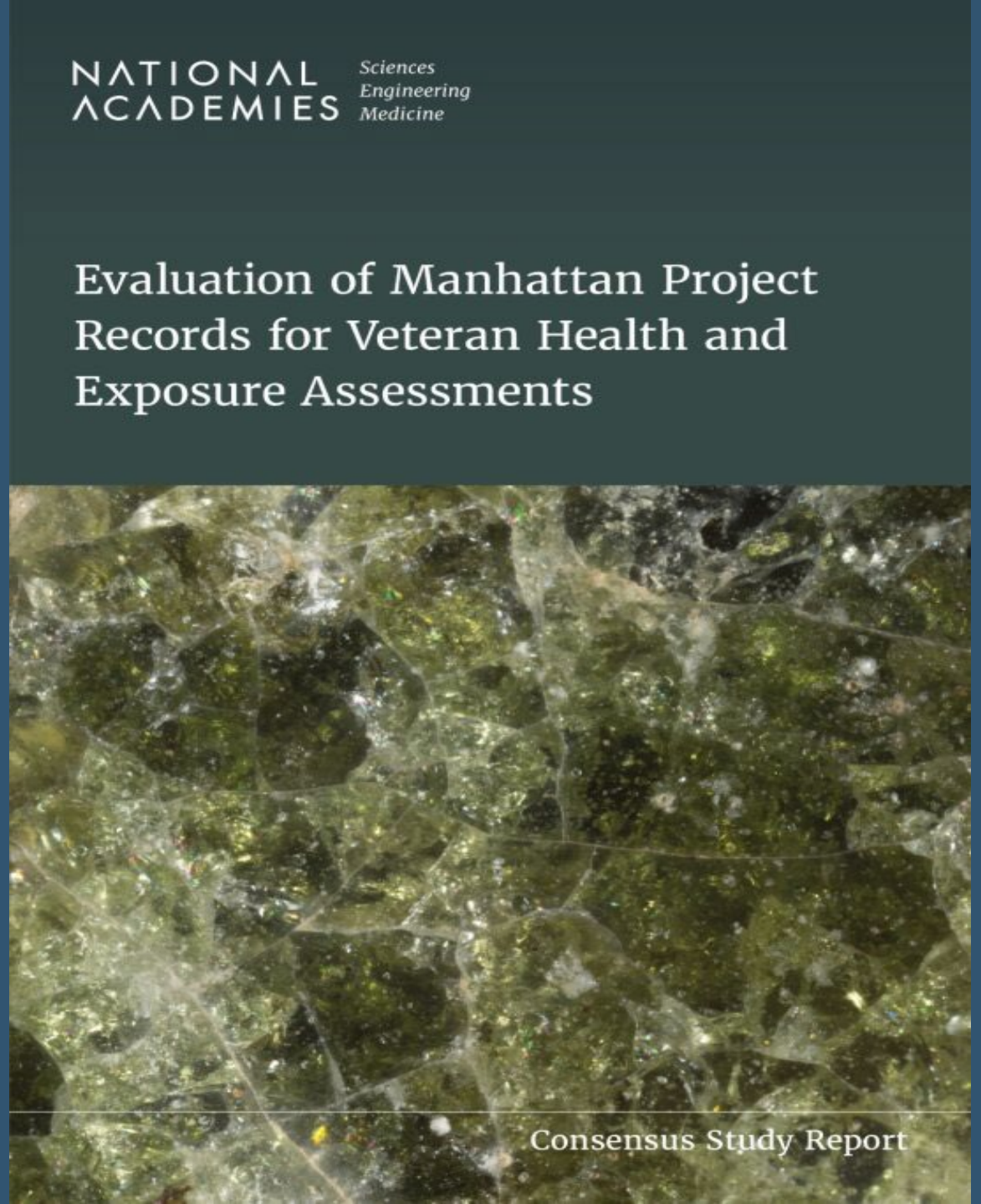
AUGUST 1, 2025

A REPORT BRIEFING

NATIONAL ACADEMIES Sciences Engineering Medicine



Study Sponsor

Department of Veterans Affairs

Through section 506 of Public Law 117-168, the Sergeant First Class Heath Robinson Honoring Our Promise to Address Comprehensive Toxics Act of 2022

