Louis H., Lawrence, J. N. P., Moss, William D. A 32-year Medical Follow-up of Manhattan Project Plutonium Workers. 1979. Health Physics. 37:445-485

LINDE

▪ LND87A01 Data File Set

Description

This analytic data file set consists of one file generated for a cohort mortality study of white males employed at the Linde Plant by Elizabeth Dupree, et al., published in the Scandinavian Journal Work Environment Health in 1987.

This retrospective cohort mortality study investigated the relationship between exposure to low-level ionizing radiation and subsequent health outcomes among workers at the Linde Plant. Two comparison groups were used in this analysis. The first group consisted of all U.S. white males and the second group was the white male population of Erie and Niagara counties in New York State. Significantly increased SMRs were observed for all causes of death, laryngeal cancer, all circulatory diseases, arteriosclerotic heart disease, all respiratory diseases, and pneumonia. No association was found with length of employment or with work in the most hazardous areas of the plant. The comparison with regional rates gave similar results.

The single analytic file, LND87A01_d1 (MOSTEXP), in this data file set consists of one record per person in the study cohort and contains demographic, work history, and vital status data as well as information concerning exposures to chemicals and uranium. Examples of these are exposures to uranium hexafluoride, nitric acid, and hydrofluoric acid.

The cohort was selected from a roster of all persons (1,551) employed at the Linde Plant, which was in operation from 1943 to 1949. All females, non-white males, males of unknown race, and people employed less than 30 days were excluded, leaving 995 white males in the study cohort. Vital status was ascertained for 94.3% of the cohort through December 31, 1979, the study end date. There were 429 deaths identified, and death certificates were obtained for 406 (94.6%) of these deaths.

At the Linde Plant, Congo pitchblende and uranium from domestic mines were converted to uranium tetrafluoride. This process yielded intermediate products, including uranium oxide, uranium trioxide, and uranium dioxide. Compared with uranium tetrafluoride, these products are relatively insoluble. Workers were also potentially exposed to low levels of external radiation and to a wide variety of chemicals. The more hazardous chemicals included chlorine, hydrofluoric acid, lead sulfate, nickel, nitric acid and nitrogen oxides, silicon dioxide, sulfuric acid, uranium dust, and uranium hexafluoride. Generally, four types of measurements contained information useful in assessing radiation hazards. They were (1) air monitoring results for radon-222 and airborne uranium, (2) measurements of surface contamination, (3) urinalysis results, and (4) personnel film badge results. The first three types of measurements were used to assess the potential for internal radiation exposure for each job that existed at the plant. Three separate analyses were carried out using each type of data, and the results were combined to assign a given job to one of three exposure groups. These data also were used to estimate individual lung doses. The limited film badge data were used to evaluate the potential for exposure to external radiation. Each job at the plant was assigned to one of two categories, namely, jobs with mean weekly film badge results below the minimum detectable level and jobs with mean weekly film badge results above the minimum detectable level.

Citations

Dupree, E.A., Cragle, D.L., McLain, R.W. -- Center for Epidemiologic Research, Oak Ridge Associated Universities (ORAU). Crawford-Brown, D.J. -- Univ. of North Carolina (UNC)
Teta, M.J. -- Union Carbide Corporation. Mortality among workers at a uranium processing facility, the Linde Air Products Company Ceramics Plant, 1943-1949. Scandinavian Journal Work Environmental Health. 13:100-107

MALLINCKRODT

▪ MCD94A01 Data File Set

Description

This analytic data file set consists of one file generated for a retrospective cohort mortality study of white males employed in the Uranium Division of MCW in Missouri by Elizabeth Dupree..

The study cohort comprised 2,542 white males employed for at least 30 days from 1942 through plant shutdown in 1966. Excluded were 556 females, 43 non-white males, as well as those employed for less than 30 days or having “critical errors” in their data. Follow-up was through the end of 1988. The total person-years of follow-up was 79,600 with a median of 27.3 years. A typical worker was first employed in 1951 at 30 years of age and worked slightly more than 5.5 years. The all-causes SMR was 0.94 with 95% confidence interval 0.87 to 1.00. The elevation in the all-cancers SMR of 1.13 (0.99 to 1.28)

resulted from increases in a variety of cancers, particularly in those of the digestive and respiratory systems and prostate and brain cancer.

The single analytic file, MCD94A01_d1, contains a record for each member of the cohort, which includes vital status as of January 1, 1989. The last SSA submission for this population provided "alive" status as of January 1, 1985; the "alive" category is no longer obtainable from SSA. However, NDI provides a record of all deaths occurring since January 1, 1979, and Pension Benefit Information Incorporated (PBI) also identifies deceased individuals. If not identified as deceased by SSA, NDI, or PBI, individuals last known to be alive before January 1, 1979 were considered lost to follow-up on the last date known alive, while those known to be alive after January 1, 1979, were considered alive at the end of the study. There were 837 deaths from all causes with death certificates available for 98.2% of these individuals. Causes of death were coded to ICDA8.

MCW was one of the oldest and largest uranium processing facilities in the United States, operating in St. Louis, Missouri from 1942 to 1958 and in Weldon Springs, Missouri, from 1958 through 1966. From 1946 through 1955, pitchblende ore was used in the processing of uranium dioxide and uranium metal. This ore was a dry solid that dusted easily and was up to 60% pure uranium, resulting in exposure levels that may have been nearly 200 times the contemporary maximum permissible concentration. Most of the uranium compounds present were relatively insoluble. Potential exposures included gamma (from radium), beta, and alpha radiation; thorium; and chemicals including nitric and hydrofluoric acids. Each employee had a pre-employment and annual physical exam, with abnormal findings leading to a transfer to another division of MCW. Transferred workers remained in this study cohort with follow-up through 1988. The exposure variables available include pitchblende (categorical), thorium (categorical), uranium urine bioassay (categorical), whether film badge readings were available, and whether radon breath monitoring was completed.

▪ MCD98A02 Data File Set

Description

This analytic data file set consists of four files generated for the retrospective cohort mortality study of white male workers at MCW in Missouri by Elizabeth Dupree-Ellis.

The purpose of the study was to (1) evaluate the mortality of this cohort as compared with the U.S. population, and (2) evaluate the relationship between external ionizing radiation exposure and cancer and other diseases of the respiratory, digestive, genitourinary, and lymphatic systems. This particular analysis considers only external

radiation doses. The first of the four data files contains demographic and vital status data on this cohort. The other three contain dosimetry data, based on a 0-year, 2-year, and 10-year lag.

File MCD98A02_d1 contains demographic and vital status data including date of birth, cause of death (ICDA8), and employment dates. Files MCD98A02_d2, MCD98A02_d3, and MCD98A02_d4 contain dosimetry data through 1993 with varying lag of 0, 2, or 10 years. Dosimetry data are reported as cumulative external radiation exposure (mSv).

Citations

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External radiation exposure and mortality among a cohort of uranium processing workers, September, 1998, Center for Epidemiologic Research, Oak Ridge Institute for Science and Education (ORISE)

▪ MCG19A01 Data File Set

Description

Mallinckrodt Chemical Works was the earliest uranium processing facility in the United States, and in 1942, produced the uranium oxide used for the first sustained and controlled nuclear fission chain reaction at the University of Chicago. A second follow-up through 2012 was conducted of 2,514 white male workers employed 1942 to 1966 at the MCW for dose-response analyses for selected causes of death. The cohort was the same as used in the first analysis with follow-up through 1993 (Ellis 2000). The current analysis extended follow-up through 2012 and included organ doses. Organ/tissue-specific dose reconstruction included both external (12,686 MCW film badge records, 210 other facility film badge records, and 31,297 occupational chest x-rays) and internal sources of uranium and radium (39,451 urine bioassays, 2,341 breath radon measurements, and 6,846 ambient radon measurements). Dust measurements from pitchblende facilitated quantitative risk estimates for non-radiogenic effects on the lung and kidney.

Vital status was determined from multiple sources including the National Death Index and the Social Security Administration. Results: Vital status was determined for 99% of the workers, of whom 75% had died.

The mean lung dose from all sources of external and internal radiation combined was 69.9 mGy (maximum 885 mGy; percent workers greater than 100 mGy, 10%) and there was no evidence for a dose response for lung cancer (HR of 0.95 [95% CI 0.81–1.12] at 100 mGy). A significant association with radiation was found for kidney cancer (HR of 1.73 [95% CI 1.04–2.79] at 100 mGy) and suggested for non-malignant kidney diseases (HR of 1.30 [95% CI 0.96–1.76] at 100 mGy). A non-radiation etiology

could not be discounted, however, because of the possible renal toxicities of uranium, a heavy metal, and silica, a component of pitchblende dust. Non-significant HRs at 100 mGy for other sites of a priori interest were 0.36 (0.06–2.03) for leukemia other than CLL, 0.68 (0.17–2.77) for liver cancer, and 1.23 (0.79–1.90) for non-Hodgkin lymphoma. The HR at 100 mGy was 1.09 (0.99–1.20) for ischemic heart disease. An association was seen between dust and combined malignant and non-malignant lung disease, HR at 10mgm^-3 year^-1 of 1.01 (1.00–1.02). A positive radiation dose response was observed for malignant and non-malignant kidney disease, and a negative dose response was observed for malignant and non-malignant lung disease. Cumulative measures of dust were significantly associated with malignant and non-malignant lung disease and suggested for malignant and non-malignant kidney disease. Small numbers preclude definitive interpretations, which will await the combination with similar studies of early uranium processing workers.

The file Annual Data (MCG19A01_d1) contains 121,375 records and covers 1942 through 1968 exposures. The Person Data (MCG19A01_d2) has 2,514 people and contains their demographic information and their underlying cause of death (ICDA8). Other demographic variables available include date of birth, pay code, year of hire, and follow-up start and stop dates.

Citation

Ashley P. Golden, Elizabeth D. Ellis, Sarah S. Cohen, Michael T. Mumma, Richard W. Leggett, Phillip W. Wallace, David Girardi, Janice P. Watkins, Roy E. Shore, John D. Boice, Updated mortality analysis of the Mallinckrodt uranium processing workers, 1942–2012, 2019, International Journal of Radiation Biology, DOI: 10.1080/09553002.2019.1569773

Dupree-Ellis, E., Watkins, J., Ingle, N., Phillips, J., External radiation exposure and mortality in a cohort of uranium processing workers. 2000, American Journal of Epidemiology, 152(1):91-95

External radiation exposure and mortality among a cohort of uranium processing workers, September, 1998, Center for Epidemiologic Research, Oak Ridge Institute for Science and Education (ORISE)

Elizabeth D. Ellis, John D. Boice, Ashley P. Golden, David Girardi, Sarah H. Cohen, Michael T. Mumma, Roy W. Shore, Richard W. Leggett, George D. Kerr, Dosimetry is Key to Good Epidemiology: Workers at Mallinckrodt Chemical Works had Seven Different Source Exposures, 2018

Health Physics, 114(4):386-397, DOI: 10.1097/HP.0000000000000847

MOUND

▪ MDB13A01 Data File Set

Description

Polonium-210 is a naturally occurring radioactive element that decays by emitting an alpha particle. It is in the air we breathe and also a component of tobacco smoke. Polonium-210 is used as an anti-static device in printing presses and gained widespread notoriety in 2006 after the poisoning and subsequent death of a Russian citizen in London. More is known about the lethal effects of polonium-210 at high doses than about late

effects from low doses. Cancer mortality was examined among 7,269 (MDB13A01_d1) workers at the Mound nuclear facility in Dayton, Ohio, where polonium-210 was used (1944 to 1972) in combination with beryllium as a source of neutrons for triggering nuclear weapons. Other exposures included external gamma radiation and to a lesser extent plutonium-238, tritium, and neutrons. Vital status and cause of death were determined through 2009. Lifetime occupational doses from all places of employment were sought and incorporated into the analysis. Over 250,000 urine samples were analyzed to estimate radiation doses (MDB13A01_d2) to body organs from polonium and other internally deposited radionuclides in mSv. Vital status was determined for 98.7% of the workers of which 3,682 had died compared with 4,074.7 expected (SMR 0.90; 95% CI 0.88–0.93). The mean dose from external radiation was 26.0 mSv (maximum 1.4 Sv) and the mean lung dose from external and internal radiation combined was 88.4 mSv (maximum 17.5 Sv). Among the 4,958 radiation workers, all cancers taken together (SMR 0.86; 95% CI 0.79–0.93), lung cancer (SMR 0.85; 95% CI 0.74–0.97), and other types of cancer were not significantly elevated. Cox regression analysis revealed a significant positive dose-response trend for esophageal cancer (relative risk [RR] and 95% confidence interval at 100 mSv of 1.54 [1.15-2.07]) and a negative dose-response trend for liver cancer (RR 95% CI at 100 mSv of 0.55 [0.23-1.32]). For lung cancer, the RR at 100 mSv was 1.00 (95% CI 0.96–1.04) and for all leukemia other than CLL it was 1.14 (95% CI 0.65–1.99). There was no evidence that heart disease was associated with exposures (RR at 100 mSv of 1.06). Assuming a relative biological effectiveness factor of either 10 or 20 for polonium and plutonium, alpha particle emissions had little effect on the dose-response analyses. Polonium was the largest contributor to lung dose, and a relative risk of 1.04 for lung cancer at 100 mSv could be excluded with 95% confidence. A dose-related increase in cancer of the esophagus was consistent with a radiation etiology but based on small numbers. A dose-related decrease in liver cancer suggests the presence of other modifying factors of risk and adds caution to interpretations. The absence of a detectable increase in total cancer deaths and lung cancer in particular associated with occupational exposures to polonium (mean lung dose 150 mSv) and to plutonium to a lesser extent (mean lung dose 14 mSv) is noteworthy. Nonetheless, larger combined studies of U.S. workers are needed to clarify radiation risks following prolonged exposures and radionuclide intakes.

Citations

Boice, J.D. Jr., Cohen, S.S., Mumma, M.T., Dupree Ellis, E., Cragle, D.L., Eckerman, K.F., Wallace, P.W., Chadda, B., Sonderman, J.S., Wiggs, L.D., Richter, B.S., Leggett, R.W., 2014, Radiation Research, 181(2):208-228, Mortality Among Mound Workers Exposed to Polonium-210 and Other Sources of Radiation, 1944–1979

MDEXTA02 Data File Set

Description

This data file set contains one analytic file generated for a cohort mortality study of men and women employed at the Mound Plant in Ohio by Laurie Wiggs, et al., published in the Journal of Occupational Medicine in 1991.

This cohort mortality study of Mound workers was conducted to test the association between mortality and exposure to radiation. The published analyses focused on 3,229 white males monitored for exposure to external radiation, who were already employed as of January 1, 1947, or who were subsequently hired before 1979. A strong healthy worker effect was noted among white males who were monitored for external radiation (all causes of death SMR = 79, 95% CI = 70-88). No cause of death was significantly elevated. When mortality for workers who received external, cumulative whole-body doses that were at least 10 mSv was compared with mortality among non-exposed workers, the rate ratios were not significantly elevated for any cause of death. However, a dose-response analysis was conducted considering three categories: non-exposed, or less than 10 mSv cumulative whole-body dose exposed; 10-49.9 mSv; and exposed, greater than or equal to 50 mSv. This analysis reported a statistically significant relationship between external dose and mortality from all leukemia. This result was based on the identification of two deaths in the highest exposure category, one of which was a chronic lymphatic leukemia, a type of leukemia which has not been considered a radiogenic cancer.

The analytic file, MDEXTA02_d1, contains 6,904 records representing male and female workers first hired from the beginning of the Dayton Project (about 1943) through part of 1979. During the course of the analyses, 20 of these records were found to be duplicates of other records in the file. The analyses in the published paper did not include these 20 duplicate records (N = 6,884). After the paper was published, two additional records were found to be either duplicative or belonging to a person who never worked at Mound. These 22 records have blank identification numbers. Monitoring data in the file include estimated first date of monitoring, cumulative whole-body dose through the end of 1979, and dates on which the cumulative whole-body dose reached 10, 50, or 100 mSv. Demographic variables included in the file are date of birth, date of death, sex, race, education level, date of hire, and duration of employment.

Vital status ascertainment was 98.1% complete for the 4,182 white males through January 1, 1980. Death certificates were obtained for 98.8% (586) of the 593 deaths that occurred between 1947 and 1979, inclusive. Causes of death were coded as ICDA8.

Major operations conducted at Mound included the separation, chemistry, and metallurgy of polonium-210 and processing of plutonium-238 for heat sources. Later, small research projects involved other isotopes, including radium and thorium. Personal external monitoring data are available at Mound for years after 1947.

Citations

Wiggs, Laurie D., Cox-DeVore, Carol A., Wilkinson, Gregg S., Reyes, Michele -- Los Alamos National Laboratory (LANL). Mortality Among Workers Exposed to External Ionizing Radiation at a Nuclear Facility in Ohio. May, 1991. Journal of Occupational Medicine. 33(5):632-637

▪ MDPOLA03 Data File Set

Description

This data file set consists of one analytic file generated for a cohort mortality study of men who were employed at the Mound Plant by Laurie Wiggs, et al., published in Health Physics in 1991.

This cohort mortality study of Mound workers was conducted to test the association between mortality and exposure to polonium-210. The published analyses focused on 4,402 white and presumed white males employed during 1944 to 1972, the period during which Mound conducted operations using polonium-210. Of the 4,402 white males, there were 2,181 who were monitored for exposure to polonium. A healthy worker effect was noted among the cohort of 4,402 white males (all causes of death SMR = 93, 90% CI = 89-99; all cancer SMR = 100, 90% CI = 89-113). The SMR for lung cancer was elevated to a level of statistical significance only for workers employed between 1944 and 1945. The SMR for deaths due to all causes for workers exposed to polonium was less than 100 (SMR = 92, 90% CI = 85-98). Although the SMR for lung cancer was elevated (SMR = 113), the 90% confidence limits included 100 (87-117). Dose-response analyses using the MOX program were performed using kidney dose as the exposure metric. No statistically significant trends in mortality were observed.

The single analytic file, MDPOLA03_d1, in this data file set contains data for 6,884 workers who were initially hired between 1943 through 1979, inclusive. Exposure data in the file include the estimated first date of monitoring, cumulative whole-body dose (mrem) through the end of 1979, and dates on which the whole-body dose reached 10, 50, or 100 mSv. Polonium exposure data include the date and volume of the sample, the results of the radiochemical analysis, and any comments specific to the sample or the radiochemical analysis of the sample. An electronic file containing these data was used by Mound staff to calculate kidney and spleen doses due to polonium-210 (in mrem). These organ doses appear in this analytic file.

Vital status was ascertained for 95.6% of the 4,402 white males through January 1, 1984. There were 987 deaths identified in this group, and death certificates were obtained for 97.4% (961) of these deaths. Vital status was ascertained for 96.6% (2,106) of the 2,181 polonium workers, and death certificates were obtained for 98.6% (558) of them. Causes of death were coded to ICDA8. Other variables include sex, race, and education level.

Major operations conducted at Mound include the separation, chemistry, and metallurgy of polonium-210 and processing of plutonium-238 for heat sources. Later, small research projects involved other isotopes, including radium and thorium. Records pertaining to Mound's external dosimetry monitoring program, first using film badges and later switching to thermoluminescent dosimeters, began in 1947. Mound began urine bioassays for polonium in 1944. The last time a worker entered the polonium bioassay program was in 1972.

Citations

Wiggs, L. D., Cox-DeVore, C. A., Voelz, G. L. Mortality Among a Cohort of Workers Monitored for Po-210 Exposure: 1944-1972 (polonium 210). 1991. Health Physics. 61(1):71-76

▪ MDSMRA01 Data File Set

Description

This analytic data file set consists of one file generated for a cohort mortality study of white males employed at the Mound Plant by MG Reyes, et al., published as a LANL Report.

A cohort mortality study of workers was conducted to test for an association between mortality and employment at the Mound Plant. The study examined differences in mortality for workers at the plant during its polonium-210 era (1943 to 1959) and for its plutonium-238 era (1960 to 1980) by computing period-specific SMRs based on U.S. rates. The analysis focused on 4,697 white and presumed white males who were employed between April 1, 1942, and December 31, 1979, at the Mound Plant. SMRs of 96 were observed for all causes and for all cancers for the study period (1943 to 1979). No SMR was significantly greater than 100 for these workers. A significantly elevated SMR for lung cancer (SMR = 204, 90% CI = 140, 290) was observed for workers employed during World War II (1943 to 1945). Similar results were noted for all causes of death, all cancers, cancer of the rectum, non-malignant respiratory diseases, and all injuries during this time period. SMRs for these causes of death during the polonium era, but after World War II, were not elevated. No elevated SMRs were observed during the plutonium era. A very strong healthy worker effect was observed for workers in the plutonium era, although the length of follow-up for these workers was relatively short.