PACT Act (PL 117-168) Section 506

The Sergeant First Class Heath Robinson Honoring Our Promise to Address Comprehensive Toxics Act (PACT Act) of 2022 statutorily recognizes the long-term cost of war by adding several presumptive conditions, establishing requirements for how conditions for presumption are considered, and calling for new studies to examine the relationships between specified exposures and health outcomes in military and veteran populations.

Section 506 pertains specifically to Manhattan Project–era veterans. It required the Department of Veterans Affairs to contract with the National Academies of Sciences, Engineering, and Medicine to conduct a study on health outcomes in active-duty military veterans who participated in activities related to the Manhattan Project, including activities related to toxic exposures of covered waste, or who resided at or near at least one of 13 locations as specified by the legislation or added by VA.

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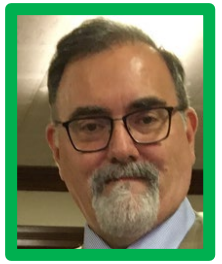
Sarah Cohen



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Charge to the Committee in Brief

VA emphasized that the purpose of this feasibility assessment was to

(1) identify what information exists on the veteran population, their exposures, and their health outcomes,

(2) determine the availability and condition of the information, and

(3) given those findings, determine the extent to which the available information could be used to conduct a full study on exposures and health outcomes in this population of veterans or provide alternative study design options.

The committee's task emphasizes information discovery and characterization on a select group of **military veterans**, defined by **time** (January 12, 1942–August 15, 1947) and **13 specified locations**.

Statement of Task

An ad hoc committee of the National Academies of Sciences, Engineering, and Medicine will conduct a feasibility assessment of the congressionally requested study on the health effects of radioactive materials or waste related to the Manhattan Project on veterans who served on active duty in the military in accordance with PL 117-168 [PACT Act]. The feasibility assessment will identify, understand, and delineate the process for accessing available records. To the extent that records or data dictionaries for these records are available, the committee will characterize the information they contain as well as the quality and completeness of those records related to the following aspects:

1. The approximate number of veterans exposed to toxic substances during the Manhattan Project (January 12, 1942–August 15, 1947) at the following sites* across the United States.

2. Demographic and military characteristics of the veterans determined to have participated in the Manhattan Project (e.g., age, sex, race, tasks performed related to the Manhattan Project).

3. Types of exposures (e.g., chemical, radiation, combined exposures).

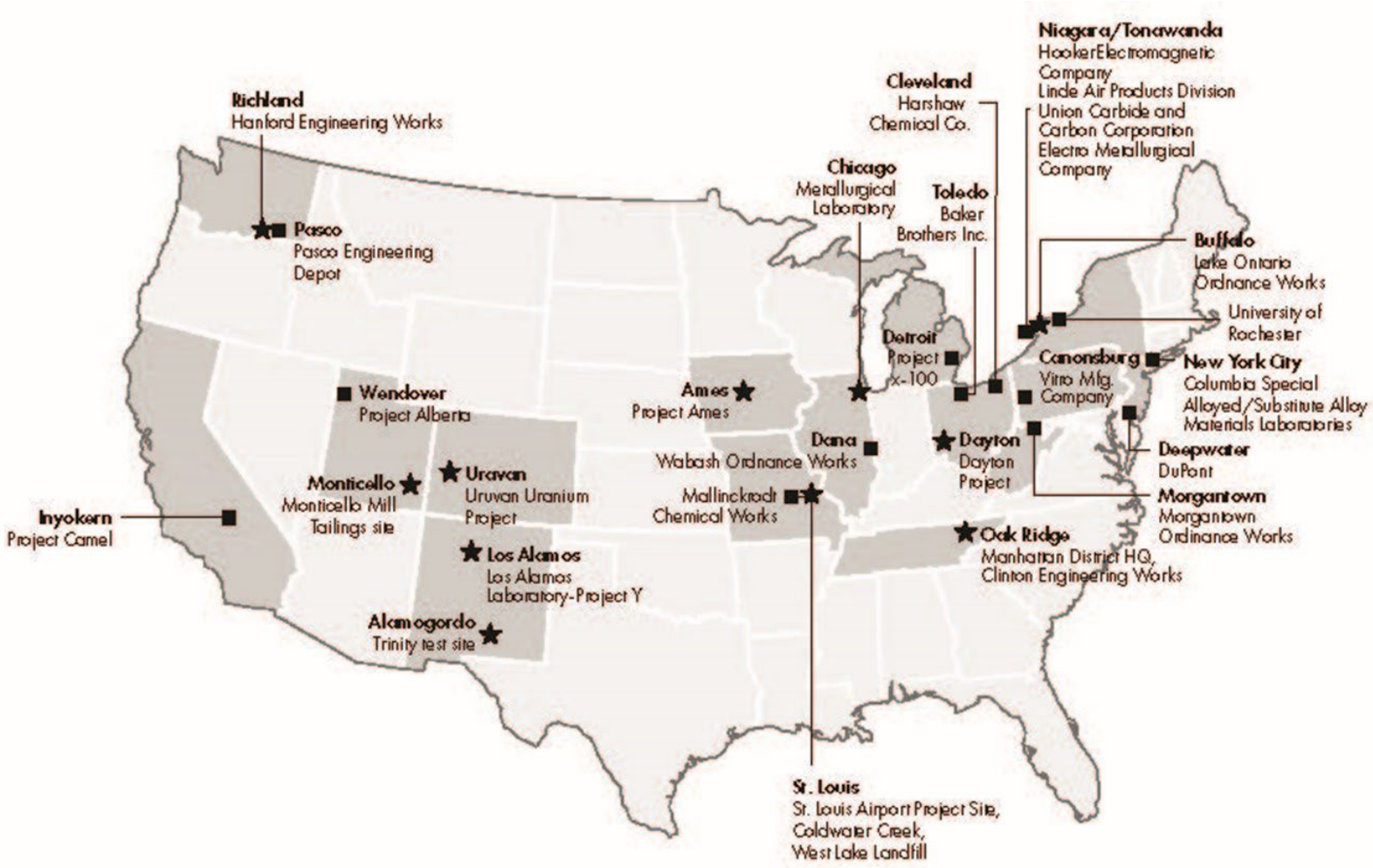
4. Other missions these veterans were involved in before or after the Manhattan Project that may have exposed them to toxic substances and may have contributed to their overall health risks during their military service.

5. Health outcomes including cancer occurrence and cause of death of the exposed veterans. The committee will provide a report on the format (e.g., electronic, paper, other) and sources of available records as well as their contents to the extent possible. Site visits may be conducted to covered sites to better understand possible exposures or availability of paper records.

The committee will also provide conclusions regarding its assessment of the ability to conduct the congressionally requested study. If conducting the study as requested by Congress is found to be possible based on the committee's assessment, the committee will recommend a design framework for the study and an estimate of the time and funding required to conduct such a study. If conducting the study as requested by Congress is not found to be possible given the availability or state of data, the committee will explore possible alternative options for understanding the health effects on the veterans due to exposures from the Manhattan Project.