The single analytic file, MDSMRA01_d1, in this data file set contains demographic and vital status data for 4,697 white males and presumed white males who were employed between April 1, 1942, and December 31, 1979. Not included in the analytic file are workers employed less than 30 days during this period, workers with unknown birth dates, and workers with both unknown hire and termination dates. No exposure data are included in the file.

Vital status was determined for 97.6% (4,588) of the workers in this file. Death certificates were obtained for 97% (803) of the known deaths. Causes of death were coded to ICDA8. Sex, race, education level, and dates of employment are also included in the data.

The Mound Plant has been a center for the separation, chemistry, and metallurgy of polonium-210 and processing of plutonium-238 for heat sources. Other small research projects involved radium and thorium. Workers could have been exposed to external and internal sources of radiation; however, this analysis did not examine exposure data.

Citations

Reyes, Michele, Wilkinson, Gregg S., Tietjen, Gary L., Wiggs, Laurie D., Galke, Warren A. Mortality Among Workers at the Mound Facility, a Preliminary Report. April, 1991. Los Alamos National Laboratory (LANL). Los Alamos Report No. LA-11997-MS

OAK RIDGE/K-25

▪ ORK25A01 Data File Set

Description

This analytic data file set consists of one file generated for a case-control study of white male nickel workers at the Oak Ridge K-25 Facility by Donna Cragle, et al., published in IARC Scientific Publications.

This study examined mortality patterns in a group of 814 workers potentially exposed to nickel powder because previous studies of workers at nickel refineries had shown excesses of lung and nasal sinus cancers. Between January 1, 1948, and December 31, 1953, the ORGDP (now known as the K-25 Facility) employed over 800 white males in the manufacture of "barrier" material for nuclear weapons. This process required the use of metallic nickel powder. For the study, a comparison group of 7,552 white males employed for at least 1 day at K-25 between January 1, 1948, and December 31, 1953, and who had no indications of occupational involvement in the production of barrier material was selected. Mortality rates in the nickel workers and non-nickel workers were compared with each other and with those of U.S. white males. There was no evidence of increased mortality due to lung cancers or nasal sinus cancers in the nickel

workers. Increases, not statistically significant, in mortality due to cancers of the buccal cavity, pharynx, and digestive system were observed in the nickel worker group when compared with the non-nickel worker group.

The single analytic file, ORK25A01_d1 (K25EVER1), contains one record for each of the 8,378 individuals in the cohort that includes the nickel workers and the comparison group of non-nickel workers. Vital status was ascertained for 100% of the cohort through December 31, 1977, which allowed at least 24 years of follow-up for each individual. There were 137 deaths identified in the nickel worker group and 1,920 deaths in the comparison group. Death certificates were obtained for 97% of the total number (2,057) of deaths.

Radiation monitoring data were not used in this study.

Citations

Cragle, D.L., Hollis, D.R., Newport, T.H. -- Oak Ridge Associated Universities (ORAU). Shy, C. M. -- Univ. of North Carolina (UNC). A retrospective cohort mortality study among workers occupationally exposed to metallic nickel powder at the Oak Ridge Gaseous Diffusion Plant. 1984. Nickel in the Human Environment. IARC Scientific Publications. 53:57-63

Godbold, Jr. J. H., Tompkins, E.A. A long-term mortality study of workers occupationally exposed to metallic nickel at the Oak Ridge Gaseous Diffusion Plant. 1979. Journal of Occupational Medicine. 21:799-806

▪ ORK25A02 Data File Set

Description

This analytic data file set consists of one file generated for a retrospective cohort mortality study of all workers at the K-25 Facility in Oak Ridge, Tennessee, who were employed for at least 30 days and hired before January 1, 1985, by Donna Cragle.

Of the 35,712 workers in the study cohort, 72.1% were white males, 3.4% were non-white males, 22.6% were white females, and 1.9% were non-white females. Full-scale operation at the facility began in January 1945, and more than 57% of the members of the study cohort were hired by the end of that year. Although the plant was in operation until 1985, less than 16% of the cohort was employed for 10 or more years, while 44% was employed for less than 1 year. Unlike most occupational cohorts, no healthy worker effect was seen for these workers. Further, there were statistically significantly elevated standardized mortality ratios for white males for all causes (1.03, 95% CI = 1.01- 1.05), along with malignant and non-malignant respiratory diseases and bone cancer.

The single analytic file, ORK25A02_d1 (ANALUPD1), contains a record that includes vital status as of January 1, 1990, and demographic and work history data for 40,785 employees of both genders and all races who were employed for at least 30 days and

hired before January 1, 1985. Due to "critical errors" in their data, mainly missing race, gender, or pay code status, 5,073 of these individuals were eliminated from the study cohort.

The last SSA submission for this population provided "alive" status as of January 1, 1985. The "alive" category is no longer obtainable from SSA. However, NDI provides a record of all deaths occurring since January 1, 1979. If not identified as deceased by SSA or NDI, individuals last known to be alive before January 1, 1979, were considered lost to follow-up on the last date known alive while those known to be alive after January 1, 1979, were considered alive at the end of the study. There were 12,848 deaths from all causes with death certificates available for 97.8% of these individuals. The number of deaths by race/gender groups were 10,956 white males, 370 non-white males, 1,412 white females, and 110 non-white females.

K-25 produced enriched uranium through gaseous diffusion processes. There were numerous occupational exposures at the site with soluble uranium being a major contributor. Other potential hazards included some external radiation, insoluble uranium oxides, uranium hexafluoride, hydrofluoric acid, solvents, laboratory chemicals such as fluorocarbons, metallic nickel, and epoxy resins and hardeners. Mortality outcomes of special interest because of the particular occupational exposures present included cancers of the respiratory, lymphatic, and hematopoietic systems and non-malignant diseases of the kidney and respiratory system.

Citations

Dupree, E. A., Wells, S. M., Watkins, J.P., Wallace, P.W., Davis, N.C. Mortality among workers employed between 1945 and 1984 at a uranium gaseous diffusion facility. Final Report. February 1996. Center for Epidemiologic Research, Oak Ridge Institute for Science and Education (ORISE), National Institute for Occupational Safety and Health under contract DE-AC05-76ORO00033

▪ ORK25A03 Data File Set

Description

The analysis file, prepared for studies by H.D. Wooten and Donna Cragle, consists of seven files containing questionnaire data administered through interviews with K-25 workers who were employed in the gas centrifuge process and K-25 workers who were not involved in this process. These data were analyzed by conducting a case-control study.

K-25 workers who were employed in the gas centrifuge process were the focus of an interview study completed by Cragle et al. The study was conducted to determine the incidence rate of cancers and illness symptoms that could be related to epoxy resin and solvent exposures that were prevalent in this process. A total of 263 workers who were judged to have worked the closest to the process for the longest period of time were

interviewed, as well as 271 other employees who were at the plant during the same era of time but did not work in the centrifuge process.

The centrifuge workers and the non-centrifuge workers had similar overall cancer incidence rates. However, the centrifuge workers reported five incident bladder cancers since beginning to work in the centrifuge process versus none reported in the non-centrifuge group. The centrifuge workers also reported significantly more rashes, dizziness, and numb or tingling limbs during employment, which are all symptoms of high solvent exposure.

The analysis file consists of seven files containing identifying data from interviews with centrifuge workers, ORK25A03_d1 (CENTRIF.ID), and questionnaire data, ORK25A03_d2 through ORK25A03_d7 (CENTRIF.Q2, CENTRIF.Q3, CENTRIF.Q4, CENTRIF.Q5, CENTRIF.Q6, and CENTRIF.Q7).

Exposures of interest in context of operations conducted at the facility: One of the epoxy resins used in the early years of the process was potentially a bladder carcinogen, but none of the workers with bladder cancer had jobs that required routine, hands-on work with the material. A specific causative agent for the increase in bladder cancer was not identified.

Citations

Cragle, D. L., Wells, S. M., Tankersley, William G. An Occupational Morbidity Study of a Population Potentially Exposed to Epoxy Resins, Hardeners, and Solvents. December 1992. Applied Occupational and Environmental Hygiene. 7(12):826-834

Dupree, E. A., Wells, S. M., Watkins, J.P., Wallace, P.W., Davis, N.C. Mortality among workers employed between 1945 and 1984 at a uranium gaseous diffusion facility. Final Report. February 1996. Center for Epidemiologic Research, Oak Ridge Institute for Science and Education. (ORISE), National Institute for Occupational Safety and Health under contract DE-AC05-76ORO00033

Wooten, H. D. Centrifuge workers study. Phase II, completion report. September 01, 1994. Oak Ridge National Laboratory. ORNL--6822, NTIS Order Number DE97002963

OAK RIDGE/MULTI-FACILITY

▪ ORMULA01 Data File Set

Description

This analytic data file set consists of one file generated for a cohort mortality and morbidity study of white male welders employed at one or more of the three Oak Ridge facilities by AP Polednak, published in Archives of Environmental Health in 1981.

This study examined mortality from various diseases, including cancer of the respiratory system, in a cohort of 1,059 white male welders exposed to nickel compounds. The study also examined the long-term health effects of exposure to

several other compounds (dust, fumes, and gases) among welders. A subgroup of these welders was exposed to nickel oxides at the Oak Ridge K-25 Facility, formerly known as ORGDP. These workers were subjected to air concentrations of nickel higher than proposed standards. However, SMRs for lung cancer and diseases of the respiratory system were not higher among K-25 welders than among other welders.

The single analytic file, ORMULA01_d1 (ANALYSIS), in this data file set contains demographic and vital status data for 1,062 individuals. There is one record per person. Three individuals were not included in the final analyses. Radiation monitoring data were not used in the analysis.

The study cohort of 1,059 white male welders was determined by examining work histories (payroll records) that specified job titles and job codes indicative of welding. Industrial hygienists at the plant were consulted to avoid possible exclusion of job titles and job codes associated with welding on a full-time basis. Vital status was ascertained for approximately 92% of the study cohort through December 31, 1974, the study end date. There were 173 deaths identified, and death certificates were obtained for 166 (95.9%) of these deaths. Personal radiation monitoring data were not used.

Citations

Polednak, Anthony P. Mortality among welders, including a group exposed to nickel oxides. 1981. Archives of Environmental Health. 36(5):235-242

Wells, S. M., Cragle, D. L., Tankersley, W. G. An update of mortality among welders, including a group exposed to metal oxides. Undated. Oak Ridge Associated Universities (ORAU) Oak Ridge Institute for Science and Education (ORISE)

Wells, S., Cragle, D.L., Tankersley, W. Mortality update among welders at multiple sites. Final Report. July, 1997. Oak Ridge Associated Universities. Document 98-0790

▪ ORMULA02 Data File Set

Description

This analytic data file set consists of one file generated for a cohort mortality study of white males who worked at the Oak Ridge facilities during World War II (WWII) by Ed Frome, et al., published in Radiation Research in 1990.

This study demonstrated that Poisson regression methods can effectively describe the effect of multiple risk factors on cause-specific mortality. The cohort was defined as 28,008 white males who were employed for at least 1 month at any one of the three Oak Ridge facilities. Between 1943 and 1947, two of the facilities (Y-12 and K-25) produced enriched uranium. The third facility, Oak Ridge National Laboratory, was a research and development facility. During WWII, radiation monitoring programs were in developmental stages. Only persons considered likely to be exposed or those who were thought to

be representative samples of workers likely to be exposed were monitored. The paper discusses how a modified version of the traditional SMR analysis was used to compare the cause-specific mortality experience of these workers with the U.S. population. The SMR for all causes was 1.11, and there was a significant upward trend of 0.74% per year. The excess mortality was primarily due to lung cancer and diseases of the respiratory system.

The single analytic file, ORMULA02_d1 (PHASE1B), in this data file set contains 28,008 records, one for each person in the cohort. Each record consists of demographic, vital status, and work history data and external exposure indicators. The indicators were used as surrogates for external exposure data and were determined by analyzing job title and department combinations, categorizing each combination by risk of exposure.

The cohort included only those workers who were hired at one of the facilities between the start of operations at that respective facility and December 31, 1947. Each person was considered to have entered the cohort on January 1, 1950. Vital status was ascertained for 98.1% of the cohort through December 31, 1979, the study end date. There were 11,671 deaths identified, and death certificates were obtained for 96.8% of these deaths.

Because radiation monitoring programs were still in developmental stages, complete personal monitoring data for this cohort were not available during the time period. Therefore, exposure indices based on job title and department combinations were developed as surrogates for monitoring data.

Citations

Frome, Edward L. -- Oak Ridge National Laboratory (ORNL). Cragle, Donna L., McLain, Richard W. -- Oak Ridge Associated Universities (ORAU). Poisson Regression of the Mortality among a Cohort of World War II Nuclear Industry Workers. 1990. Radiation Research. 123:138-152

▪ ORMULA03 Data File Set

Description

This analytic data file set consists of one file generated for a matched pair case-control study examining ill-defined causes of death of white males at the three Oak Ridge facilities by Donna Cragle, et al., published in the American Journal of Public Health in 1992.

This study determined the association between various factors and a recorded ill-defined cause of death. A matched pair case-control study was conducted with one control per case and within an occupational cohort of workers at three Oak Ridge facilities (Y-12 and K-25 Plants and the Oak Ridge National Laboratory). The study found a strong association between the ill-defined classification given as a cause of death and particular certifiers, especially if the certifier was a medical examiner. Results

from other cohort mortality studies of workers at the Oak Ridge facilities have indicated unusual increases in the rate of deaths due to unexplained or unspecified causes. In this study, the SMR for deaths coded to these categories was 3.05 (338 observed versus 110.92 expected).

The single analytic file in this data file set, ORMULA03_d1, contains 1,216 records, one for each case and each matched control. The file contains demographic, work history, and cause-of-death data, plus codes for the different certifiers. Each individual in this cohort must have worked for more than 30 days at any Oak Ridge facility between 1943 and 1982 and must have died between 1945 and 1982. Death certificates were obtained for 608 cases in which deaths were due to unexplained or unspecified causes. Based on cause of death and matching birth and death dates within 2 years (plus or minus), a control was selected for each case. The control also had to work at the same facility as the case.

Considerable data, in addition to cause of death, were abstracted from death certificates obtained for all 1,216 cases and controls.

Personal or environmental radiation monitoring data were not used in this study.

Citations

Cragle, D. L., Fetcher, A. Risk Factors Associated with the classification of unspecified and/or unexplained causes of death in an occupational cohort. 1992. American Journal of Public Health 82(3):455-457.

▪ ORMULA04 Data File Set

Description

This analytic data file set consists of one file generated for a retrospective cohort mortality study of white males employed at the K-25, X-10, or Y-12 facilities in Oak Ridge, Tennessee by JP Watkins, et al.

A previous study (Polednak, et al. 1981. Archives of Environmental Health, 57:1-17) of 1,059 white male welders employed between 1943 and 1973 in these three plants compared the mortality experiences of welders employed at K-25, who had potential for nickel oxide exposure, with those employed only at the other sites, who were not exposed to nickel oxides. Based on deaths through 1974, there was an elevated lung cancer SMR of 1.88 for K-25 welders employed for at least 50 weeks, but this was based on only five observed deaths. The current update was based on deaths through 1989 for 1,211 white male welders employed between 1943 and 1985, including the subgroup of 683 K-25 employees with potential for nickel oxide exposure. There were 18,790 person-years of follow-up and 237 deaths for the K-25 subgroup and 15,992 person-years and

226 deaths for the second subgroup employed at the other facilities. Results for the combined cohort showed statistically significant SMRs for lung cancer and prostate cancer. Investigating SMRs separately for the two subgroups, the only statistically significant SMR was for prostate cancer among those welders without potential exposure to nickel oxide, although the prostate cancer SMR for K-25 welders was also elevated. There did not appear to be notable differences between the mortality patterns of the welders with and without potential exposure to nickel oxides. No deaths from nasal sinus cancer were found in either group, and the healthy worker effect was not evident.

The single analytic file, ORMULA04_d1 (COHORT), contains a record that includes vital status as of January 1, 1990, for each of the 1,211 members of the cohort. The last SSA submission for this population provided "alive" status as of January 1, 1985; the "alive" category is no longer obtainable from SSA. However, NDI provides a record of all deaths occurring since January 1, 1979. If not identified as deceased by SSA or NDI, individuals last known to be alive before January 1, 1979, were considered lost to follow-up on the last date known alive, while those known to be alive after January 1, 1979, were considered alive at the end of the study. There were 463 deaths from all causes with death certificates available for 98.5% of these individuals.

Nickel oxide exposure occurred at K-25 when workers welded mild steel pipes that were coated with nickel. These pipes were widely used throughout this facility. Nickel-coated pipes were not used at the other sites. Materials welded at Y-12 and X-10 included mild steel and aluminum. In addition, stainless steel was sometimes used at Y-12.

Citations

Watkins, J.P., Reagan, J.L., Cragle, D.L., Frome, E.L., West, C.M., Crawford-Brown, D., Tankersley, W.G. Data Collection, validation, and description of data for the Oak Ridge nuclear facilities mortality study. 1993. ORISE. Technical Report J42

Wells, S., Cragle, D.L., Tankersley, W. Mortality update among welders at multiple sites. Final Report. July, 1997. Oak Ridge Associated Universities. Document 98-0790

▪ ORMULA05 Data File Set

Description

This analytic data file set consists of six files generated for a retrospective cohort mortality study of all workers employed at the K-25, X-10, or Y-12 facilities in Oak Ridge, Tennessee, who were hired before January 1, 1983, and employed for at least 30 days by Ed Frome, et al.

Results of this study were published in Applied Occupational and Environmental Hygiene and Radiation Research in 1997.

This study, an update of a previous study by Ed Frome (data file set ORMULA02), is based on deaths through 1984 for 106,020 workers of both genders. There were 2,810,000 person-years of follow-up with 65% from white males, 30% from white females, 3% from non-white males, and 2% from non-white females. The study involved three stages of analysis. First, SMRs were calculated for each of the four race/gender groups for a series of causes of death. Next, a comparison of mortality among the facilities for selected causes of death was conducted by race/gender group. Finally, a dose-response analysis for cumulative external dose was carried out for white male employees from Y-12 after mid-1947 and X-10.

A previous study (Frome et al. 1990. Radiation Research 123:138-152) of 28,008 white males employed between 1943 and 1947 at these three sites evaluated the influence of the ever/never radiation exposure status along with duration of employment, facility, socioeconomic status, birth year, and period of follow-up, on cause-specific mortality. Based on deaths through 1980, there was an elevated SMR of 1.11 for all causes of death with a significant upward trend of 0.74% per year. The excess mortality was due primarily to lung cancer and diseases of the respiratory system. However, the increase was found to be related to socioeconomic status rather than radiation exposure status.

The analytic file, ORMULA05_d1 (DEMGR), contains a record for each of the 118,588 workers hired by one of the Oak Ridge facilities before January 1, 1983. For the study cohort, 12,568 were eliminated from this group, including 11,002 who were employed for fewer than 30 days and the remainder who had "critical errors" in their data. This file contains demographic, work history, and vital status information as of December 31, 1984. Of the 27,982 deaths, 22,724 were white males. There are three exposure files, ORMULA05_d2, ORMULA05_d4, and ORMULA05_d6 (K25EXP, X10EXP, and Y12EXP, respectively), that contain, for the designated facility, annual unadjusted external radiation doses, annual indicator variables for internal radiation exposure, and annual flags that specify employment in that facility during the year. White males received 93% of the annual recorded doses, which totaled 405.5 sieverts (Sv). There are two additional exposure files. Annual adjusted doses for X-10 are contained in ORMULA05_d5 (X10ADJ), along with data used to compute these values, including annual values for days worked, department, and type of adjustment. Doses through 1956 were adjusted upward to compensate for potential bias in recorded doses due to monitoring policies and practices at X-10 during early years of plant operation. Early Y-12 doses were adjusted because of the large number of non-monitored person-years at Y-12

through 1960. The adjusted dose file for Y-12, ORMULA05_d5 (Y12ADJ), contains annual adjusted doses, as well as flags to specify type of adjustment.

ORNL began operation at X-10 early in 1943 as a research and development facility. Potential exposures to X-10 employees included external radiation, a variety of radionuclides, lead, beryllium, and chemicals associated with a research and development laboratory. From 1943 through mid-1947, Y-12 produced enriched uranium by the electromagnetic separation process and was operated by TEC. Potential exposures at Y-12 included uranium dust, some external radiation, and a variety of chemicals, including solvents and lubricants. After mid-1947, Y-12 was managed by Union Carbide Corporation Nuclear Division and changed operations to nuclear materials fabrication. At that time, potential exposures expanded to include metals and asbestos. K-25 began in 1945 to produce enriched uranium using a gaseous diffusion process. Uranium dust was a potential exposure at K-25, along with some external radiation exposure, uranium compounds, metals, solvents, and chemicals.

Citations

Frome, E.L., Cragle, D.L., Watkins, J., Wing, S., Shy, S., Tankersley, W., West, C. A Mortality Study of Employees of the Nuclear Industry in Oak Ridge, Tennessee. 1997. Radiation Research. 148:64-80. Erratum. 1997. Radiation Research. 148:297-298. A Mortality Study of Employees of the Nuclear Industry in Oak Ridge, Tennessee. Final Report. July, 1997. Oak Ridge National Laboratory. ORNL-6785, pp 1-67

Frome, Edward L. -- Oak Ridge National Laboratory (ORNL). Cragle, Donna L., McLain,. Richard W. -- Oak Ridge Associated Universities (ORAU). Poisson Regression of the Mortality among a Cohort of World War II Nuclear Industry Workers. 1990. Radiation Research. 123:138-152

Watkins, J. P., Cragle, D.L., Frome, E.L., West, C.M., Crawford-Brown, D.J., Tankersley, W.G. Adjusting external doses from the ORNL and Y-12 facilities for the Oak Ridge nuclear facilities. Mortality study. 1994. ORISE. Technical Report G-34

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Watkins, J.P., Reagan, J.L., Cragle, D.L., Frome, E.L., West, C.M., Crawford-Brown, D., Tankersley, W.G. Data Collection, validation, and description of data for the Oak Ridge nuclear facilities mortality study. 1993. ORISE. Technical Report J42

OAK RIDGE/X-10

▪ ORX10A01 Data File Set

Description

This analytic data file set consists of four files generated for the cohort mortality study of white males employed at ORNL by Harvey Checkoway, et al., published in the British Journal of Industrial Medicine in 1985.

The publication focuses on 8,375 white males employed at ORNL for at least 1 month (30 days) between 1943 and 1972. The study presents internal comparisons of mortality (standardized rate ratios) between subgroups of the cohort according to radiation dose

level and duration of employment in various job categories. No consistent gradients of cause-specific mortality were assessed with respect to radiation exposure. Among monitored workers, deficits in mortality due to arteriosclerotic heart disease and all cancers were found. However, elevated (but not statistically significant) SMRs were seen for all leukemia, cancer of the prostate, and Hodgkin's disease.

There are four analytic files in the ORX10A01 data file set.

- The first file, ORX10A01_d1 (X1CH0210), provides information for 12 employment groupings, which were based on an examination of each individual's work history and on the calculation of a 10-year latency period for each person.
- The second file, ORX10A01_d2 (X1CH0810), contains external radiation doses as assessed from external monitoring data.
- The third file, ORX10A01_d3 (X1CH1201), contains all demographic data and summary exposure data pertaining to the cohort. This file contains one record per individual in the cohort, whereas the other files may contain several or no records per individual, depending on the availability of monitoring data for those individuals.
- The fourth file, ORX10A01_d4 (CUMEXP), contains all internal monitoring data pertinent to the cohort.

Vital status was ascertained for 92.2% of the cohort of 8,375 white males through December 31, 1977, the study end date. There were 966 deaths identified, and death certificates were obtained for 939 (97.2%) of these deaths. External and internal exposures to radiation were examined.

ORNL began monitoring personnel for exposure to penetrating external radiation, primarily gamma rays, in 1943. Pocket chambers were used until June 1944, when film dosimeters (film badges) became the primary dosimeters. Film dosimeters were used for personnel monitoring until 1975, when they were replaced with thermoluminescent dosimeters. From 1943 until the early 1950s, the usual practice was to provide personal dosimeters to only those workers entering designated areas where the potential for exposure was presumed to exist. Subsequently, all workers at ORNL were monitored for exposure to radiation. In 1951, based primarily on the potential for contamination from their work area, some workers began to be monitored by urine bioassays for internal exposure to radionuclides. Additional workers were monitored to evaluate exposures incurred during incidents. Internal exposures were determined by results of urine and fecal bioassays and whole-body counting. For purposes of the study, internal

monitoring results were used to place the worker into one of three exposure categories each year. Quantitative dose estimates due to internally deposited radionuclides were not available because they usually were not required to be calculated in the past, and all of the basic data needed to compute doses for the many radionuclides used at ORNL were not computerized. However, knowledgeable plant health physicists and dosimetrists state that the majority of internal monitoring results for this cohort suggest small internal doses, especially when compared with external doses.

Citations

Checkoway, H., Mathew, R. M., Shy, C. M., Watson, J. E., Tankersley, W. G., Wolf, S. H., Smith, J. C., Fry, S. A. Radiation, work experience, and cause specific mortality among workers at an energy research laboratory. 1985. British Journal of Industrial Medicine. 42(8):525-533

Ostrouchov, George, Frome, E. L., Kerr, G. D. Dose estimation from daily and weekly dosimetry data. 1998. Oak Ridge National Laboratory. ORNL-6945

▪ ORX10A02 Data File Set

Description

This analytic data file set consists of three files that were used in updated cohort mortality analyses of white males employed at ORNL presented in two papers by Steve Wing, et al.

Both papers analyzed data for a cohort of 8,318 white males employed at ORNL for at least 30 days between 1943 and 1972. In the first paper (JAMA 1991), two types of analyses were performed. The first was a cause-specific mortality analysis comparing the study population with the mortality of white males in the U.S. The second was an analysis of the relationship between protracted exposure to low levels of external penetrating ionizing radiation and mortality within the study population. Compared with the mortality experience of all U.S. white males, relatively low mortality was observed for most causes of death. However, mortality from leukemia was elevated in the total cohort and in workers who had at some time been monitored for exposure to internally deposited radionuclides. The second publication (AJIM 1993) examined the role of possible selection and confounding factors not previously studied. Risks associated with length of time in 15 job categories were considered as proxies for the effects of other occupational carcinogens. The findings suggest that selection factors and potential for chemical exposure do not account for the previously noted association of external radiation dose with cancer mortality.

There are three analytic files in the ORX10A02 data file set.

- The first file, ORX10A02_d1 (X1UPGEN2), contains demographic and some work history data for the entire cohort. The original study (ORX10A01) contained 8,375

males, but further investigation revealed that 57 individuals in the original cohort were not white males.

- The second file, ORX10A02_d2 (X1UPFLAT), contains annual and cumulative external whole-body doses for each individual.
- The third file, ORX10A02_d3 (X1UPJTGB), contains a record for each individual, including the unique job title of the individual and the number of days, by year, that the person retained the job title.

Vital status was ascertained for 91.8% of the cohort (96.5% of potential person-years of follow-up), and 1,524 deaths were identified by the end of 1984, the study end date. Death certificates were obtained for 1,490 (97.8%) of these deaths. External radiation monitoring data were used to compile annual and cumulative whole-body doses. For the 4.9% of the work-years for which external monitoring data were not available, doses were estimated. By using internal monitoring data qualitatively as a "yes/no" indicator of potential exposure to internal radiation, workers who had at some time been monitored for internal exposure (N = 3,763) generally had higher external doses; 50% of those ever monitored, but only 8% of those never monitored for internal exposure had cumulative external doses greater than 1 rem (10 millisieverts).

ORNL began monitoring personnel for exposure to external penetrating radiation, primarily gamma rays, in 1943. Pocket chambers were used until June 1944, when film dosimeters (film badges) became the primary dosimeter. Film dosimeters were used for personnel monitoring until 1975, when they were replaced with TLDs. From 1943 until the early 1950s, the usual practice was to provide personal dosimeters to only those workers entering designated areas where there was a potential for exposure. Subsequently, all workers at ORNL were monitored.

Based primarily on the potential for contamination from their work area, some workers were monitored for internal exposure to radionuclides beginning in 1951. Additional workers were monitored to evaluate exposures incurred during incidents. Internal exposures were determined by examining results of urine and fecal bioassays and whole-body counting. Quantitative dose estimates due to internally deposited radionuclides are not available because, in the past, they usually were not required to be calculated. Also, all of the basic data needed to compute doses for the many radionuclides used at ORNL are not computerized. However, knowledgeable plant health physicists and dosimetrists state that the majority of internal monitoring results for this cohort suggest small internal doses, especially when compared with external doses.

Citations

Ostrouchov, George, Frome, E. L., Kerr, G. D. Dose estimation from daily and weekly dosimetry. Data. 1998. Oak Ridge National Laboratory. ORNL-6945

Prichard, Howard M., Gilbert, E., Wing, S., Cragle, D. L. Correspondence. Mar. 1992. Health Physics. 62(3):260-264

Shy, C. M., Wing, S. Comprehensive epidemiology of DOE atomic workers. A report on mortality among workers at Oak Ridge National Laboratory: Follow-up through 1990 Final Report. March 31, 1994. University of North Carolina, NIOSH (under Purchase Order number 3C-70837)

Wing, S., Shy, C. M., Wood, J. L., Wolf, S., Cragle, D. L., Tankersley, W., Frome, E. L. Job factors, radiation and cancer mortality at Oak Ridge National Laboratory: follow-up through. 1984. Feb. 1993. American Journal of Industrial Medicine. 23:265-279. Erratum. 1993. American Journal of Industrial Medicine. 23(4):673

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▪ ORX10A03 Data File Set

Description

This analytic data file set consists of one file generated by N.A. Elghany in 1983 for a nested case-control study of cancer mortality of workers at ORNL. The study was conducted for a doctoral dissertation.

The dissertation investigated the relationship between cancer mortality and occupational exposure to radiation among the male employees at ORNL. The study was based on a case-control study nested in a cohort study, using two controls per case. Results indicated that certain subgroups encountered excess cancer mortality risk in relation to radiation exposure.

The single analytic file, ORX10A03_d1 (NAIMA), in this data file set contains data relating to demographics, work history, exposure index rankings, internal hazard codes based on urine bioassay data, vital status, and causes of death. There are 1,785 records in this file, including one record for each of the 423 cases and one record for each of the 846 matched controls (the case-control group), plus one record for each of the remaining 516 workers in the overall cohort. A case was defined to be any male employee who died between January 1943 and December 1977, whose death certificate indicated cancer as the cause of death. Controls were selected from the “population at risk” at ORNL, excluding those who died of cancer. The controls could be either dead or alive.

Vital status was ascertained for 91.7% of the male controls and for 66.5% of the female controls through December 31, 1977, the study end date.

Personal monitoring data were used to place workers into exposure classes; doses were not calculated. Groups based on job title were also formed for the analysis. Smoking histories were obtained for a sample (25%) of the cohort. Exposures to lead, beryllium, and mercury were also considered in the analysis.

Citations

Elghany, N. A. An epidemiological study of cancer mortality among workers exposed to occupational low levels of ionizing radiation. 1983. Ph.D. Dissertation. University of North Carolina, Chapel Hill

Ostrouchov, George, Frome, E. L., Kerr, G. D. Dose estimation from daily and weekly dosimetry data. 1998. Oak Ridge National Laboratory. ORNL-6945

▪ ORX10A04 Data File Set

Description

This analytic data file set consists of 66 files that were used by Cary Suzanne Lea for updated cohort mortality analyses of white males employed at ORNL. The CEDR data set ORX10A02 was the primary source of data (demographic, work history, radiation monitoring). The purpose of this dissertation was to address the following research questions. Can excess cancer be explained as due to: (1) confounding by time-related factors, (2) selection bias resulting from choice of empirical induction period, (3) grouping of cancer outcomes, and (4) impact of high-dose outliers in a cohort of workers experiencing low-level cumulative dose?

ORNL began monitoring personnel for exposure to external penetrating radiation, primarily gamma rays, in 1943. Pocket chambers were used until June 1944, when film dosimeters (film badges) became the primary dosimeter. Film dosimeters were used for personnel monitoring until 1975, when they were replaced with TLDs. From 1943 until the early 1950s, the usual practice was to provide personal dosimeters to only those workers entering designated areas where there was a potential for exposure. Subsequently, all workers at ORNL were monitored.

This dissertation re-analyzed data for a cohort of 8,318 white males employed at ORNL for at least 30 days between 1943 and 1972, with follow-up through 1984. This re-analysis was motivated to understand more fully the results published by Wing et al., 1991 (JAMA, 1991), since mortality results differed from historically similar cohorts of nuclear energy workers.

Due to rounding, there are 213,950 person-years in ORX10A04, whereas in ORX10A02 there are 215,680 person-years. All other aspects of the source data for ORX10A04 are the same as ORX10A02, as described below.

During the course of the prior study (ORX10A02), vital status was ascertained for 91.8% of the cohort (96.5% of potential person-years of follow-up), and 1,524 deaths

were identified by the end of 1984, the study end date. Death certificates were obtained for 1,490 (97.8%) of these deaths. External radiation monitoring data were used to compile annual and cumulative whole-body doses. For the 4.9% of the work-years for which external monitoring data were not available, doses were estimated.

The results of this dissertation analysis were the following: (1) confounding by time-related factors -- year of hire was significantly related to mortality risk, but duration of employment and length of employment were not. (2) Selection bias resulting from choice of empirical induction period -- latency refers to removing deaths and person-years during some pre-determined interval of follow-up, say the first 5 years of follow-up. Lagging refers to shifting dose forward by the number of years in the lag interval, say 5 years. There was no difference in mortality risk using either of these approaches for incorporating an empirical induction period. (3) Grouping of cancer outcomes -- grouping by cancer outcome indicated that smoking-related cancer sites, excluding lung cancer, showed the highest mortality risk.

The analytic data for this study are partitioned into separate data files according to specific factors of interest (all cancers, solid cancers, lung cancers, smoking-related deaths, and leukemia) in various combinations and over selected lag and latency times.

Citations

Lea, Cary Suzanne, Buffler, P. A. -- School of Public Health, Univ. of California at Berkeley. Durst, M. J., Merrill, D. W. -- Lawrence Berkeley National Laboratory. Selvin, S. -- School of Public Health, Univ. of California at Berkeley and Lawrence Berkeley National Laboratory
Reassessment of cancer mortality among employees at Oak Ridge National Laboratory with follow-up through 1984: a comparison with results of previously published studies. 2000
Technology. Vol. 7:303-316

Lea, Cary Suzanne. Evaluation of cancer mortality in a cohort of workers exposed to low-level radiation. LBL-38319. Evaluation of cancer mortality in a cohort of workers exposed to low-level radiation. December, 1995. Ph.D. Dissertation. University of California, Berkeley

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Wing, S., Shy, C.M., Wood, J.L., Wolf, S., Cragle, D.L., Frome, E.L. Mortality Among Workers at Oak Ridge National Laboratory: Evidence of Radiation Effects in Follow-up through 1984. March 20, 1991. The Journal of the American Medical Association (JAMA). 265(11):1397-1402. Errata. 1991. The Journal of the American Medical Association (JAMA). 266(5):657. Reply to Comments by Gilbert and Prichard. March, 1992
Health Physics. 62(3)261-264 (Correspondence). A report on mortality among workers at Oak Ridge National Laboratory: Follow-up through 1990. Final Report. 1994. Oak Ridge Associated Universities. PO 3C-70837

▪ ORX10A05 Data File Set

Description

This data file set consists of one analytic file containing data for a study of radiation-mortality association among an expanded cohort of workers employed at ORNL during the period 1943 to 1972 by David Barrie Richardson, et al.

This analytical data set, ORX10A05_d1, consists of one file used for a NIOSH-funded study of mortality among workers at Oak Ridge National Laboratory, located in Oak Ridge, Tennessee. This study examined a cohort of 14,095 workers hired between 1943 and 1972 who worked at least 30 days at ORNL, for whom there was complete information on gender, race, dates of birth and hire, and who had no more than 2 years of missing annual whole-body dosimetry data from employment at other DOE facilities. The cohort included 3,389 women and 1,071 non-white workers. Vital status had been ascertained for 94% of the cohort in follow-up through 1990, identifying 3,269 deaths. Personal monitoring data for whole-body exposure to ionizing radiation were available for the period 1943 to 1985. Annual whole-body radiation doses were estimated for work-years at ORNL with missing dose data using dose estimates in adjacent time periods and average values for similar workers. Analyses of these data focused on time-related factors that might influence radiation-mortality associations. Positive associations were observed between low-level exposure to ionizing radiation and mortality among workers at ORNL. These associations were larger for doses received after age 45, larger under longer lag assumptions, and primarily due to cancer causes of death.

Citations

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Richardson, D. B. Time-related Factors in Radiation-Cancer Associations among Workers at Oak Ridge National Laboratory. 1997. Ph.D. Dissertation. University of North Carolina, Chapel Hill

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Wing, S., Richardson, D. -- Univ. of North Carolina (UNC). Time-related factors in radiation-cancer dose response Final Report.. August 5, 1997. National Institute for Occupational Safety and Health (NIOSH). NIOSH Grant No. R03 OH03343

Wood, Joy, Richardson, David B., Wing, Steven -- Univ. of North Carolina (UNC) at Chapel Hill. A simple program to create exact person-time data in cohort analyses. 1997. International. Journal of Epidemiology. 26(2):395-399

OAK RIDGE/Y-12

▪ ORY12A01 Data File Set

Description

This data file set consists of three analytic files for the cohort mortality study of white males employed at the Y-12 Facility in 1947 to 1974 by Harvey Checkoway, et al., published in the American Journal of Epidemiology in 1988.

This study examines the mortality of a cohort of 6,781 white males who worked at the Y-12 Facility for at least 30 days between May 4, 1947, and December 31, 1974. This cohort included workers who were known to have worked only at Y-12. Individuals who worked at Y-12 when TEC operated the facility (which was before May 4, 1947) or who worked at any other DOE-owned or operated facility were excluded. Workers in this cohort were exposed to low levels of alpha and gamma radiation while working with uranium compounds at an enriched nuclear materials fabrication plant. Relative to U.S. white males, the cohort experienced mortality deficits from all causes of death combined, from cardiovascular diseases, and from most site-specific cancers. When compared with national and state rates, excess mortality due to cancer of the lungs, brain, and central nervous system were seen. Dose-response trends, which diminished in magnitude when a 10-year latency assumption was applied, were detected for lung cancer mortality with respect to cumulative alpha and gamma radiation. The most pronounced trend associated with gamma doses was among workers who received doses equal to or greater than 5 rem of alpha radiation. There were 22 workers who received greater than or equal to 10 rem of external radiation, including 8 workers involved in a criticality accident at the facility in 1958.

There are three analytic files in this data file set.

- The first file, ORY12A01_d1 (LDBEST01), contains annual and cumulative lung doses for each person for the years 1947 through 1979. Estimates of doses delivered to the lungs were based on results of urinalysis measurements and in vivo counting of internally deposited uranium.
- The second file, ORY12A01_d2 (Y1ANGE14), contains demographic, work history, and vital status data for the cohort.
- The third file, ORY12A01_d3 (Y1ANFB03), contains annual and cumulative penetrating doses that were compiled from external personnel monitoring information.

Periods in which a worker was not in the monitoring program were assigned doses of zero, under the assumption that only workers with a reasonable likelihood of exposure had been monitored.

Vital status was ascertained for 6,477 workers (95.5% of the cohort) through December 31, 1979, the study end date. There were 862 deaths identified (12.7%), and death certificates were obtained for 846 (98.1%) of these deaths. Eighty-five percent of the cohort was followed for at least 10 years. The median duration of follow-up was 20.6 years, and the cohort contributed 133,535 person-years of observation.

Workers at Y-12 were exposed to radiation resulting from external sources (primarily gamma radiation from the uranium decay series) and from internal deposition of uranium (primarily alpha particles). Personal monitoring for external exposure began in 1948 with the use of film dosimeters. They were used for personnel monitoring until the late 1970s, when they were replaced with TLDs. Monitoring for internal exposure to uranium began in 1950, but was not in full effect until 1953. By 1961, the internal monitoring program included in vivo measurements, such as lung counting. Metabolic models were used to convert urinalysis and in vivo measurements to lung doses for each worker.

Citations

Checkoway, Harvey -- Univ. of Washington and Univ. of North Carolina, Chapel Hill (UNC). Pearce, Neil -- Univ. of Washington and Wellington Clinical School of Medicine, New Zealand. Crawford-Brown, Douglas J. -- Univ. of North Carolina, Chapel Hill (UNC). Cragle, Donna L. -- Center for Epidemiologic Research (CER), Oak Ridge Associated Universities (ORAU). Radiation doses and cause-specific mortality among workers at a nuclear materials fabrication plant. 1988. American Journal of Epidemiology. 127(2):255-266. 1989. American Journal of Epidemiology. 129:639-640

▪ ORY12A02 Data File Set

Description

This analytic data file set consists of one file generated for a case-control mortality study of white males exposed to elemental mercury at the Oak Ridge Y-12 Facility in 1953 to 1958 by Donna Cragle et al., published in the Journal of Occupational Medicine in 1984,.