Specified Sites in the Statement of Task

- St. Louis County, MO:
  - Coldwater Creek
  - St. Louis Airport Project Site
  - The West Lake Landfill
- Oak Ridge, TN
- Hanford, WA
- Los Alamos, NM
- Alamogordo, NM
- Lake Ontario Ordnance Work Buffalo, NY
- University of Chicago, IL
- Iowa State, Ames, IA
- Dayton Project, Dayton, OH
- Monticello, UT
- Uravan, CO



Aspects Outside the Scope of the Task

- Exposures related to nuclear atmospheric and weapons testing.
- Populations other than military veterans, such as civilian workers, families or descendants of veterans, or surrounding community members (including downwinders).
  - "Veteran" refers to any individual who served as active duty in the U.S. military during the Manhattan Project and at one of its sites.
- Activities and exposures outside the continental United States (e.g., Enewetak, Bikini Atoll, Guam).
- Environmental effects of nuclear waste, clean up, or remediation.
- No access to classified records or materials.
- Collection of records or analysis of data was not permitted; only examples of records or their contents was provided.

Approach – Epidemiologic Study

- The committee **identified five key elements** needed to conduct an observational epidemiologic study, which have also been used by prior National Academies consensus committees to assess exposures and health outcomes in veterans.
  - Identification of a **population of interest** from which a representative sample can be drawn;
  - Individual-level **exposure assessment** of adequate quality;
  - Individual-level **health outcome assessment** of adequate quality;
  - Identification of an appropriate **comparison group** and ability to control for contributing factors that might be related to the exposures and the health outcomes of interest;
  - Sufficient **sample size** for precise estimation.
- These five elements guided the committee's information gathering

Approach to Information Gathering

- Systematic process to describe contents, condition, format of records and data
- Utilized a variety of information-gathering activities
  - **24 invited speakers** and accompanying experts presented to the committee
    - **8 public information gathering sessions,**
    - **4 near specified Manhattan Project locations** to hear from site-specific experts
  - **20+ written information requests** to:
    - Federal agencies (including VA, National Archives and Records Administration [NARA], Department of Energy [DOE], and DoD)
    - Researchers
    - Advocacy organizations (e.g., Atomic Heritage Foundation)
    - Site-specific historians and museum curators
    - Hospital records departments for Manhattan Project-era clinics
  - Requests for **public comment**

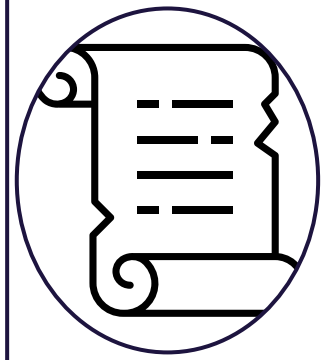
Types of Information Requested

- Knowledge of the location of information or records on the military veterans who served at site-specific locations
- **Any records, lists, or rosters** that would enable researchers to quantify the military personnel who served in these locations and their demographic and military characteristics
- Existence and availability of **individual or area-level exposure records** (dosimetry reports, accident reports, chemical exposures, and combined exposure reports) from 1942–1947 of military personnel or workers with similar jobs, duties, or locations at each of the sites
- **Health records** of the population of interest, both during and after active-duty service
- Descriptions of any records in terms of their **chronological scope, format, and availability to researchers**
- **Knowledge of other entities** holding archival material pertaining to the veterans of interest.

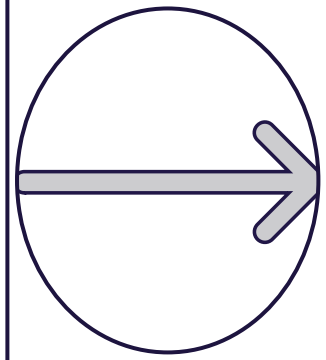
Types of Information Reviewed

- The committee reviewed many different types of information and records including:
  - Government and government-contractor reports
  - Historical documents and books
  - Databases on exposure
  - Published epidemiologic studies of workers at each specified site
  - Examples of military, exposure, and health records
  - Site-specific phonebooks and yearbooks
  - Historical photos

Organization of Report

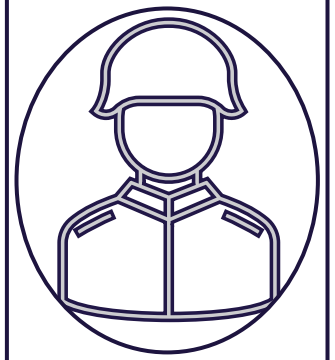


Chapter 1:
Background, Policy Context, and Statement of Task.