This study examined the mortality experience of a group of white male workers who were exposed to elemental mercury and mercury vapors. The mortality experience of the mercury workers was examined with respect to mercury-sensitive systems, including lung, liver, and kidney organs, and the central nervous system (CNS). Statistically significant excesses of deaths from cancer of the lung, brain, and CNS were observed in the group not involved in the mercury process. Exposure to mercury vapors at Y-12 was not found to be related to any excess of deaths from diseases or cancers of target organs for mercury, but an excess of lung cancer was observed in the mercury worker group. No excesses were found when level of exposure and length of exposure were considered.

The single analytic file, ORY12A02_d1 (MERANAL2), in this data file set contains demographic, vital status, and employment data and results of urinalysis monitoring (for mercury). There is one record for each of 5,664 workers; one individual was not included in the final analyses.

The overall population was defined as all white males who worked at least 4 months at Y-12 between January 1, 1953, and April 30, 1958. These criteria allowed 5,663 individuals to enter the study. The study group was separated into two smaller ones. The first group consisted of 3,530 workers for whom no urinalysis results were recorded and who were presumed as never having been monitored for mercury exposure. The remaining 2,133 workers were placed into the mercury worker group because their records contained results of mercury urinalyses.

Vital status was ascertained for all 5,663 workers through December 31, 1978, the study end date. There were 1,140 deaths identified, and death certificates were obtained for 1,125 (98.7%) of these deaths.

Records indicating participation in a mercury urinalysis program were used to classify the individual as a mercury worker. Personal radiation monitoring data were not used in the study.

Citations

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▪ ORY12A03 Data File Set

Description

This analytic data file set consists of one file generated for a cohort mortality study of white males at the Oak Ridge Y-12 Facility in 1943 to 1947 by AP Polednak, et al., published in the Journal of Occupational Medicine in March 1981.

The study examined the mortality experience of white male workers employed at a uranium enrichment facility (Y-12) between June 1943 and May 1947. During this time, Y-12 was operated for the government by TEC. In May 1947, Union Carbide Corporation Nuclear Division became the operating contractor. With this transition, significant changes were made to plant processes, and most of the Y-12 work force was replaced. These occurrences led epidemiologists to study the Y-12 workers employed by TEC (the TEC cohort) separately from those working at Y-12 after May 1947 (the Y-12 cohort). The TEC cohort was selected for this mortality study because (1) a long period of follow-up was available, (2) data were available showing that average levels of airborne uranium dust were high in certain departments, (3) the size of the sample was large, and (4) data were limited on the possible long-term health effects of uranium exposure in human populations.

SMRs for various causes of death in the entire cohort were generally less than 1.00; however, after correction for missing death certificates and unascertained deaths, the SMR for lung cancer was 1.22. Other causes of particular interest, including bone cancer, leukemia, and diseases of respiratory and genitourinary systems, did not exhibit high SMRs. The authors suggested that an increased number of lung cancer deaths occurred in chemical workers who were 45 or more years old when first hired.

The single analytic file, ORY12A03_d1 (FROMEPOL), in this data file set contains 38,521 records, i.e., one record for each person who had a payroll record at the plant when TEC was the operating contractor. Application of the cohort selection criteria reduced the cohort under study to 18,869 white males. The records excluded from the analysis pertained to females (about 18,100), non-white males, individuals who worked less than 2 days at Y-12, and those lacking essential vital status and demographic data. Records for the study cohort can be determined by examining the published manuscript for all the criteria and checking certain variables in the file. The file contains demographic, work history, vital status, and some urinalysis data.

Vital status was ascertained for 97.6% of the cohort through December 31, 1973, the study end date. There were 5,394 deaths identified in this cohort, and death certificates were obtained for 5,133 (95.2%) of these deaths. The study had 494,742 person-years of follow-up.

The TEC cohort did not wear personal dosimeters (film badges); however, exposure to penetrating external (gamma) radiation was low due to the nature of plant operations. The primary radiological hazard for the TEC cohort was inhalation of uranium compounds. Some urinalysis for uranium was performed for individuals working in areas of airborne material, and these data were used in the analysis.

Citations

Polednak, A.P., Frome, E.L. Mortality among men employed between 1943 and 1947 at a uranium-processing plant. 1981. Journal of Occupational Medicine. 23(3):169-178

▪ ORY12A04 Data File Set

Description

This analytic data file set consists of one file generated for a case-comparative mortality study of white males exposed to phosgene at the Oak Ridge Y-12 Facility from 1943 to 1945 by A.P. Polednak, published in Environmental Research. A follow-up article was later published in Toxicology and Industrial Health.

Studies of humans and animals indicate that exposure to high levels of phosgene result in short-term health effects that include emphysema, pulmonary edema, pneumonitis, and other possible effects. This study examined the mortality experience of workers exposed to phosgene gas while working at Y-12 from 1943 through 1945. The study population consisted of 18,869 white males employed at Y-12, while Tennessee Eastman Corporation was the operating contractor (1943 to 1945). There were two groups of interest: the first group included 699 white males that received daily exposure to low levels of phosgene, and the second group consisted of 106 men with definite acute exposures and symptoms that indicated exposure to levels as high as 50 ppm or higher. No evidence of excess overall mortality or mortality from diseases to the respiratory system was found. Pneumonitis was diagnosed in 23.6% of the 106 workers in the second group. The primary author analyzed updated information for this cohort approximately 5 years after the initial study. The major finding in the updated study was the occurrence of five deaths in the second group of 106 workers due to respiratory diseases (1.88 deaths expected), although the standardized mortality ratio did not reach statistical significance. There were no deaths due to lung cancer in the second group despite 33 to 35 years of follow-up.

The single analytic file, ORY12A04_d1 (ANALYSIS), consists of 106 records, one for each person in the second group. The file contains demographic and work history data.

Vital status was ascertained through December 31, 1973, for the initial study and through December 31, 1978, for the updated study. There were 29 deaths identified in the highly exposed group for the first study and 41 deaths found for the group in the updated study.

No personal monitoring data were used in either study.

Citations

Polednak, A. P. -- New York State Dept. of Health. Hollis, D. R. -- Center for Epidemiologic Research (CER), Oak Ridge Associated Universities (ORAU). Mortality and Causes of Death Among Workers Exposed to Phosgene in 1943-1945. 1985. Toxicology and Industrial Health. Vol.1 (2):137-151

Polednak, A. P. Mortality among men occupationally exposed to phosgene in 1943-1945
1980. Environmental Research. 22(2):357-367

ORY12A05 Data File Set

Description

This analytic data file set consists of two files generated for a cohort mortality study of male and female workers employed during 1947 to 1974 at the uranium enrichment facility (Y-12) plant in Oak Ridge, Tennessee by DP Loomis, et al., published in the American Journal of Industrial Medicine in 1996.

This cohort mortality study of Y-12 workers presents updated results from a long-term mortality study of workers at Y-12 between 1947 and 1974, with follow-up of white men through 1990 and data reported for the first time for women and men of other races. The Y-12 plant is part of a nuclear production and research complex at Oak Ridge, Tennessee. Workers at Y-12 were exposed to low doses of internal, alpha radiation, and external, penetrating radiation, as well as to beryllium, mercury, solvents, and other industrial agents.

Vital status was determined through searches of the National Death Index and other records, and the workers' mortality was compared with the national population's using SMRs. Total mortality was low for all Y-12 workers and total cancer mortality was as expected. Among the 6,591 white men, there were 20% more lung cancer deaths than expected. Death rates from brain cancer and several lymphopoietic system cancers were also elevated among white men, with SMRs of 1.28 and 1.46. Mortality from cancer of the pancreas, prostate, and kidney was similarly elevated. There was evidence of excess breast cancer among the 1,073 female workers.

The file, ORY12A05_d1 (Y2AN0102), includes data for those who worked only at Y-12. File ORY12A05_d2 (Y2AN0103) includes individuals who worked at both Y-12 and TEC.

Citations

Loomis, D. P., Wolf, S. H. -- Department of Epidemiology, University of North Carolina School of Public Health Chapel Hill, NC. Mortality of workers at a nuclear materials production plant at Oak Ridge, Tennessee, 1947-1990. February 1996. American Journal of Industrial Medicine.. 29(2):131-141. 1997. American Journal of Industrial Medicine. 31:121

PANTEX

▪ PXSMRA01 Data File Set

Description

This data file set consists of one file generated for a cohort mortality study of 3,546 white male workers at the Pantex Plant in Texas by JF Acquavella, et al., published in Health Physics in 1985.

This cohort mortality study of white male Pantex Plant workers was conducted to determine if there was an association between employment at the facility and mortality from various causes. A subanalysis examined the association between mortality and exposure to external radiation. The published analysis focused on 3,564 white and presumed white males who were ever employed by the prime contractor operating the plant between the start of plant operations in 1951 and December 31, 1978, the study end date. The subanalysis focused on the 209 workers who were exposed to 1 rem or more through 1978. Total and cause-specific mortality was compared with expected mortality based on U.S. death rates. Significantly fewer deaths than expected from all causes of death, all cancers, digestive cancers, lung cancer, arteriosclerotic heart disease, and digestive diseases were observed. No causes of death occurred significantly more frequently than expected. Analyses of worker mortality by duration of employment, time since first employment, and cumulative radiation exposure greater than 1 rem produced similar results. No evidence was found that mortality from any cause of death was increased as a result of employment at the Pantex Plant.

The single analytic file, PXSMRA01_d1, contains demographic and exposure data for 5,438 male and female workers employed either by the prime contractor or by one of several subcontractors from the beginning of plant operations through 1981. Exposure data in the file include exposure monitoring status and cumulative external radiation doses (in mrem) through 1980. The file includes demographic variables sex, education level, race, date of birth, and state of birth.

Vital status through 1978 was ascertained for 97% of the 3,564 white male Pantex workers included in the analysis. Death certificates were obtained for 96% (257) of the 269 known employee deaths. ICDA8 was used to code causes of death.

The Pantex Plant is a large facility that has been engaged in the assembly and disassembly of nuclear weapons since 1951. Sources of occupational exposures include external radiation, both gamma and neutron, from nuclear weapons components. Workers may also be exposed to x-rays while using industrial radiographic equipment. All exposure readings in the file are film badge measurements and were available only for workers employed after 1963.

Citations

Acquavella, J., Wiggs, L., Waxweiler, R., MacDonnell, D., Tietjen, G., Wilkinson, G. Mortality Among Workers at the Pantex Weapons Facility. 1985. Health Physics. 48(6):735-746

▪ PXSMRA02 Data File Set

Description

This analytic data file set consists of one file (PXSMRA02_d1) that contains 11 variables used in a cohort mortality study of workers at the Pantex plant. The study was published in Mortality Update for the Pantex Weapons Facility: HHS (NIOSH) Publication No. 2005-124, by Silver SR, Anderson P, Burphy J, Hiratzka S, Schubauer-Berigan MK, and Waters KM.

Study Population: The current study population includes all males and females, regardless of race, ever employed at the Pantex facility between the start of operations in 1951 and December 31, 1978. Vital status follow-up was extended through December 31, 1995. This full NIOSH cohort comprises 4,668 workers. Because complete work history information was not collected for workers who continued employment after December 31, 1978, analyses involving duration of employment were limited to an early-term subcohort of 2,721 workers who had died or terminated employment before 1979.

How This Study Was Done: This epidemiologic study examined the underlying causes of death among all Pantex workers employed by the facility between September 1, 1954, and December 31, 1991. Deaths among the workers were compared with rates for the general U.S. population. For the early-term subcohort, internal comparisons (SRRs) based on employment duration were calculated for leukemia using 0-, 2-, and 5-year lag periods and for solid tumors using 10-, 15-, and 20-year lag periods. The variables used for this study were: ID, vital status, sex, race, date of birth, date of death,

underlying cause of death, begin date of employment, end date of employment, early-term subcohort flag, and ICD revision number in which death information was coded. The study report and findings were reviewed by experts outside NIOSH.

Study Findings: The all-cause SMR for the early-term subcohort (0.98, 95% CI = 0.92-1.05) was higher than that seen in the full NIOSH cohort (SMR = 0.81, 95% CI = 0.76-0.86) and was close to that expected from U.S. population rates. The leukemia SMR was elevated (early-term subcohort SMR = 1.47, 95% CI = 0.73-2.63) but SRRs showed no evidence of a positive exposure-response relation with increasing duration of employment. Lung cancer SMRs with 10- and 15-year lags were just below expectation. Breast cancer was elevated only in workers with employment durations of 5 to 10 years. The SMR for prostate cancer was as expected, but this outcome showed a statistically significant positive exposure-response (slope: 1.36 x 10^-5 per person-year [PY] x year of employment [YOE], standard error: 4.31 x 10^-6 per PY x YOE), with a very high, though imprecise, point estimate (SRR = 7.57, 95% CI = 1.03-55.72) for workers employed at least 20 years with a 10-year lag imposed. Multiple myeloma also exhibited a statistically significant positive exposure-response.

Study Limitations: There is a potential for positive bias in the early-term subcohort due to exclusion of long-term healthy workers from this group. Caution should therefore be exercised in generalizing the exposure-response results beyond the early-term subcohort.

Data from this file were used in the Life Table SMR and SRR analyses.

Citations

Silver, Sharon – NIOSH. Anderson-Mahoney, Pamela -- Health Research Association, Los Angeles, Californi. Burphy, Jenneh -- Associated Schools of Public Health, Public Health Graduate Training Program. Hiratzka, Shannon -- Constella Group Inc., Durham, North Carolina. Schubauer-Berigan, Mary K. – NIOSH. Waters, Kathy M – NIOSH. Mortality Update for the Pantex Weapons Facility: Final Report. January 2005. HEALTH-RELATED ENERGY RESEARCH BRANCH, National Institute for Occupational Safety and Health. HHS (NIOSH) Publication No. 2005-124. APHA 132nd Annual Meeting and Exposition. Health-Related. Energy Research Branch (HERB). November 8, 2004. National Institute for Occupational Safety and Health (NIOSH). November 8, 2004

ROCKY FLATS

▪ RFANLA02 Data File Set

Description

The RFANLA02 data file set consists of two analytic files constructed from a single file created by Laurie Wiggs at Los Alamos National Laboratory in August of 1993 in anticipation of a cohort mortality study of workers employed during 1951 to 1978 at RFP.

- The first file, RFANLA02_d1, contains data for 9,490 people of all races (9,025 white, 328 black, and 137 other) and includes 7,938 males and 1,552 females. It represents those people hired at Rocky Flats from March 1951 through December 1978. It does not include contractors (2), Credit Union employees (1), or those who failed to report to work after being hired (20). Demographic variables include sex, race, date of birth, and hire and term dates. Annual readings of whole-body penetrating dose for external ionizing radiation (in mrem) are available from 1951 to 1989. The data from August 1976 through December 1989 was taken from computerized dosimetry badge readings provided by RFP. The data from 1952 to 1978 were abstracted from microfiche records provided by RFP.
- The second file, RFANLA02_d2, contains internal exposure data for americium and plutonium, but not uranium. Exposures are listed by sample date and percent of maximum permissible body burden for the years 1952 to 1989.

Vital status is included from different sources: Rocky Flats (RFSTAT), SSA, and NDI. The Rocky Flats vital status shows 7,639 living, 1,033 dead, and 764 unaccounted for as of May 1, 1992. There were 1,324 workers reported dead as of December 31, 1990, by NDI and SSA. ICDA8 was used to code the cause of death.

An end-of-study date of December 31, 1989, was assigned to the file based on the years covered by the dosimetry data.

Citation
No data available

RFPLUA01 Data File Set

Description

This analytic data file set consists of one file generated for a cohort mortality study of white males employed at RFP during 1951 to 1979 by Gregg Wilkinson, et al., published in the American Journal of Epidemiology.

A cohort mortality study of RFP workers was conducted to test for an association between mortality and exposure to plutonium. The analysis described in the publication focused on 5,413 white male workers employed for 2 or more years between 1951 and 1979. Fewer deaths than expected were found for all causes of death, all cancers, and lung cancer. No bone cancer was observed. An excess of brain tumors was found. Elevated rate ratios for all causes of death and all lymphopoietic neoplasms were found when workers with plutonium body burdens greater than or equal to 2 nCi were compared with those with body burdens less than 2 nCi. No elevated rate ratios were noted for bone and liver cancers.

The single analytic file, RFPLUA01_d1, in this data file set contains demographic and exposure data for 7,616 white males initially employed by RFP between 1951 (construction phase) and the end of 1979. Females, non-white males, and workers with missing sex or race were not included in the analytic file. White males with less than 2 years of employment were dropped from the study but included in the analysis. Data pertaining to each worker's exposure to external ionizing radiation include: monitoring status and the date it was determined, date of first monitoring, and dates of achieving 1 rem, 5 rem, and 10 rem cumulative external whole-body doses through 1978. Cumulative external radiation exposure is reported in millirem. Dates of exposure to plutonium-239 cover years 1952 (partial year) through 1977 and include monitoring status, date of first urine bioassay sample, dates of first achieving body burdens of 2 nCi and 5 nCi, and the fraction of maximum permissible body burdens of plutonium acquired as of December 1977.

Vital status was ascertained for 98.9% of the 5,413 white males employed for 2 or more years through December 31, 1979, the study end date. There were 409 deaths identified in this group. Causes of death were coded to ICDA8.

RFP had been a weapons production facility since 1952. Sources of occupational exposure included external radiation, both gamma and neutron, and potential for internal deposition of plutonium-239. Film dosimeters and thermoluminescent dosimeters were used to monitor for external radiation. Formal bioassay programs to monitor for internal exposures were begun in 1952. Results of both types of monitoring programs reflect technological improvements and changes in concepts and models during these years.

Citations

Brown, Shannon C. -- Department of Health Policy and Management, Bloomberg School of Public Health, Johns Hopkins University. Schonbeck, Margaret F. -- Colorado Department of Public Health and Environment. McClure, David, Baron, Anna E. -- Department of Preventive Medicine and Biometrics, Health Sciences Center, University of Colorado. Navidi, William C. -- Department of Mathematical and Computer Sciences, Colorado School of Mines. Byers, Tim, Ruttenber, James A. -- Department of Preventive Medicine and Biometrics, Health Sciences Center, University of Colorado. Lung Cancer and Internal Lung Doses among Plutonium Workers at the Rocky Flats Plant: A Case-Control Study. 2004. American Journal of Epidemiology. 160:163-172

Wilkinson, Gregg S., Tietjen, Gary L., Wiggs, Laurie D., Galke, Warran A. -- Los Alamos National Laboratory. Acquavella, John F. -- Exxon Corp. Reyes, Michael, Voeltz, George -- Los Alamos National Laboratory. Waxweiler, Richard J. -- Centers for Disease Control (CDC). Mortality Among Plutonium and Other Radiation Workers at a Plutonium Weapons Facility. 1987. American Journal of Epidemiology. 125(2):231-250

▪ RFR04A01 Data File Set

Description

The study was a nested case-control study of the association between lung cancer mortality and cumulative internal lung doses among a cohort of workers employed at the Rocky Flats Plant in Colorado from 1951 to 1989. Lung cancer risk was elevated among workers with cumulative internal lung doses of more than 400 mSv. The dose-response relation was not consistent at high doses. Restricting the analysis to workers employed 15 to 25 years showed a statistically significant linear trend with dose, suggesting a strong healthy worker survivor effect. No associations were found between lung cancer mortality and cumulative external penetrating radiation dose or cumulative exposures to asbestos, beryllium, hexavalent chromium, or nickel.

Cases and controls were selected from a preliminary database of 22,883 workers who were employed at the Rocky Flats Plant between January 1, 1952, and July 10, 1996. Vital status was determined through December 31, 1996, by submitting personally identifying information to the Social Security Administration and Pension Benefits, Inc., a commercial provider of vital status information. A final cohort roster was developed for 16,248 production-era workers who were employed for 6 months or more between 1952 and 1989. Incidence density sampling was used to select controls from the set of subjects at risk at the time of death of each case. Four controls were randomly selected from each risk set for comparison with each lung cancer case.

The Rocky Flats Plant produced nuclear weapons components from 1952 to 1989. Workers were exposed to several plutonium isotopes, americium 241, and uranium. Uranium was used in the construction of some weapons components in the 1960s and americium 241 was used for weapons and other uses. Internal exposures to the radionuclides occurred primarily by acute inhalation of radioactive particles accidentally released into the workplace atmosphere. Data from a job exposure matrix were used

to estimate annual exposures to asbestos (fibers/cc), beryllium (µg/m3), hexavalent chromium (ppm), and nickel (µg/m3), expressed as the product of time worked and the estimated time-weighted average daily breathing zone concentrations that were usually experienced by workers. Exposures to plutonium isotopes were routinely quantified with estimates of systemic deposition. Data for external radiation doses came from electronic databases of recorded doses from film and thermoluminescent personal dosimeters that measured total body doses from external gamma photon and neutron exposures. The dosimeters recorded doses for individual workers for periods ranging from quarter years to years. Unadjusted neutron doses are reported in millirad, and unadjusted gamma exposures are in millirem. The total unadjusted penetrating dose (neutrons + gamma) is reported in millirem Histories of smoking frequency for cases and controls were obtained by telephone interviews with surrogate interviewees, regardless of the vital status of the subject, in an effort to provide reliable historical data and to reduce potential bias from self-reporting.

Citations

Brown, Shannon C., Schonbeck, Margaret F., McClure, David, Baron, Anna E., Navidi, William C., Byers, Tim, Ruttenber, James A. Lung Cancer and Internal Lung Doses among Plutonium Workers at the Rocky Flats Plant: A Case-Control Study. 2004. American Journal of Epidemiology. 160:163-172

SANTA SUSANA FIELD LABORATORY

▪ SSCO97A1 Data File Set

Description

This data file set consists of three data files for the Santa Susana Field Laboratory Worker Study, a retrospective cohort analysis of workers employed at Rocketdyne/AI between 1950 and 1993, conducted by Dr. Hal Morgenstern, Principal Investigator, UCLA School of Public Health.

The purpose of this retrospective cohort study was to estimate the effects of low-level occupational exposures to external ionizing radiation (penetration of the whole body primarily by gamma and x-rays) and internal radiation (inhalation and ingestion of alpha-emitting radionuclides, primarily uranium and mixed fission products) on cancer mortality (total and selected sites) among workers employed at the Santa Susana Field Laboratory and associated facilities of Atomics International (AI) and Rocketdyne in Greater Los Angeles. The Rocketdyne division of Rockwell International (now a division of The Boeing Company) was merged with AI in 1984. The source population for the study was all workers employed at Rocketdyne/AI between 1950 and 1993.

The study population for estimating the effects of external radiation consisted of 4,563 workers who had been enrolled in the health physics monitoring program and

had been monitored for external radiation by the company (the externally monitored cohort). The study population for estimating the effects of internal radiation consisted of 2,297 workers who had been enrolled in the health physics monitoring program and had been monitored for internal radiation (the internally monitored cohort). All but 44 members of the internally monitored cohort were included in the externally monitored cohort. Thus, the total sample size was 4,607.

All subjects were followed from the start of monitoring (or 1/1/50 if later) through the end of 1994 for vital status, using company records and three different record systems. A licensed nosologist coded the underlying cause of death, according to ICD9, using information obtained from death certificates. Radiation doses were calculated from the data monitoring records provided by Rocketdyne's health physics program. External doses were based primarily on periodic film badge readings. Internal doses were based on bioassays of urine and feces, in vivo whole-body counts, and lung counts.

The first file, SSCO97A1_d1 (RKCOHORT), contains sociodemographic data, vital status, ICD9 codes, and summary monitoring and exposure data for all 4,607 subjects in the radiation study. The second file, SSCO97A1_d2 (RKEXTEXP), contains 31,730 records of annual external radiation doses for all 4,563 subjects in the externally monitored cohort. The third file, SSCO97A1_d3 (RKINTEXP), contains 10,503 records of annual internal radiation doses for all 2,297 subjects in the internally monitored cohort.

Citations

Morgenstern, H., Froines, J., Ritz, B., Young, B. B. Epidemiologic Study to Determine Possible Adverse Effects to Rocketdyne/Atomics International Workers from Exposure to Ionizing Radiation, Final Report to the Public Health Institute. 1997. Subcontract No. 324A-8701-S0163

Morgenstern, H., Ritz, B. Effects of radiation and chemical exposures on cancer mortality among Rocketdyne workers: A review of three cohort studies. 2001. Occupational Medicine: State of the Art Reviews. 16(2):219-237

Ritz, B., Morgenstern, H., Crawford-Brown, D., Young, B. B. The effects of internal radiation exposure on cancer mortality in nuclear workers at Rocketdyne/Atomics International. 2001. Environmental Health Perspectives. 108:743-751

Ritz, B., Morgenstern, H., Froines, J., Young, B. B. Effects of exposure to external ionizing radiation on cancer mortality in nuclear workers monitored for radiation at Rocketdyne/Atomics International. 1999. American Journal of Industrial Medicine. 35:21-31

Ritz, B., Morgenstern, H., Moncau, J. Age at exposure modifies the effects of low-level ionizing radiation on cancer mortality in an occupational cohort. 1999. Epidemiology. 10:135-140

SSFL05A2 Data File Set

Description

This set of three files contains demographic and radiation monitoring and dosimetry data on 5,801 Atomics International-Boeing-Rocketdyne employees who were monitored for either external or internal radiation from 1948 until 1999. The three analytic files contain data on: (1) SSFL05A2_d1 employee demographics, (2) SSFL05A2_d2 external radiation (including neutron) dose, and (3) SSFL05A2_d3 internal radiation dose. All three data sets can be linked using the ID variable. The principal investigator for this study is John D. Boice, Jr.

The demographics file contains key demographic (but not personally identifiable) information on all 5,801 radiation workers. Each record represents one employee. Variables include sex; race; year of birth; year of hire and termination; whether the employee was monitored for external, internal, and/or neutron radiation; occupational variables indicating whether the employee was primarily a factory worker; the primary pay type (hourly versus salary); and if the employees ever worked as a test stand mechanic or related position. The vital status, as of December 31, 1999, is also included. If a worker was found to be dead, the year of death, along with the cause of death coded in the ICD revision in effect at the time of death are included.

The two dose files contain dosimetry data. The external file contains annual total external (gamma and x-rays) and neutron doses for 5,743 workers monitored for external radiation. Each record represents one employee (n = 5,743), with variables for ID, total external dose in 1940 to 1999 (texd1940-texd1999), and total neutron dose in 1948 to 1999 (tned1948-tned1999). The internal file contains 15 annual committed equivalent internal organ doses (in mrem) for 285 workers who had committed equivalent doses to any organ expected to be greater than 10 mSv. Each record represents 1 year of organ dose for each employee (n = 8,760). Variables include the ID, year, and organ doses, including bladder, bone surface, brain, breast, colon, esophagus, kidney, liver, lung, respiratory lymph node, red marrow, stomach, testes, thyroid, and the remainder dose.

A retrospective cohort mortality study was conducted of workers engaged in nuclear technology development and employed for at least 6 months at Rocketdyne-Atomics International-Boeing Facilities in California, from 1948 to 1999. The entire work force of 46,970 Rocketdyne-AI employees was identified from 35,042 Kardex work histories cards, 26,136 electronic personnel listings, and 14,189 radiation folders containing individual exposure histories. Overall, 5,801 workers were monitored for radiation at Rocketdyne-AI: 5,743 for external exposure and 2,232 for internal intake of radionuclides; 41,169 workers were not monitored for radiation.

Because incomplete radiation exposure histories, inadequate treatment of internally deposited radionuclides, and failure to account for neutron exposures can be important uncertainties in epidemiologic studies of radiation workers, the lifetime occupational doses, including radiation received prior to and subsequent to work at Rocketdyne, were obtained from both company records and linkages with national dosimetry data sets. To obtain prior and subsequent occupational exposure information, the roster of all workers was matched against nationwide dosimetry files from the Department of Energy, the Nuclear Regulatory Commission, the Landauer dosimetry company, the U.S. Army, and the U.S. Air Force. Dosimetry files of other worker studies were also accessed.

Detailed internal exposure scenarios were developed and annual internal doses were derived on a case-by-case basis for 292 workers with committed equivalent doses indicated by screening criteria to be greater than 10 mSv to the organ with the highest internal dose. Computation of organ doses from radionuclide intakes was complicated by the diversity of bioassay data collected over a 40-year period (urine and fecal samples, lung counts, whole-body counts, nasal smears, and wound and incident reports) and the variety of radionuclides with documented intake including isotopes of uranium, plutonium, americium, calcium, cesium, cerium, zirconium, thorium, polonium, promethium, iodine, zinc, strontium, and hydrogen (tritium). Over 30,000 individual bioassay measurements, recorded on 11 different bioassay forms, were abstracted. The bioassay data were evaluated using ICRP biokinetics models recommended in current or upcoming ICRP documents (modified for one inhaled material to reflect site-specific information) to estimate annual doses for 16 organs or tissues taking into account time of exposure, type of radionuclide, and excretion patterns.

Vital status was determined for 97.6% of the monitored workers of whom 25.3% (n = 1,468) had died. The average period of observation was 27.9 years. SMRs compared the observed numbers of deaths with those expected in the general population of California. Cox proportional hazards models were used to evaluate dose-response trends over categories of cumulative radiation dose, combining external and internal organ-specific doses.

The mean dose from external radiation was 13.5 mSv. However, the mean cumulative external dose based on Rocketdyne-AI records alone was 10.0 mSv, and the dose distribution was highly skewed with most workers experiencing low cumulative doses and only a few with high doses (maximum 500 mSv). Only 45 workers received greater than 200 mSv while employed at Rocketdyne-AI. However, nearly 32% (or 1,833) of the Rocketdyne-AI workers had been monitored for radiation at other nuclear facilities and

incorporation of these doses increased the mean dose to 13.5 mSv (maximum 1,005 mSv) and the number of workers with >200 mSv to 69. The mean lung dose from external and internal radiation combined was 19.0 mSv (maximum 3.6 Sv). However, for a small number of workers (n = 292), lung doses from internal radionuclide intakes were relatively high (mean 106 mSv, maximum 3,560 mSv) and increased the overall population mean dose to 19.0 mSv and the number of workers with lung dose >200 mSv to 109.

Although nearly 12% of the radiation workers were monitored for neutron exposures (mean 1.2 mSv, 10% at Rocketdyne-AI, 2% elsewhere), the cumulative dose levels were small in comparison with other external and internal exposure. Interestingly, 1,477 workers not monitored for radiation at Rocketdyne-AI (3.6%) were found to have worn dosimeters at other nuclear facilities (mean external dose of 2.6 mSv, maximum 188 mSv). Without considering all sources of occupational exposure, an incorrect characterization of worker exposure would have occurred with the potential to bias epidemiologic results. For these pioneering workers in the nuclear industry, 26.5% of their total occupational dose (collective dose) was received at other facilities both prior to and after employment at Rocketdyne-AI. In addition, a small number of workers monitored for internal radionuclides contributed disproportionately to the number of workers with high lung doses.

Overall, this study showed: (1) radiation exposure has not caused a detectable increase in cancer deaths in this population, but results are limited by small numbers and relatively low career doses, and (2) risk estimates based on nuclear worker data must be interpreted cautiously if internally deposited radionuclides and occupational doses received elsewhere are not considered.

Citations

Boice, John D. Rocketdyne Worker Health Study. Final Report. Executive Summary & Appendices
July 13, 2005

Boice, John D., Leggett, Richard W., Ellis, Elizabeth Dupree, Wallace, Phillip W. Mumma, Michael, Cohen, Sarah S., Brill, A. Bertrand, Chadda, Bandana, Boecker, Bruce B., Yoder, R. Craig, Eckerman, Keith F. A comprehensive dose reconstruction methodology for former Rocketdyne/Atomics International radiation workers. May, 2006. Health Physics. Vol. 90(5). pp. 409-430

Boice, John D., Marano, Donald E., Cohen, Sarah S., Mumma, Michael, Blot, William J., Brill, A. Bertrand, Fryzek, Jon P., Henderson, Brian E., McLaughlin, Joseph K. Mortality among Rocketdyne workers who tested rocket engines, 1948-1999. May, 2006. Journal Occupational Environmental Medicine. Vol. 48:1070-1092

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SAVANNAH RIVER

▪ SRC88A01 Data File Set

Description

This analytic data file set consists of one file generated for a retrospective cohort mortality study of white males employed at the SRS in 1952 to 1974 by Donna Cragle, et al., published in the American Journal of Industrial Medicine in 1988.

The published paper describes the overall and cause-specific mortality for a cohort of 9,860 white males who were hired between 1952 (when the facility began operation) and December 31, 1974, and who were employed at SRS for at least 90 days during this time. Exposures to radiation or chemicals were not considered. Separate analyses were presented for hourly employees (6,687) and salaried employees (2,745) by time period of first hire and by length of employment. These workers experienced mortality comparable with that of U.S. males and, in fact, exhibited fewer deaths than expected in many categories of diseases. Specifically, fewer deaths were noted in the categories of all causes, all cancers, cancer of the digestive organs, lung cancer, brain cancer (hourly workers only), diabetes, all diseases of the circulatory system, all respiratory diseases, all digestive system diseases, all diseases of the genitourinary system (hourly workers only), and all external causes of death. A statistically significant, and as yet unexplained, increase in leukemia mortality appeared in a subset of the hourly workers who were first hired before 1955 and were employed between 5 and 15 years.

The one analytic file, SRC88A01_d1 (SRANA4), in this data file set contains one record per person in the cohort, including demographic, work history, and vital status data on all members of the cohort.

Hourly employees were judged to be those employees who worked for 90 or more consecutive days at an hourly classification and less than 90 consecutive days at a salaried classification. Salaried employees were judged to be those employees who worked 90 or more consecutive days in a salaried classification and less than 90 days in an hourly classification. A third category consisted of those who worked 90 or more days consecutively in both classifications. Vital status was ascertained for 94.2% (N = 9,288) of the cohort through December 31, 1980, the study end date. There were 1,091 deaths identified, and death certificates were obtained for 96.9% of these deaths.

No personal monitoring data were used in this analysis.

Citations

Brown, Karen T., Crase, Kenneth W., Singh, Lakshmi P. Summary of Epidemiology Studies or Activities Involving Workers at the Savannah River Site or the Surrounding Public: An Update. Department of Energy. ESH-WHS-2002-00005

Cragle, D. L., McLain, R. W., Qualters, J. R., Hickey, J. L. S., Wilkinson, G. S., Tankersley, W. G., Lushbaugh, C. C. Mortality among workers at a nuclear fuels production facility. 1988. American Journal of Industrial Medicine. 14(4):379-401

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Cragle, Donna L. Mortality among workers at a nuclear fuels production facility: The Savannah River Site, 1952-1986. Final Report. 1994. Statistics in epidemiology. Mortality Among Workers at the Savannah River Nuclear Fuels Production Facility (variant citation). American Statistical Association. 1998. pp. 83-87

▪ SRC94A02 Data File Set

Description

This analytic data file set consists of two files generated for a retrospective cohort mortality study of white males employed at the SRS in Aiken, South Carolina in 1952 to 1974 by Donna Cragle, et al.

A previous study (Cragle et al. 1988. American Journal of Industrial Medicine 14: 379-401) of 9,860 white males was descriptive in nature because radiation doses were not accessible for dose-response analysis. Men first hired from the plant opening in 1952 through 1974 entered the study 90 days after hire and were followed up through 1980. For hourly workers, there were 13 leukemia deaths versus the 7.95 expected based on U.S. white male rates. Overall, there was a strong healthy worker effect evident with SMRs significantly below 1 for all causes (0.80) and all cancers (0.72). The current update was based on deaths through 1986 for the same cohort of workers. With the 6 additional years, there was a total of 290,000 person-years of follow-up. For hourly workers, there were 19 leukemia deaths, giving an SMR of 1.34 with a 95% confidence interval from 0.80 to 2.09. The healthy worker effect was still evident with SMRs significantly below 1 for all causes (0.78) and all cancers (0.82). Dose-response analysis was performed for all cancers, lung cancer, leukemia, colon cancer, and pancreatic cancer. There was no indication of a dose-response relationship except for leukemia. However, the leukemia dose-response relationship was based on only 20 deaths, including 2 non-underlying causes of death and excluding chronic lymphocytic leukemia, which has not been linked to radiation exposure.

There are two analytic files for this cohort.

- SRC94A02_d1 (DLC9860) contains a record for each member of the cohort, which includes vital status as of January 1, 1987. The last SSA submission for this population provided “alive” status as of January 1, 1985; the “alive” category is no longer obtainable from SSA. However, NDI provides a record of all deaths occurring since January 1, 1979. If not identified as deceased by SSA or NDI, individuals last known to be alive before January 1, 1979, were considered lost to

follow-up on the last date known alive, while those known to be alive after January 1, 1979, were considered alive at the end of the study. There were 1,722 deaths from all causes with death certificates available for 97.9% of these individuals.

- The exposure file, SRC94A02_d2 (SRSEXPOS), contains yearly dose values for all monitored workers, including 9,757 of the workers for external radiation exposure and 455 for internal exposures due to transuranics or fission products. The annual external doses are more accurately "deep" doses resulting from exposures to photons, neutrons, and tritium.

The SRS was built after World War II and was specifically designed for nuclear operations. Operations at the SRS have included uranium processing, nuclear fuel fabrication, nuclear reactor operation and maintenance, nuclear fuel reprocessing, and thorium processing. The site contains five large production reactors, two chemical separation facilities, a heavy water extraction plant, nuclear fuel and target fabrication facilities, test reactors, research and development laboratories, power plants, and administration buildings.

Citations

Brown, Karen T., Crase, Kenneth W., Singh, Lakshmi P. Summary of Epidemiology Studies or Activities Involving Workers at the Savannah River Site or the Surrounding Public: An Update. Department of Energy. ESH-WHS-2002-00005

Watkins, Janice P., Robertson-DeMers, Kathryn. Mortality Among Workers at the Savannah River Nuclear Fuels Production Facility.

Cragle, Donna L. Mortality among workers at a nuclear fuels production facility: The Savannah River Site, 1952-1986. Final Report. 1994. Statistics in epidemiology. Mortality Among Workers at the Savannah River Nuclear Fuels Production Facility (variant citation). American Statistical Association. 1998. pp. 83-87

ZIA

ZARADA01 Data File Set

Description

This analysis by Laurie Wiggs, comprising one data file, sought to determine whether mortality among 5,424 radiation monitored Zia workers hired prior to 1979 differed significantly from the general population in the United States and whether the subgroup of this cohort exposed to radiation was at an increased risk of dying from cancer when compared with the unexposed group. Additional analyses were undertaken to examine mortality for the Hispanic subgroup of this population (51%). Zia was the principal subcontractor to LANL from 1946 to June 1986. Zia performed construction and maintenance functions at LANL.

The group at Zia responsible for construction was called Los Alamos Constructors, Inc (LACI), and data for LACI workers are also included in this file.

The single analytic file, ZARADA01_d1, contains demographic and exposure data for 5,424 Zia employees hired before January 1, 1979, and monitored either for external radiation or plutonium as of December 31, 1984. There are data for 365 females. A total of 11 females are Native Americans, and the rest are considered white (unknown race assumed white). There are 94 Native American males, 10 black males, 1 Oriental male, and 4,954 white males. Demographic data were abstracted from four primary record sources provided by the Zia Company and supplemented with data from LANL records. Demographic data available included race, ethnicity, sex, birth date, and dates of employment.

Vital status was ascertained for 97% of the 5,424 workers through December 31, 1984, the end of study date. There were 1,197 deaths identified in this cohort as of end of the study. An additional 51 workers were identified as dead with no certificate, giving a 96% recovery rate for death certificates. Vital status was determined from information provided by the SSA valid through December 31, 1984. Some deaths after end of the study are recorded. ICDA8 was used to code causes of death.

The sources of occupational radiation exposures for the Zia Company were external radiation, primarily gamma, and internal deposition of plutonium-238 and plutonium-239. Pocket chambers or film dosimeters were used for personnel monitoring from 1944 through 1980, when they were replaced with thermoluminescent dosimeters. Formal bioassay programs to monitor for internal exposures were begun in 1944.

External exposure data consist of dates (in decimalized notation) at which the worker was first monitored, first received a positive exposure, first accumulated 1 rem whole-body dose, first accumulated 5 rem whole-body dose, and first received 10 rem whole-body dose. Whole-body dose (in centirem) was defined as the sum of all tritium, neutron, and penetrating gamma readings. Annual penetrating external dose, based on film or TLDs, from 1944 to 1984 is also present in the file. External data were available through 1984. Data pertaining to internal plutonium exposure include isotope, dates (in decimalized notation) of first and last samples, and estimated body burdens (in units of both nCi and nCi-years) of plutonium-239 and plutonium-238 combined. Dates that body burdens reached 2, 5, and 10 nCi are also presented as separate readings for plutonium-238 and plutonium-239.