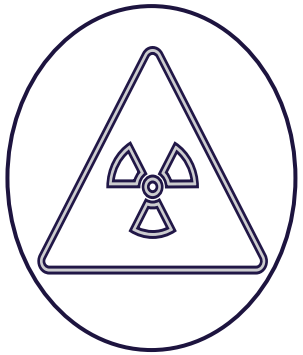


Chapter 2:
Committee's Approach to its Statement of Task

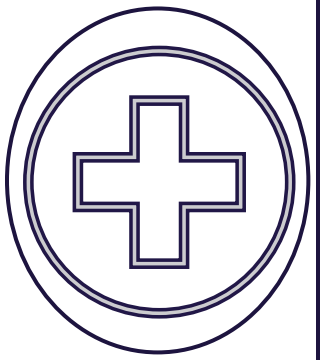
Chapter 3:
Historical Context - Locations Specified in the Statement of Task and Other Manhattan Project Sites with a Military Presence



Chapter 4:
Identifying the Veteran Population – Roles of the military and creating a roster of veterans involved in the Manhattan Project



Chapter 5:
Manhattan Project Exposures and Associated Records – Assessing which exposure assessments are possible based on the records available

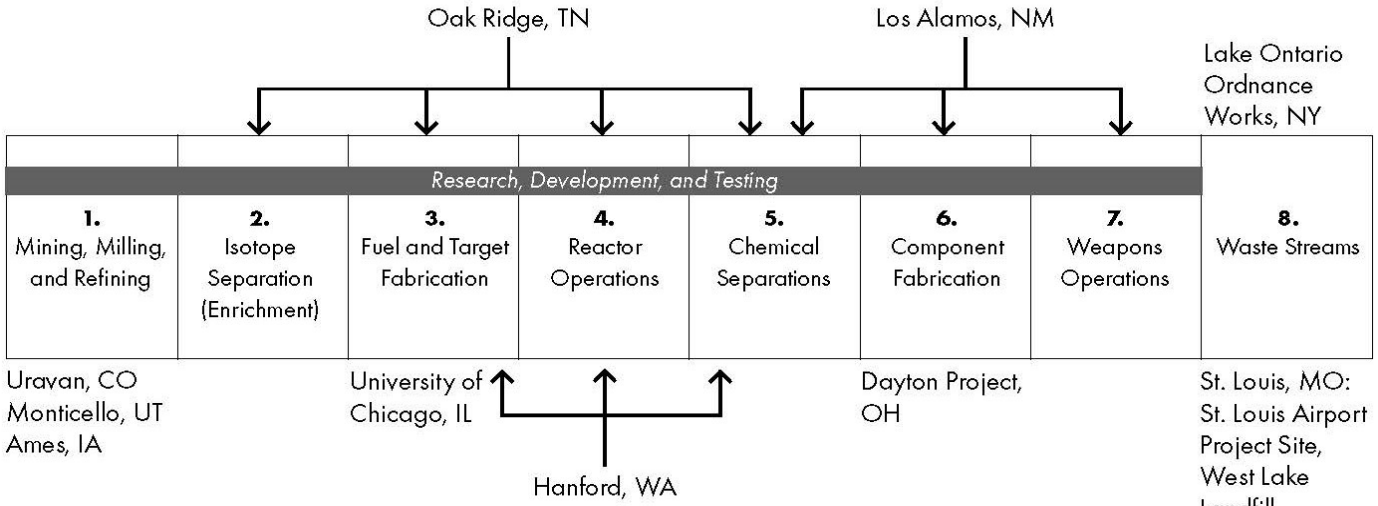


Chapter 6:
Sources of Health Outcome Information – determining which health outcomes are feasible to study.