Body burdens were estimated as of December 31, 1984, or death date and as of last sample date. The computer code PUQFUA was used to generate body burden data. Dosimetry data were provided by the health physics group at LANL, which is responsible for monitoring of all Zia (and other subcontractor) personnel in addition to LANL employees. These radiation data can include readings while employed at Zia, LANL, or another subcontractor of LANL; therefore, sample dates may not fall within the period worked at Zia for all workers in this file.

Citations

G, Johnson, Voelz, E., et al. Mortality of 224 male workers exposed to plutonium. February 9, 1993

Galke, G.A., Johnson, E.R. & Tietjen, G.L. (1992) Mortality in an ethnically diverse radiation exposed occupational cohort

APPENDIX B – Part 2

Analytic Data File Sets Multiple Sites Health and Mortality Studies

HANFORD

- **MFCLCCA1 Data File Set**

Description

This multiple-site analytic data file set consists of four files generated for a childhood leukemia case-control study, published in 1997, of childhood cancers near three DOE sites.

The focus of the study is to evaluate if childhood leukemia is associated with the exposure of parents to radiation before the conception of the child. The study's principal investigator, epidemiologist Lowell Sever, Ph.D., proposed the study following publication of the British study by Martin Gardner that found an association between paternal preconception exposure to radiation and childhood cancer. Researchers were to use a variety of sources to identify children under 15 years of age from Benton and Franklin Counties who were diagnosed as having leukemia between 1957 and 1991. These two counties are the closest to Hanford. Up to eight controls, children without leukemia, were to be chosen for each case of leukemia identified. If the parents of the children identified as cases and controls worked at Hanford, researchers also were to determine the parents' exposure to radiation both prior to conception and during pregnancy. Statistical analyses were to examine associations between parental employment at Hanford and the risk of childhood leukemia and between parental radiation exposure and the presence or absence of childhood leukemia. A final report was expected to be available in 1996.

The purpose of this multiple-site study was to investigate cases of three major categories of childhood cancers in the populations around Hanford, the INEL site, and the K-25, Y-12, and X-10 facilities at Oak Ridge. The hypothesis of an association between childhood cancer risk and paternal preconception occupational radiation exposure was examined. This hypothesis was based on the finding of such an association in the population around the Sellafield nuclear facility in England (Gardner, et al. 1990). Since the publication of Gardner's findings, several other studies have been conducted using different approaches to explore the same question.

This childhood leukemia investigation was carried out in three phases. The first phase was a pilot study at Hanford to test all aspects of a case-control study and examine the proposed design of the study. The second phase was to determine the feasibility of adding other DOE sites. The third phase was to conduct this case-control study at Hanford and two additional DOE sites.

A total of 233 children meeting the case definitions for this study were identified. Fathers of 28 of these cases were employed at one of the three sites prior to their child's conception. For each case whose father worked at one of the study sites, controls were restricted to those children whose fathers also worked at that site. Additional unrestricted control children were also identified for each case from birth certificates.

The results of this study, for all cancer types combined, for leukemia and lymphoma, both for individual DOE facilities and for the three facilities combined, are consistent with a null hypothesis of no association between paternal preconception exposure and risk of these forms of childhood cancer. These findings do not support the earlier association observed in the Gardener study and are consistent with subsequent studies that have failed to demonstrate (observe) increased risks associated with preconception doses of radiation received by fathers employed by nuclear facilities.

- MFCLCCA1_d1 (HFMLKCAS) has one record for each of 233 cases and contains the same types of information as MFCLCCA1_d3 (HFMLKCON).
- MFCLCCA1_d3 (HFMLKCON) has one record for each of 1,036 controls. This file contains demographic data, information from hospitals, and DOE employment status.
- MFCLCCA1_d2 (HFMLKCAD) has one record for each of 57 cases and contains the same types of information as MFCLCCA1_d4 (HFMLKCOD).
- MFCLCCA1_d4 (HFMLKCOD) has one record for each of 382 controls. This file contains dosimetry and work history data.

The Hanford site and its activities are described in Section 6 of the CEDR catalog. The Hanford analytic data file sets in Appendix B also provide information about this site. INEL facilities are located in Idaho Falls, Idaho, and on an 890-square-mile tract west of Idaho Falls. Historically, a leader in DOE reactor technology programs and engineering projects, INEL conducts applied research and development to support the missions of DOE and other government agencies. It has expertise in biotechnology, chemical and engineering sciences, instrumentation development, materials and materials processing, nuclear reactor research technology, information

and communications technology, sensor development and measurement science, mechanical and electronic system development, robotics, computational intelligence, and environmental and waste treatment technology.

The K-25, Y-12, and X-10 facilities at the Oak Ridge site and their activities are described in Section 6 of the CEDR catalog. The Oak Ridge analytic data file sets in Appendix B also provide information about these facilities.

This study was funded by the National Institute of Occupational Safety and Health of the Centers for Disease Control and Prevention.

Citation

Sever, L.E., Gilbert, E.S., Tucker, K., Greaves, J.A., Greaves, C., Buchanan, J.A. -- Battelle Memorial Institute, Epidemiologic Evaluation of Childhood Leukemia and Paternal Exposure to Ionizing Radiation. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH), Health-Related Energy Research Branch (HERB), U50/CCU012545-01

MULTIPLE SITES (Uranium Dust)

▪ MFD94A01 Data File Set

Description

This analytic data file set consists of 12 files generated for a nested case-control study of respiratory cancer through 1982 for workers in selected occupations employed at four uranium processing or fabrication operations in Missouri, Ohio, and Tennessee, where there was potential for uranium dust exposure by Elizabeth Dupree, et al.

The analysis files contain 1,580 observations for the original 790 cases and their matched controls. Cases were identified as those workers employed at least 183 days in any one of these four operations who died before January 1, 1983, with respiratory cancer (ICDA8 codes 162.0 through 163.9, inclusive) listed anywhere on the death certificate. Each case was matched with one control. The main analysis file is MFD94A01_d1, which contains demographic, work history, medical history, and smoking data. The essential exposure files are MFD94A01_d2 (for internal radiation doses), MFD94A01_d3 (for external radiation doses), and MFD94A01_d4 (for thorium, radium, and radon exposures). MFD94A01_d2 and MFD94A01_d3 contain cumulative doses (mrem) lagged 10 years and 20 years before the date of death for each case and matched control. In addition, for each study member, there are annual doses by separate operations, annual doses across operations, and annual cumulative doses across operations. MFD94A01_d4 contains the number of years with exposure to thorium, to radium, and to radon lagged 0, 10, and 20 years before the date of death for each case and matched control. Also, there are annual individual indicators of exposure

to thorium, radium, and radon. The file MFD94A01_d7 includes employment and job title data. MFD94A01_d5 and MFD94A01_d8 contain cumulative internal dose case-control data. MFD94A01_d6 and MFD94A01_d11 contain smoking history data. MFD94A01_d9 contains medical data. MFD94A01_d10 contains average daily external exposure. MFD94A01_d12 contains average daily internal exposure.

Two of the four operations were at the Y-12 facility in Oak Ridge, Tennessee. The first was a uranium enrichment operation managed by TEC from 1943 to June 1947. The second, managed by Union Carbide Corporation from June 1947 through the end of the study, was a weapons fabrication operation and was referred to in the study as Y-12. The third was the Uranium Division of MCW located in St. Louis, Missouri, from 1942 to 1958 and in Weldon Springs, Missouri, from 1958 to plant shutdown in 1966. The FMPC, located in Fernald, Ohio, was the fourth operation. It came online in 1951 and, along with MCW, processed ore concentrate into uranium metal. MCW also processed radium-bearing pitchblend ores. Of the 787 pairs, 567 had been employed in the TEC operation with 428 of these workers employed only in this operation. Information collected on all study members included smoking status, socioeconomic status, complete work histories, and radiation monitoring data. Annual doses to the lung resulting from deposited uranium, which was mainly insoluble, were estimated using methodologies appropriate to the type of radiation exposure data that had been collected from each operation. The radiation dose to the lung arose almost exclusively from alpha radiation, but annual whole-body doses from gamma radiation were determined for the FMPC, MCW, and Y-12 workers who had personnel monitoring data available for calculating them. In addition, potential for production exposure to thorium existed in all but the TEC operation and to radium and radon at MCW. The mean cumulative lung doses for cases and controls were 1.52 and 1.49 cGy (rad), respectively, and medians were 0.38 and 0.43 cGy, respectively.

Citations

Dupree, E. A., J. P. Watkins, J. N. Ingle, P. W. Wallace, C. M. West, W. G. Tankersley. Uranium Dust Exposure and Lung Cancer Risk in Four Uranium Processing Operations. Epidemiology 1995 Jul, 6(4):370-5.

MULTIPLE SITES (5 Rem Study)

▪ MFF94A02 Data File Set

Description

This analytic data file set consists of a single file generated for a retrospective cohort mortality and morbidity study of all workers throughout the United States who received at least 5 rem (50 mSv) of penetrating ionizing radiation during 1 calendar year before 1979 while employed at DOE nuclear facilities or the U.S. Navy's Nuclear Reactor Propulsion Plants (NRPPs). The registry of 5 rem workers was assembled between 1979 and 1982 in response to Congressional concern about the long-term health effects on DOE and predecessor agency workers of exceeding the 50 mSv occupational radiation standard for external radiation. Civilian NRPP workers were also eligible for the registry.

The study cohort comprised 3,145 persons, including 2,035 DOE workers and 1,010 NRPP personnel from 32 DOE and contractor facilities and 7 naval shipyards. The median length of follow-up was 20 years with approximately 69,000 person-years of follow-up with 76% attributed to white males, 4% to black males, 10% to "other" males (race not determinable), 10% to those of undeterminable race and gender, and the remaining less than 1% to females.

The total population external radiation dose through 1978 was 718.0 Sv (85% to white males) with a median of 153.4 and a range of 50.0 to 44,010.0 mSv. The median year of hire at the facility of first 50 or more mSv per year exposure (FF50) was 1954, with median length of employment at FF50 being 14 years. Median hire age at FF50 was 27 years, while first yearly exposure to at least 50 mSv occurred at a median age of 33. Approximately two-thirds of the cohort was retired or terminated before 1979. DOE workers comprised 96.4% of those entering the registry from 1943 through 1959 but only 33% of those entering from 1960 through 1978. More than 80% of the cohort received a 50 mSv or greater exposure in only 1 year.

The analytic file, MFF94A02_d1, contains a record for each of the 3,145 cohort members. This file contains demographic, work history, facility, vital status as of December 31, 1984, and exposure information. Vital status was obtained for 86.6% of the population, with 588 identified as deceased. Cause of death (ICDA8) was certified by 96.3% of these and included 159 cancers (127 for white males). The analytic file doses for each study member are reported in rem. A cumulative dose of 500 mSv (50 rem) or more was acquired by 147 members of the cohort. The standardized mortality ratio for white males was .88 (95% CI = .80-.97) for all causes, 109 (95% CI = .90-1.29) for all cancers, and 1.15 (95% CI = .61-1.97) for all lymphoma and hematopoietic cancers.

The DOE workers had been involved from 1947 through 1978 in research, development, and production operations with potential exposure to external and internal radiation, as well as to industrial chemicals, depending on the facility of employment and the time period. Non-radiologic hazards included organic solvents, cutting oils, asbestos, and toxic metals, such as uranium, lead, cadmium, nickel, mercury, and beryllium. The NRPP workers had higher potential for radiation and chemical exposures starting in the 1960s during overhauling and refitting of nuclear vessels, with cobalt-60 as a primary source of external radiation.

Citations

Fry, S., Dupree, E.A., Sipe, A.H., Seiler, D.L., Wallace, P.W. A study of mortality and morbidity among persons occupationally exposed to > 50 mSv in a year: Phase I, mortality through 1984. 1996. Applied Occupational & Environmental Hygiene. 11(4):334-343

MULTIPLE SITES (MFFEGWA1)

▪ MFFEGWA1 Data File Set

Description

This data file set comprises two analytic data files used in a retrospective cohort mortality study of female workers at one or more DOE facilities by Gregg Wilkinson. The sites include Los Alamos National Laboratory; Zia Company; Rocky Flats; Hanford; Mound; Savannah River; Oak Ridge X-10, Y-12, and K-25; Fernald; Linde; and Pantex. The year 1994 is the end of the study date or end of follow-up.

Although women have been employed in the nuclear weapons industry since its inception, little is known about the potential health effects that women may experience as a result of work-related exposures to ionizing radiation and non-radiation hazards. Studies that have reported results for women have tended to suffer from small numbers of observations, short follow-up, young average age of cohort members, and a lack of exposure information. Despite these shortcomings, suggestive but inconsistent elevations for several types of neoplasms have been reported including several known to be associated with ionizing radiation and for several non-neoplastic conditions. This study attempted to overcome the shortcomings just mentioned by combining cohorts of female nuclear workers from 12 U.S. nuclear weapons facilities. These included Los Alamos National Laboratory; Zia Company; Rocky Flats; Hanford; Mound; Savannah River; Oak Ridge X-10, Y-12, and K-25; Fernald; Linde; and Pantex.

The specific aims of this study were to combine data for female employees from these 12 facilities, to estimate doses or exposures to individuals for radiation and non-radiation hazards, to estimate the relative risk of mortality from neoplastic and non-neoplastic diseases, and to estimate the amount of uncertainty associated with these relative risk estimates.

To accomplish these specific aims, a retrospective cohort mortality study of neoplastic and non-neoplastic health endpoints was conducted of female workers who were hired at the above facilities before 1980. The cohorts were assembled from roster files that had been developed by previously funded Department of Energy researchers at Pacific Northwest Laboratories (Hanford), ORISE (Fernald, Linde, K-25, Savannah River, X-10, Y-12) and Los Alamos National Laboratory (Los Alamos, Mound, Pantex, Rocky Flats, Zia).

Data on radiation exposures for workers at Fernald, K-25, Y-12, X-10, and Savannah River were obtained from researchers at ORISE. Data for Fernald workers were updated by information obtained directly from Fernald. No data on radiation exposures were available for Linde workers. Radiation exposure data for Hanford workers were abstracted from a file that was compiled for a study conducted by the IARC. Data on radiation exposures for Pantex, Los Alamos, and Zia workers were obtained directly from health physicists at these facilities. Updated information on radiation exposures was not available for Mound workers. Radiation exposure data for Rocky Flats workers was made available to us from researchers at the University of Colorado.

In collaboration with researchers at the University of North Carolina, we developed questionnaires on radiation dosimetry practices and data resources and on physico-chemical exposures, industrial hygiene practices, and data resources. The radiation dosimetry questionnaire expanded on a questionnaire that had been previously devised by staff at the Department of Energy. These questionnaires were sent to designated contacts at the study facilities. Unfortunately, fewer than half of the questionnaires were completed and returned.

Vital status ascertainment for the combined study cohort was completed by matching a roster of study subjects, who had not already been identified as deceased, with Social Security Administration Master Death Tapes. The matching process was conducted by the Epidemiology Research Institute in Boston using a matching algorithm they developed. Death certificates were requested from state departments of health and vital statistics for individuals who were identified as deceased. Deaths were then coded to the 8th revision of the International Classification of Diseases by a qualified nosologist. Vital status follow-up ended in 1994.

A total of 65,984 women and 2,544,433.51 person-years were identified from the 12 study facilities. Among these, 13,671 deaths were observed. Although the total number of African American women varied between the study facilities, overall, less than 10 percent were identified as African American. For the total combined cohort, 32.5% had a radiation record indicating they had been monitored for external radiation. Among women with a radiation record, mean cumulative external radiation doses ranged from 0.065 cSv at Fernald to 0.966 cSv at Savannah River.

When mortality for the combined cohort was compared with U.S. death rates, fewer deaths than expected were observed for most causes of death. Exceptions were deaths from mental disorders, certain genitourinary system diseases, as well as symptoms and ill-defined conditions. Mortality from conditions that have in the past been found to be associated with exposures to ionizing radiation was not higher than expected or was close to expectation.

A strong healthy worker effect was observed for the entire cohort and for each individual subcohort with the exception of Linde, in which case the observed number of deaths was similar to the number expected. The weaker healthy worker effect observed among Linde workers was largely due to more deaths than expected from ischemic heart disease. The healthy worker effect was also observed among workers who were monitored for external radiation exposures and among workers who were not monitored for external radiation exposures.

Failure time analyses employing proportional hazards modeling were conducted to assess whether survival differs among workers at different facilities and to assess whether cumulative exposures to external penetrating radiation exposures are associated with mortality. The healthy worker effect is also observed in these analyses.

When time-dependent proportional hazards analyses of cumulative penetrating doses for all monitored employees, regardless of length of employment, were performed for all facilities combined, the relative risk of death per rem increased with increasing cumulative penetrating dose for all leukemias combined (Eighth Revision of the International Classification of Diseases [ICD8]: 204.0-207.9) other than chronic lymphatic leukemia (ICD8: 204.1). This increase was almost totally due to leukemia among X-10 workers. Relative risk estimates per rem were suggestively elevated for all cancers combined, breast cancer, and for all hematologic cancers combined (ICD8: 200.0-209).

- The MFFEGWA1_d2 file is used for the radiation dose response analyses. File MFFEGWA1_d2 comprises 65,984 records, each representing one female. The

records in the MFFEGWA1_d2 file pertain to a subset of the entire cohort. It contains only those individuals who were monitored for radiation exposure. Two facilities for which no updated radiation data were available are not included in this file. Individuals from the other facilities for whom there was no evidence they had been monitored for external radiation are also excluded from this file. The year 1994 is the end of the study date or end of follow-up.

- File MFFEGWA1_d1 is a roster file used for SMR analyses. Each record represents one female, some of which were not used in the analysis file MFFEGWA1_d2.

Citations

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Wilkinson, Gregg, Priore, Roger, Graham, Robin, Trieff, Norman, Fries, Michael, Jones, Jennifer, Young, Brenda, Ray, Laura, Loughlin, Jeanne. ISEE2000. Mortality Among Female Nuclear Weapons Workers (Abstract Outline). August 21, 2000.

MULTIPLE SITES (IARC)

- MFI93A01 Data File Set

Description

This analytical data file set consists of 14 files pertaining to the three U.S. nuclear sites (Hanford, Oak Ridge, and Rocky Flats) included in an international combined cohort study of cancer mortality among nuclear industry workers in the U.S., United Kingdom, and Canada by Elisabeth Cardis, et al.

The objective of this IARC study was to conduct pooled analyses of nuclear industry workers by combining data from existing studies in the United States, United Kingdom, and Canada in a way that would minimize differences between these populations and their dosimetry. The motivation for conducting pooled analyses is threefold. First, estimates of carcinogenic risk per unit would be more precise with a larger worker population. Second, by applying comparable methodology and data protocol, a better understanding of differences and similarities among the existing studies could be achieved. Third, an international cooperative effort would encourage future participation of additional sites with suitable data.

The MFI93A01 data file set is comprised of 14 analytic files constructed using the IARC protocol. MFI93A01_d1 through MFI93A01_d4 contain Hanford Site data prepared by Pacific Northwest Laboratory. MFI93A01_d5 through MFI93A01_d9 contain ORNL data prepared by Oak Ridge Associated Universities. MFI93A01_d10 through MFI93A01_d14 contain RFP data prepared by Los Alamos National Laboratory.

- The first file, MFI93A01_d1, contains demographic, work history, vital status, and internal deposition data. There is one record for each of 44,106 workers.
- The second file, MFI93A01_d2, contains external exposure data. There are 342,645 records, one for each year of external exposure data for each of 36,927 monitored workers.
- The third file, MFI93A01_d3, contains additional internal exposure data. There are 324 records, one for each year of internal exposure data for each of 125 workers.
- The fourth file, MFI93A01_d4, contains additional data related to internal exposures, off-site exposures, and cause of death. There is one record for each of 44,106 workers.
- The fifth file, MFI93A01_d5, contains demographic, work history, and vital status data. There is one record for each of 8,314 workers.
- The sixth file, MFI93A01_d6, contains additional vital status data. There are 1,525 records for 1,524 workers.
- The seventh file, MFI93A01_d7, contains external exposure data. There are 179,580 records, one for each year of external exposure data for each of 8,314 workers.
- The eighth file, MFI93A01_d8, contains internal exposure data. There is one record for each of 2,325 workers.

- The ninth file, MFI93A01_d9, contains additional exposure data. There are 11,848 records, one for each year of internal exposure data for each of 3,276 workers.
- The tenth file, MFI93A01_d10, contains demographic, work history, and vital status data. There is one record for each of 7,575 workers.
- The eleventh file, MFI93A01_d11, contains additional vital status data. There are 674 records for 671 workers.
- The twelfth file, MFI93A01_d12, contains external exposure data. There are 65,912 records, one for each year of external exposure data for each of 7,496 workers.
- The thirteenth file, MFI93A01_d13, contains internal exposure data. There is one record for each of 5,317 workers.
- The fourteenth file, MFI93A01_d14, contains off-site exposures. There is one record for each of five workers.

Workers at the Hanford Site were involved in a variety of activities that resulted in their exposure to radiation, including reactor operations, chemical separation of reactor fuel to obtain plutonium, treatment and storage of hazardous waste, and biological and engineering research.

Personal dosimeters (film or thermoluminescent) have been used at Hanford since 1944. Annual whole-body doses to penetrating external radiation are presented in units of millisieverts. Quality factors of 10 for fast neutrons, 3 for slow neutrons, and 1 for photons and electrons were used in the conversion of exposure to dose.

Bioassay programs to detect exposures to internally deposited radionuclides, primarily transuranics, at Hanford also were initiated in 1944. Internal exposure data were collected and evaluated for all individuals who worked in locations where there was a potential for intake of radioactive material.

ORNL began monitoring personnel for exposure to external penetrating radiation, primarily gamma rays, in 1943. Pocket chambers were used until June 1944, when film dosimeters (film badges) became the primary dosimeters. In 1975, film dosimeters were replaced with thermoluminescent dosimeters. From 1943 until the early 1950s, the usual practice was to provide personal dosimeters to only those workers entering designated areas where there was a potential for exposure. Subsequently, all workers at ORNL were monitored.

Based primarily on the potential for contamination from their work area, some workers were monitored for internal exposure to radionuclides beginning in 1951. Additional workers were monitored to evaluate exposures incurred during incidents. Internal exposures were determined by examining results of urine and fecal bioassays and whole-body counting. Quantitative dose estimates from internally deposited radionuclides are not available because such estimates were not required. Also, all of the basic data needed to compute doses for the many radionuclides used at ORNL are not computerized. However, knowledgeable plant health physicists and dosimetrists state that the majority of internal monitoring results for this cohort suggest small internal doses, especially when compared with external doses.

RFP has been a weapons facility since 1952. Sources of occupational exposure include external radiation, both gamma and neutron, and potential for internal deposition of plutonium-239. Film dosimeters and thermoluminescent dosimeters were used to monitor for external radiation. Formal bioassay programs to monitor for internal radiation were begun in 1952. Results of both types of monitoring programs reflect technological improvements and changes in concepts and models during these years.

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MULTIPLE SITES (MFMCHMA1)

▪ MFMCHMA1 Data Set File

Description

This analytic data file set consists of seven files generated for the Chemical Laboratory Workers (CLWs) cohort mortality study by Travis Kubale, National Institute for Occupational Safety and Health, and published in American Journal of Industrial Medicine in 2008. The study cohort consists of chemical laboratory workers at Oak Ridge facilities (K-25, X-10, and Y-12) and the Savannah River Plant in South Carolina.

The study evaluates the mortality experience of 6,157 male and female workers employed from 1943 to 1998 at the DOE Oak Ridge, Tennessee, facilities (K-25, X-10, and Y-12) and the Savannah River Plant in South Carolina. Chemicals generally encountered by these laboratory workers are the primary exposures of interest.

The study cohort consists of 6,157 CLWs employed for at least 1 day at SRS or the Oak Ridge sites (X-10, Y-12, and K-25 facilities) from January 1, 1943, through December 31, 1998.

Follow-up for each worker began with either the start of facility operations (i.e., 1943 for Oak Ridge workers or 1952 for SRS workers) or the first date employed at a study facility, whichever was later, and ended on date of death or December 31, 1998, whichever was earlier. The primary data sources used to ascertain deaths were the National Death Index-Plus (NDI-Plus) and the Social Security Administration Death Master File (SSA-DMF). In addition, the SSA "presumed living" file was used to confirm that workers not found to be deceased by NDI-Plus were alive as of December 31, 1998.

Underlying and contributing causes of death were obtained directly from NDI-Plus for workers deceased in 1979 or later. For those who died before 1979, death certificates were obtained from the states in which death occurred.

CLWs were also potentially exposed to ionizing radiation while performing duties both in the laboratory and outside the laboratory in process areas. Radiation exposure information for each worker was abstracted from available site exposure records and NIOSH databases maintained from previous studies. External occupational radiation exposure was evaluated as equivalent dose in mSv to the whole body.

Standardized Mortality Ratio Analysis

The NIOSH Personal Computer Life Table Analysis System (PC-LTAS, version 1.0d) was used to generate expected numbers for all deaths, all cancer deaths, and cause-specific deaths, by race and sex, within 5-year age and 5-year calendar time periods

[NIOSH, 2001]. Person-years and observed deaths were accumulated for each of these age and calendar time periods from the worker's follow-up begin date through the end of follow-up.

Expected numbers of deaths were based on U.S. population death rates specific for the race, gender, and 5-year age and calendar time periods. United States expected rates were based on deaths from 1940 forward except for non-Hodgkin's lymphoma and multiple myeloma, causes for which rates were available only from 1960 forward. For these outcomes, enumeration of observed deaths and person-years at risk began in 1960 or the first date employed at a study facility, whichever came last. Because differences between mortality among members of the study population and that of the United States population could be, in part, the result of regional (non-occupational) differences, mortality for selected cancers was compared with Tennessee state rates, which were also available from 1960 forward. Numbers of deaths observed for each cause were divided by the expected number of deaths to obtain cause-specific SMRs. The precision of each estimated SMR was assessed assuming a Poisson distribution, with two-sided 95% confidence intervals.

Internal Analysis

Because SMRs are affected by the age structure of the study population, comparison of SMRs for different populations can be misleading. SRRs allow for comparison among populations by weighting observed stratum-specific rates according to a common (internal) standard (Rothman and Greenland, 1998). SRR analyses were performed for the entire cohort to assess the associations between mortality outcomes and employment duration. Duration of employment categories of 0 to <5 years employed, 5 to <10 years employed, 10 to <20 years employed, and 20+ years employed were used in the analyses. For dose-response analysis, a linear trend was calculated in a person-year-weighted regression of directly standardized rates (Rothman and Greenland, 1998). Statistical significance of each trend was determined using a two-tailed z-test with an alpha of 0.05.

Modeling Analysis

Cox regression analyses were conducted to further evaluate the relation between occupational exposure and the risk of mortality due to selected cancers. Risk sets were defined from the entire cohort of CLWs for each case of interest. Each risk set also included all controls who were under observation and who lived to an age equal to or greater than the age of the case at death. Time was defined as the length of life (attained age) of the case. The cases and controls were matched on attained age because it is a strong predictor of cancer mortality and therefore an important potential

confounder of the association of interest in the analyses. All occupational exposures of the controls were truncated at the age attained by the case minus any lag.

Conditional logistic regression was calculated using the SAS procedure PHREG. This procedure performs a regression analysis of survival data, the results of which are identical to those provided by the Cox proportional hazards model (SAS Inc., 1999). The probability of death from lymphatic and hematopoietic cancers was modeled as a function of the following candidate variables: duration of employment (surrogate for chemical exposures-the primary exposure of interest), external ionizing radiation exposure, gender, and employment in a process area. A change of plus or minus 10% in the parameter estimate of the primary exposure variable was used as an indicator of confounding in determining the final model. Lag periods of 2 years for leukemia, 10 years for multiple myeloma, and 5, 10, and 20 years for lung cancer were evaluated. Because latency and risk factors may be different for CLL, the leukemia analysis was performed both with and without CLL deaths.

The data file set consists of the following files:

Work History and Demographic files used in the Life Table Analysis System (LTAS) analysis.

Both a work history and demographic file were used in all LTAS analyses, i.e., SMR and SRR analyses.

- The work history file is MFMCHMA1_d1 and
- the demographic file is MFMCHMA1_d2.
- The file, MFMCHMA1_d3, was the source file for the LTAS analysis.

There are four files that were used for the regression analyses.

- For Leukemia, MFMCHMA1_d4 was used for analysis with a duration of employment lagged 2 years.
- Multiple myeloma was analyzed using MFMCHMA1_d5 with a duration of employment lagged 10 years.
- Multiple Myeloma re-analysis (MFMCHMA1_d6) was performed with a duration of employment lagged 10 years with individuals employed for at least 1 year.
- Lung Cancer analysis (MFMCHMA1_d7) was done with a duration of employment lagged 10 years.

Citations

Kubale, Travis L., Hiratzka, Shannon, Henn, Scott, Markey, Andrea, Daniels, Robert, Utterback, David, Waters, Kathy, Silver, Shannon, Robinson, Cynthia, Macievic, Gregory, Lodwick, Jeffrey -- Division of Surveillance, Hazard Evaluations, and Field Studies (DSHEFS), National Institute for Occupational Safety and Health (NIOSH). A cohort mortality study of chemical laboratory workers at Department of Energy Nuclear Plants. July 7, 2008. American Journal of Industrial Medicine. 51(9):656-667.

MULTIPLE MYELOMA

▪ MFMM98A1 Data File Set

Description

This analytic data file set consists of eight files generated for an epidemiologic case-control study of multiple myeloma among a cohort of 115,143 workers employed at the Hanford, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Savannah River sites and hired before 1979, by Steve Wing.

This study was requested by NIOSH because of previous reports of associations of multiple myeloma with radiation exposures of workers at the Hanford site. The new study was intended to include more cases of disease, better evaluation of radiation doses, and measurement of other occupational exposures not available in the Hanford studies. The 98 multiple myeloma deaths and 391 age-matched controls were followed for vital status through 1990. Hanford workers were followed through only 1986. Information on prior work history, smoking, medical x-rays, and exposure to physical and chemical agents was derived from personnel, medical, industrial hygiene, and health physics records.

The study compared exposure histories of cases and controls to investigate whether certain occupational exposures were relatively more common among cases. Potential exposures to a variety of chemical and physical agents that might be causes of multiple myeloma were investigated, including solvents, metals, welding fumes, asbestos, and ionizing and non-ionizing radiation. With the exception of external penetrating radiation, for which most longer term workers had at least some badge data, information of exposures to specific chemical and physical agents was not sufficient to assign a quantitative exposure estimate or even to determine with a high degree of certainty whether or not a worker had been exposed.

Total cumulative radiation doses were similar between cases and controls. However, doses received at ages 45 years and older were associated with an average 7% per 10 mSv (1 rem) increased risk of multiple myeloma, adjusted for age, race, sex, facility, period of hire, birth cohort, monitoring for internal radionuclide contamination, and external radiation received prior to age 45 years. The 95% confidence limit for this estimate was 1-13%. For exposure at ages 45 years and older, the odds ratio for workers with cumulative doses of 50 mSv (5 rem) or greater compared with workers with cumulative doses of less than 10 mSv was 4.34 (95% CI 1.46-12.90).

- MFMM98A1_d1 includes annual external radiation (mrem) dosimetry data from all study facilities standardized in a common format by year.
- MFMM98A1_d2 is the basic case and control file that contains demographic data, employment dates, personnel, and occupational health variables used in the analysis.
- MFMM98A1_d3 contains one record for each individual worker and constitutes a qualitative assessment of exposures to select chemical and physical hazards for the study population.
- MFMM98A1_d4 includes employment dates at each of the study sites.
- MFMM98A1_d5 gives counts of internal monitoring records lagged 5, 10, 15, 20, and 25 years from the index date of the age at risk. Counts of Pu, SR, tritium, in vivo measurements, and nose counts are included.
- MFMM98A1_d6 documents medical x-rays in occupational health department records at the four DOE sites.
- MFMM98A1_d7 contains one record for each individual worker of coded data abstracted from occupational health records at the four DOE sites.
- MFMM98A1_d8 contains coded data abstracted from personnel records.

Citations

Wing, S., Richardson, D., Wolf, S., Mihlan, G., Crawford-Brown, D., Wood, J. A case control study of multiple myeloma at four nuclear facilities. 2000. Annals of epidemiology. 10:144-153

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APPENDIX C

Other CEDR Holdings

ILLNESS AND INJURY SURVEILLANCE PROGRAM

▪ IISP18W1 Data File Set

Description

The health of the contractor work force is a corporate responsibility of DOE. DOE strives to ensure that work is safely conducted at every site. Collecting and analyzing information on illness and injury is a good way to evaluate how safely work is being performed across the complex. From the early 1990s to 2011, the former Illness and Injury Surveillance Program (IISP) monitored and assessed the overall health of the active workforce, with the goal of identifying groups that were at increased risk of occupational illness and injury. The Injury data set contains both occupational and non-occupational injuries. Non-occupational injuries reported to the IISP were those involving an absence of 5 or more consecutive workdays or, at the discretion of the individual's supervisor, required a return-to-work (RTW) clearance from the site's occupational medicine examiner.

There are three working data sets in the IISP18W1 data set covering years from 1994 through 2011. The first file, IISP18W1_d1 (Roster), is comprised of 215,588 people making up 1,397,642 records. IISP18W1_d1 contains year of birth, year of hire, gender, and occupational code. The second file, IISP18W1_d2 (OSHA), is comprised of 15,226 people making up 42,371 records. Variables include year of event, days of lost work, days restricted, and ICD9 code for injury or illness. The third file, IISP18W1_d3 (RTW), is comprised of 9,914 people making up 42,109 records. Variables included year event began, year of event end, calendar days out of work, and ICD9 E code for injury or illness.

Citations
No data available.

PITTSBURG ENERGY TECHNOLOGY CENTER (PETC)

▪ PETC04A1 Data File Set

Description

This data file set consists of one analysis file for a cohort mortality update of workers at the Pittsburgh Energy Technology Center (PETC) by Janice P. Watkins et al., Center for Epidemiologic Research in Oak Ridge, Tennessee. The analysis was not published in a peer-reviewed journal but is posted at http://www.eh.doe.gov/health/epi/surv/index.html.

The single analysis file, PETC04A1_d1, contains 986 records, one for each person in the cohort. Updated vital statuses were ascertained on the cohort from Pension Benefit Information Incorporated and NDI. Death certificates were obtained from the respective state registries and were coded to ICD9 standards.

Person-years of follow-up were calculated beginning 122 calendar days after the date of first hire (January 1, 1944, or later) until the date of death, date last known alive, or December 31, 1992, whichever was earliest. NDI identifies deaths beginning January 1, 1979. Workers with unknown vital status and known to be alive prior to that date were considered lost to follow-up on the last date known alive. Workers known to be alive on or after January 1, 1979, were considered alive on December 31, 1992, if there was no indication of death by NDI.

Updated results through December 31, 2000, determined a total of 123 deaths with 110 for men and 13 for women. Cause of death for the 9 men (8.2%) previously known to be deceased but without death certificates were still not retrievable, but cause was established for all newly determined deaths. The cohort accumulated 20,921 person-years of follow up with 16,612 (79%) contributed by men and 4,309 by women. The average length of follow-up was 22.9 years for men and 16.6 years for women. No SMRs were statistically elevated at the 5% level of significance. The only statistically significant SMRs were decreases for all causes of death, all circulatory diseases and its subcategory arteriosclerotic heart diseases, non-malignant respiratory diseases, and accidents. All of the other SMRs were not statistically different from 100, having a lower 95% confidence interval bound below 100 and an upper bound of 100 or higher. Although the SMR for all cancers combined was 90.2, SMRs for many site-specific cancers were greater than 100, including buccal cavity and pharynx, digestive organs and peritoneum, stomach, rectum, pancreas, kidney, Hodgkin's disease, and leukemia and aleukemia. However, there were few observed deaths for any cancer sites except the lung and combined digestive organs and peritoneum.

Historically, this facility was involved in a wide variety of research and development activities for promoting the use of coal, including coal preparation and combustion, coal gasification, coal liquefaction, flue gas clean-up, and oil shale activities. It was founded in 1944 as the Bruceton Research Center by the United States Bureau of Mines (BOM), Office of Synthetic Liquid Fuels. Certain research and development activities were transferred to the Energy Research and Development Administration on January 19, 1975, and the site was designated as PETC by DOE on October 1, 1977. Exposures to organic and inorganic chemicals resulted from the major activities and associated research and development support activities at PETC. In March 1992, workers at PETC expressed concern that workplace exposures may be having an adverse effect on their health. Specifically, they were concerned about the possibility of an increase in heart attacks among former workers, the potential cumulative health effects of chemical exposures, and a possible relationship between exposure to perchloroethylene and psychological effects such as nervous tension, irritability, and anger.

In response to worker concerns at PETC, a descriptive epidemiologic investigation was initiated to examine mortality through 1992 among PETC workers employed at least 4 months between 1944 and 1992. Details of this investigation can be found in the study report (Dupree et al., 1996). Because of the materials used at PETC, cancers and diseases of the nervous system, the respiratory system, and kidneys were of particular interest, along with examining heart disease as the workers requested. With follow-up through 1992, results for male workers showed that mortality from heart diseases (17 deaths) was approximately 57% of what was expected based on U.S. comparison rates and 49% of expected deaths using Allegheny County rates. Mortality from all cancers combined (24 deaths) was 91% and 84% of expected based on U.S. and Allegheny County rates, respectively. The relatively small number of deaths made it difficult to investigate specific causes of death with any precision. Results for female workers were also unremarkable. The lower mortality through 1992 may have been influenced by the healthy worker effect, which lessens with time since hire. To further examine potential health effects over time, an updated investigation was initiated to determine whether significant mortality increases occurred with additional follow-up. This current report (Watkins, Phillips, Ellis 2004) summarizes the results of the updated mortality among PETC workers through 2000.

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PORTSMPUTH GASEOUS DIFFUSION PLANT (PIKETON, OHIO)

▪ PGDPSA01 Data File Set

Description

This analytic data file set consists of 18 files, PGDPSA01_d1 through PGDPSA01_d18, generated for a case-control study of mortality patterns among 8,877 uranium enrichment workers (both sexes and all races) employed for at least 1 day at PORTS between September 1, 1954, and December 31, 1991, conducted by the U.S. Department of Health and Human Services (DHHS), NIOSH, Centers for Disease Control and Prevention (CDC) in 2001.

Data from these files were used in the life table analysis, as well as in the case control selections for lung cancer, stomach cancer, hematopoietic cancers, and leukemia.

How This Study Was Done: This epidemiologic study examined the causes of death among all PORTS workers employed by the facility between September 1, 1954, and December 31, 1991. Deaths among the workers were compared with rates for the general U.S. population. Possible relationships were evaluated for deaths from several types of cancer and exposures to ionizing radiation and certain chemicals (fluoride, uranium metal, and nickel). Based upon previous health studies of nuclear facility workers, including an earlier NIOSH investigation at PORTS, deaths from cancers of the stomach, lung, and the lymphatic and hematopoietic systems including leukemia, were evaluated in more detail.

Study Findings: Approximately 88% of the cohort was still alive through the end of 1991. Overall cohort mortality was significantly less than expected, when compared with the United States population, as was mortality from all cancers. A total of 1,088 deaths from all causes occurred in this cohort through 1991. A total of 1,518 deaths could be expected based upon rates in the general U.S. population. The lower mortality among these workers is consistent with the healthy worker effect, which is found in most occupational epidemiologic studies. No statistically significant excesses in mortality from any specific cause were identified. Analyses of possible relationships between

causes of death and the identified exposures failed to reveal any dose-response trends. For leukemia, no effect of cumulative exposure to either external or internal radiation was identified. Additionally, no dose-response relationships were observed for cancers of the stomach, lung, Hodgkin's disease, lymph reticulosarcoma, and all cancers combined. Worker deaths from cancers of the lymphohematopoietic tissue, including leukemia, equaled U.S. rates. Stomach cancer deaths were greater than expected (12.7 deaths expected, 15 deaths found), but this difference was not statistically significant. Deaths from these cancers had been found to be slightly elevated in a previous NIOSH study of PORTS.

Study Limitations: The young average age of this cohort with 88% still living in 1991 made it difficult to fully assess patterns of death associated with work exposures. Estimated radiation and chemical exposures developed for this study are subject to error since monitoring results for chemicals and various forms of radiation were incomplete. Potentially important factors that may have an effect on the observed outcome, such as lifestyle factors (e.g., smoking), radiation due to medical procedures, and other workplace exposures could not be evaluated.

Study Advantages: A comprehensive exposure assessment was conducted, making use of nearly all health physics and industrial hygiene data from 1954 through 1991. The patterns of exposures used in this study were evaluated by experienced workers at the site. Analysis with these estimates increased the ability to detect associations between exposures and death.

This study design was a good tool for evaluating the causes of death in workers with chronic low-level radiation exposures.

The first four files and the 18th file (PGDPSA01_d1, PGDPSA01_d2, PGDPSA01_d3, PGDPSA01_d4, and PGDPSA01_d18) contain cause of death, demographic, exposure, and work history data. Contributing causes of death were coded, as well as the nature of injury. Both were coded with various ICD versions. An indicator variable for the ICD version was included. Demographic fields included sex, race, date of birth, and date of death. Gamma radiation exposures in PGDPSA01_d3 are reported in Radiation Absorbed Dose (RAD). The work history in PGDPSA01_d4 includes employment dates and a job category field. The job category field was created by NIOSH as a way to group people with similar exposures based on departments. The department and area codes for the work history are found in PGDPSA01_d18.

The other 13 files contain exposure data for case-control analyses on leukemia, lung cancer, hematopoietic cancer, and stomach cancer for electromagnetic frequency (EMF) exposure (milligauss), for chemical exposures of fluoride (exposure score), nickel (µg/m3), and uranium (exposure score), and for internal (DPM) and external radiation (millirad) at different lag times.

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PADUCAH GASEOUS DIFFUSION PLANT

▪ PGDPSA02 Data File Set

Description

The Paducah Gaseous Diffusion Plant was located in western Kentucky. In response to concern about past and present radiation and chemical exposures, NIOSH funded a collaborative study by the Universities of Louisville, Kentucky, and Cincinnati to conduct an occupational cohort mortality study titled "Health effects of occupational exposures in PGDP workers." The purpose of the study was to determine if PGDP workers had mortality patterns that differed from the general U.S. population and to investigate if mortality patterns were associated with job title or workplace exposures.

A retrospective occupational cohort mortality study was conducted on 6,759 workers. Standardized mortality ratio analyses compared the cohort to the referent U.S. population. Internal comparisons producing standardized rate ratios were conducted by job title, metal exposure, and cumulative internal and external radiation exposures.

Demographic (PGDPSA02_d1), work history (PGDPSA02_d4), and vital status (PGDPSA02_d6) data were collected on 6,820 workers. Inclusion criteria required workers to have been employed at the PGDP for at least 30 days from the start of plant operations in September 1952 through the end of study, December 2003. Analyses were conducted using LTAS, which requires three files for each analysis: a person file, an outcome file, and a history file. Separate file sets were prepared for investigation of the cohort by job title, radiation exposure, metals exposure, and TCE exposure; although all analyses used the same outcome file and some used the same person or history file.

The data file set used for the job title analysis was also used to characterize the cohort as a whole. LTAS is available from NIOSH at http://cdc.gov/niosh/ltas/. The data file set contains 6 files.

Each person file contains 6,820 records and gives gender, race, vital status, birth date, employment start date, and death or end of study date for each employee. In addition, the person file for the metals analysis also includes the category for the highest exposure to five metals during employment (low, medium, or high exposure); the radiation person file also contains variables that indicate the quartile of exposure for external and internal radiation exposure.

The history files (PGDPSA02_d3 and PGDPSA02_d5) have 119,474 records and contain multiple records for each employee. Each record represents a time period in the worker's employment history. Many workers changed job positions during their employment tenure, and therefore their exposures changed. The history files document these changes and exposures, allowing calculation of person years at risk for an exposure. All of the history files contain an ID variable, a begin date for a time period, and the date last observed, which gives the date of death or end of study. The history file used for the general, grouped job title, and radiation analyses contains information on grouped job title held through the use of ever/never variables. For each grouped job title, a variable is created that indicates if an employee ever or never held that position. The history file for the metals analysis contains variables indicating the relative rank of exposure (range 0 to 5) for the metals arsenic, beryllium, chromium, nickel, and uranium. These ranks were determined by limited measurements and interviews with long-time employees and management. The metals history file also contains ever/never variables for each metal for high exposure, which indicates whether an employee has been exposed to a metal with a 4 or 5 rank.

The outcome file (PGDPSA02_d2) is the same for all analyses. It contains 1,639 records, one for each deceased employee. It gives the date and cause of death. A total of 1,674 deaths were identified out of 6,820 workers in the cohort. Because of incomplete history and outcome data, 61 workers were eliminated, resulting in analyses on 6,759 workers and 1,638 deaths.

Known exposures at the facility included metals (arsenic, beryllium, chromium, nickel, and uranium) and both internal and external radiation exposure. For metals, certain positions in the plant were known to have higher exposures compared with other positions. Because measurements for exposures were inconsistent throughout the plant's history, a job exposure matrix was developed that ranked exposures based on the position within the plant and the time period worked. These ranks are relative

exposure amounts and are based on few measurements. The ranks allowed the comparison of workers who were employed in positions with higher exposures to be compared with workers who held positions thought to have less exposure. The job exposure matrix gave ranks on a scale of 0 (no exposure) to 5 (highest exposure). In the analysis of exposures, these ranks were condensed into low (0-1), medium (2-3), and high (4-5) exposure groups.

For internal and external radiation exposure, the ranges of measurements for external radiation exposure and internal radiation exposure were broken into quartiles. Standardized rate ratios were generated, comparing higher quartiles with the lowest exposure quartile.

Citations

Chan, C, Hughes, T S, Muldoon, S, Aldrich, T, Rice, C, Hornung, R, Brion, G, Tollerud, D J. Mortality Patterns Among Paducah Gaseous Diffusion Plant Workers. Journal of Occupational and Environmental Medicine. 201. 52(7):725-732

▪ PGDPSW02 Data File Set

Description

The Paducah Gaseous Diffusion Plant was located in western Kentucky. In response to concern about past and present radiation and chemical exposures, NIOSH funded a collaborative study by the Universities of Louisville, Kentucky, and Cincinnati to conduct an occupational cohort mortality study titled "Health effects of occupational exposures in PGDP workers." The purpose of the study was to determine if PGDP workers had mortality patterns that differed from the general U.S. population and to investigate if mortality patterns were associated with job title or workplace exposures.

Demographic, work history, and vital status data were collected on 6,820 workers. Inclusion criteria required workers to have been employed at PGDP for at least 30 days from the start of plant operations in September 1952 through the end of study, December 2003. Work history, demographic, and exposure data were gathered from employee records at the Paducah Gaseous Diffusion Plant. For vital status, personal identifying information was submitted to the U.S. Social Security Administration or the National Death Index. For known deaths, death certificates were requested from the departments of health in the state the worker was believed to have resided.

This working data file set consists of one file, PGDPSW02_d1, generated for a worker mortality study of the Paducah Gaseous Diffusion Plant.

Information found in the working file includes demographic information, employment history including positions held and start and end dates for those positions, vital status, cause of death and underlying causes of death for deceased employees, relative

exposure rankings for five metals (arsenic, beryllium, chromium, nickel, and uranium) and TCE, and actual or imputed yearly external and internal radiation exposure. The working file has 119,474 records and contains multiple records for each employee. Each record represents a time period in the worker's employment history. Many workers changed job positions during their employment tenure, and therefore their exposures changed. In addition, exposures for the same job position changed over time. Each record represents a maximum of 1 year of employment history.

A total of 1,674 deaths were identified out of the 6,820 workers in the cohort. Sixty-one workers have incomplete history or outcome data, leaving complete data for 6,759 workers and 1,638 deaths.

Known exposures at the facility included metals (arsenic, beryllium, chromium, nickel, and uranium) and both internal and external radiation exposure. For metals, certain positions in the plant were known to have higher exposures compared with other positions. Because measurements for exposures were inconsistent throughout the plant's history, a job exposure matrix was developed that ranked exposures based on the position within the plant and the time period worked. These ranks are relative exposure amounts and are based on few measurements. The job exposure matrix gave ranks on a scale of 0 (no exposure) to 5 (highest exposure). In the analysis of exposures, these ranks were condensed into low (0-1), medium (2-3), and high (4-5) exposure groups.

Measurements for radiation exposure were incomplete. For external radiation exposure, badge readings were used and average yearly exposures were determined for each grouped job title, and the average (based on number of days worked) was assigned to individuals with that job title that did not have measurements. For grouped job titles with no measurements in a year, the assigned value was the limit of detection (LOD)/sqrt(2)/365.25*number of days in time period. The LOD was 30 mrem prior to 1980 and 10 mrem from 1980 to the end of study. Four grouped job titles were considered to have no exposure and were assigned a value of 0.

The process for internal radiation exposure was similar. Measurements were in both disintegrations per minute and µg/L for specific radionuclides. More measurements were available in µg/L, so measurements in dpm were converted to µg/L, and a surrogate measure of internal radiation exposure in µg/L-years was employed. For employees with no measurements, values were imputed in the same manner as with the external radiation exposure. The LOD for internal radionuclide exposure was 5 µg/L.

Citations
No data available.

RADIUM DIAL PAINTERS

▪ RADPDW01 Data File Set

Description

This working data file set, prepared by The Center for Human Radiobiology (CHR) at the Argonne National Laboratory (ANL), consists of 25 files generated from the Internal Emitters Project, which identified about 6,000 people with significant radium exposures, including about 3,257 individuals, mostly women, who worked in the dial painting industry that used radium in paint. Many were located and followed until death; in these cases, the cause of death and body content of radium were known. One study was published in Health Physics in 1993.

The Center for Human Radiobiology Information System (CHRIS) is comprised of a set of files originally designed as working files, containing information that was continually being updated as new information was developed and new radiation exposure cases were added to the files. The program was terminated in 1990, so the files became static at that time. They, thus, show the state of the study at that date.

The CHR was originally set up in 1967 at the Argonne National Laboratory to continue the studies of radium-exposed individuals started by Professor. R. D. Evans in the mid-1930s at the Massachusetts Institute of Technology (MIT). CHR was also to include the studies of radium-exposed individuals previously undertaken (1957 to 1967) by the New Jersey State Department of Health as the Radium Research Project and the radium studies undertaken in 1951 by The Argonne National Laboratory and the Argonne Cancer Research Hospital. The working files from these organizations were transferred to the CHR and eventually integrated into a file system known as the CHR Information System.

The level of detail for each individual in the study is not uniform, but there are some data on general demographics, smoking and social history, radium exposure history, measurements of radium body content, clinical examinations results, clinical laboratory results, observed medical abnormalities, calculated doses, radiographic surveys, and causes of death.

All of the files in the CHRIS system were originally set up for the collection of information about radium-exposed individuals. However, individuals exposed to other radioelements were often examined by CHR, and the data obtained were entered in CHRIS. Case numbers of the form aa-bbb (for example 00-001) were assigned to most of the individuals studied. The two digit prefix identifies people with some common characteristics. Originally these two digits indicated the laboratory where the case was

studied, i.e., 00 was MIT, 03 was ANL, and 05 was New Jersey. Many of these original numbers remain, but the system was changed to indicate other characteristics. The present system reserves the prefixes 00 to 15 for individuals exposed to radium, 20 for uranium miners, 30 miscellaneous, 35 for Th-232 other than Thorotrast, 40 for Pu-239, 50 for general controls, 51 to 59 for miscellaneous samples not identified with an individual case, 60 for Thorotrast cases, and 98 and 99 for temporary case numbers.

The 25 files comprising this data file set include data containing demographic, administrative, and exposure data (RADPDW01_d1 and RADPDW01_d6) , three files consisting of data concerning Lindsay Chemical Co. (RADPDW01_d2, RADPDW01_d3 , and RADPDW01_d25), radium deposition and retention data (RADPDW01_d7 and RADPDW01_d8), two dose calculation files (RADPDW01_d9 and RADPDW01_d10), a death certificate follow-up (RADPDW01_d4), government agency follow-up (RADPDW01_d5), radium deposition and retention data (RADPDW01_d9 and RADPDW01_d10), skeletal radiograph data (RADPDW01_d11), bone scan measurements (RADPDW01_d12), measurements of radium in vivo (RADPDW01_d13 and RADPDW01_d14), blood chemistry (RADPDW01_d15), urinalysis and hematology (RADPDW01_d16), special tests (RADPDW01_d17), physical measurements and medical/dental histories (RADPDW01_d18), data descriptive of the ranges of several variables (RADPDW01_d19), medical abnormalities (RADPDW01_d20), chemical and radiochemistry (RADPDW01_d21 and RADPDW01_d22), and gamma measurement data for bones and skeleton (RADPDW01_d23 and RADPDW01_d24).

Case numbers of the form L-nnnn (for example L-0001) were assigned to employees of the Lindsay Chemical Company. In addition, case numbers of the form LX-nnnn were used for visitors to the plant and LC-nnnn were used for controls. The data from this study of the effects of inhalation of dust containing Th-232 and daughter products, as well as rare earth elements, are contained in four files. These are RADPDW01_d2, RADPDW01_d3, RADPDW01_d25, and RADPDW01_d14. Additional information may be found in the files RADPDW01_d4, RADPDW01_d5, RADPDW01_d6, and RADPDW01_d20.

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SALMON SITE DESCRIPTIVE STUDY

▪ TDBSRA01 Data File Set

Description

This data file set consists of one file generated for a descriptive epidemiologic study of cancer versus non-cancer deaths of residents of Lamar County, Mississippi, the location of a large salt dome by Donna Cragle. The salt dome, now called the Salmon Site, was previously known as the Tatum Dome Test Site.

This study was conducted to determine if there was an association between usual residence near the Salmon Site and death due to cancer. The analysis file contains demographic information on 2,185 residents who died between 1980 and 1991. As shown on the summary death table, there were 562 cancer deaths and 1,623 deaths due to other causes.

The analysis file, TDBSRA01_d1 (ANAL0997), includes demographic variables, cause of death (ICD9), and distance of usual residence from the Salmon Site.

Citations

Richter, B. Tatum Salt Dome Test Site Descriptive Study

Richter, Bonnie S., Stockwell, Heather G. Descriptive Study of Deaths from Cancer Associated with Residential Proximity to the Site of Underground Nuclear Detonations. March/April 1998. Archives of Environmental Health. Vol. 53 (2), 109-113. Descriptive Study of Deaths from Cancer Associated with Residential Proximity to the Site of Underground Nuclear Detonations. Office of Epidemiologic Studies, U.S. Department of Energy

Glossary

Analytic Data File Set
A collection of static data files containing the data upon which a researcher directly bases a study's reported findings.

Analytic File
A single data file containing data upon which a researcher directly bases a study's reported findings.

ANL
Argonne National Laboratory in Lemont, IL.

Authorized CEDR User
An individual who has submitted completed User Authorization forms (see catalog Appendix D) and received necessary notification from DOE that authorization has been approved.

BNL
Brookhaven National Laboratory in Upton, NY.

CEDR
Comprehensive Epidemiologic Data Resource. The CEDR Program is managed by the U.S. Department of Energy, Office of Domestic and International Health Studies (AU-13).

CER
Center for Epidemiologic Research at Oak Ridge Associated Universities (ORAU) in Oak Ridge, TN.

Ci
The abbreviation for curie. The curie is a unit of measure used to describe the amount of radioactivity in material. One curie is that amount of radioactive material in which 37 billion (3.7 x 1010) atoms are transformed per second. Fractions of a curie may be shown as nanocuries (nCi) or picocuries (pCi).

CI
Confidence interval.

CNS
Central nervous system.

Cohort
Any designated group of persons who are followed or traced over a period of time. For example, a cohort may be defined as all white males working at a specific facility during a specific period of time.

cpm
Counts per minute.

Data File
Rectangular fixed-width file where rows are records and columns are variables.

Data File Set
A collection of logically related files. CEDR contains two types of data sets: analytic and working.

Data Provider
An organization that provides data and structured documentation to CEDR.

Diagnosis Rate
The number of new, reported health events observed per thousand individuals at risk during a given period of time.

DOE
U.S. Department of Energy.

dpm
Disintegrations per minute.

Facility
A specific DOE plant such as the X-10 Facility at the Oak Ridge Site.

File
See Data File.

FNL/FNAL
Fermi National Accelerator Laboratory in Batavia, IL.

FMP/FMPC
Feed Materials Production Center in Harrison, OH.

Hanford
A DOE Site in Richland, Washington.

IARC
International Agency for Research on Cancer.

ICD Codes
The International Classification of Diseases diagnostic codes. Standardized codes used to classify morbidity and mortality information for statistical purposes. Various versions are used throughout CEDR Data File Sets. ICD codes are defined by the World Health Organization (https://www.who.int/). The most current version of the ICD codes is located at https://www.who.int/classifications/icd/en/

INL
Idaho National Laboratory.

K-25
Previously a gaseous diffusion facility at the Oak Ridge Site in Oak Ridge, TN. K-25 closed in 1985 and cleanup was completed in 2017.

LANL
Los Alamos National Laboratory in Los Alamos, New Mexico.

LAP
Linde Air Products in Buffalo, NY.

LLNL
Lawrence Livermore National Laboratory in Livermore, CA.

LBNL
Lawrence Berkeley National Laboratory in Berkeley, CA.

MCW
Mallinckrodt Chemical Works was in St. Louis, MO .

Mound
Mound Laboratories was in Miamisburg, OH. Mound was closed in 2006 and cleanup was completed in 2010.

MPBB
Maximum permissible body burden.

mGy
A milligray is a unit of absorbed radiation dose equal to 0.001 gray.

mrem
Millirem. See rem for more information.

mSv
Millisievert. A millisievert equals 0.001 sievert. See sievert and rem.

NIOSH
National Institute for Occupational Safety and Health.

NTS/NNSS
Nevada Test Site in Nye County, NV. In 2010 their name changed to Nevada National Security Site (NNSS).

ORAU
Oak Ridge Associated Universities, Oak Ridge, Tennessee. This is the operating contractor of ORISE.

ORISE
Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee.

ORNL
Oak Ridge National Laboratory, Oak Ridge, Tennessee. Also known as X-10 Facility.

PETC
Pittsburgh Energy Technology Center in Pittsburgh, PA.

PGDP
Paducah Gaseous Diffusion Plant in McCracken County, KY.

Po
Polonium.

PNL/PNNL
Pacific Northwest Laboratory, operated for DOE by Battelle in Richland, Washington. In 1995, Pacific Northwest Laboratory added National to their name to become Pacific Northwest National Laboratory.

PORTS
Portsmouth Gaseous Diffusion Plant in Pike County, OH.

ppm
Parts per million.

Primary User
An authorized CEDR user who is assigned a CEDR account number and may be the direct recipient of CEDR data.

PTX
Pantex Plant in Panhandle, TX.

Pu
Plutonium

rem
A measure of radiation dose related to biological effect. Fractions of a rem may be shown as millirem or centirem. Also, 1 rem equals 1 centisievert (cSv), and 100 rem equals 1 sievert (Sv).

RFP
Rocky Flats Plant was near Denver, CO. RFP was shut down in 1992 and cleanup was completed in 2006.

Secondary User
An Authorized CEDR User with whom a Primary User may share CEDR data.

Sievert
A unit of radiation dose, equal to the dose delivered by a point source of 1 milligram of radium, enclosed in a platinum container with walls 1/2-millimeter thick, to a sample at a distance of 1 centimeter over a period of 1 hour. 1 sievert = 100 rem.

Site
A geographical area on which one or more major DOE facilities or plants are located. For example, the Oak Ridge Site includes the X-10, Y-12, and K-25 facilities. A site is sometimes referred to as a reservation.

SMR
Standardized mortality ratio.

SNL
Sandia National Laboratory in Livermore, CA.

SRS
Savannah River Site near Jackson, SC.

SS
Salmon Site (Tatum Salt Dome) was in Lamar County, MS.

SSA
Social Security Administration.

Structured Documentation
Documentation that describes CEDR Data Files, organized quasi-hierarchically:

- Date Files Set level is an overview
- File level describes a Data File
- Variable level describes a variable
- Code level describes code sets.

TLD
Thermoluminescent dosimeter used to measure exposure to radiation.

U
Uranium.

Variable
A specific field or data element in a file.

Working Data File Set
Defined in CEDR as a collection of dynamic files that contains the data from which a researcher selects variables to analyze and forms an initial analytic data file set. The data in working data file sets may be gathered from a variety of sources and contain the least refined form of data in CEDR.

Working File
Defined in CEDR as a file that contains the data from which a researcher selects variables to analyze and forms an initial analytic data file set. The data in working files may be gathered from a variety of sources and contain the least refined form of data in CEDR.

X-10
Alternate name for Oak Ridge National Laboratory located at the Oak Ridge Site.

Y-12
A weapons production facility at the Oak Ridge Site.

COMPREHENSIVE EPIDEMIOLOGIC DATA RESOURCE

Office of Environment, Health, Safety and Security

U.S. Department of Energy ▪ Office of Domestic and International Health Studies ▪ Washington, D.C. 20585

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