Chapter 7:
Feasibility Assessment: Overarching Themes and Conclusions

Selected Manhattan Project Sites with Military Presence

- Used historical documentation to understand work being conducted and potential military presence at each site including authorized unit strength.
- For each site, committee examined:
  - Manhattan Project activities conducted
  - Likely sources of exposures and waste generated by those activities
  - Documented active-duty military presence, including numbers when available
  - Epidemiologic studies of workers, since no epidemiologic studies specifically of service members or veterans were identified



Sites with Military Presence and Estimated Number

- Of the 13 sites, 6 were found to have active military during the timeframe 1942-1947:
  - Oak Ridge, Tennessee
  - Hanford, Washington
  - Los Alamos, New Mexico
  - Dayton, Ohio
  - Uravan, Colorado
  - Alamogordo, New Mexico*
- Numbers of Manhattan Project military personnel ranged from a low of 30–40 members at the Dayton Project to several thousand at Los Alamos.
- Of the estimated 600,000 workers engaged in the Manhattan Project 1942–1947, approximately 10,000 (~1.6%) were military personnel.
- Military presence peaked at 5,600 across all sites in 1945.

Primary Manhattan Project Sites

- **Oak Ridge**
  - The site included the X-10 Graphite Reactor, which began the process of transforming uranium-238 into plutonium through neurons released by uranium fission. The S-50, K-25, and Y-12 facilities were designed to operate simultaneously, each using a different chemical separation method to enrich natural uranium with uranium-235, increasing the concentration at each stage.
- **Hanford**
  - The Hanford site consisted of three production reactors, chemical separation plants to remove plutonium from uranium fuel rods (T Plant and B Plant) and uranium slug production operations. Nearly two-thirds of the plutonium in the Trinity test and the nuclear weapons used by the U.S. military in World War II was produced at Hanford.
- **Los Alamos**
  - Project Y was established at Los Alamos to develop, design, and test nuclear weapons. This site became home to more than 6,000 scientists, engineers, technicians, and military and support personnel.
  - Inside the technical work area of Los Alamos, the uranium gun–type and plutonium core implosion–type nuclear weapons were developed and constructed.
  - Additionally, military personnel were tasked with transporting radioactive materials between Los Alamos and Alamogordo for the Trinity test.

Other Manhattan Project Sites with Military Presence (Specified in the Statement of Task)

- Dayton
  - Under contract with the Manhattan Project, the Monsanto Chemical Company established the Dayton Project
  - Scientists conducted research necessary to create neutron initiator, a device designed to trigger the fission chain reaction, using plutonium and polonium purification and production.
  - 30–40 military service members and armed guards provided 24-hour security at its research and production locations.
- Uravan
  - Established as the site of a carnotite ore mine by the United States Vanadium Corporation.
  - Carnotite ore deposits, which contained small amounts of uranium, were converted into uranium sludges for use by the Manhattan Project.
  - Uravan carnotite deposits and the other carnotite mines on the Colorado Plateau averaged ~3 tons of uranium sludge per day, provided 14% of total uranium acquired for Manhattan Project.
- Alamogordo
  - Prior to the Trinity test, military constructed base camp with high-security measures, miles of roads for material transport, and observation bunkers for the upcoming test of the world's first nuclear weapon.
  - Construction of the base camp required laborers, engineers, security details, and maintenance staff: military presence at Alamogordo included 125 military police, and most of the military personnel likely came from the Los Alamos detachment.

Sites with Military Presence Not Included in the Task

- Several other sites with documented military presence were not included in the statement of task but are important pieces of the complex Manhattan Engineer District structure. These include:
  - **Special Alloyed/Substitute Alloy Materials Laboratories (SAM Labs)** at Columbia University, New York where scientists (some whom were military personnel) and workers researched and developed the gaseous diffusion process for the separation of uranium.
  - **Z Division, Los Alamos** was associated with weapons development, particularly the nonnuclear components, research on future weapons development, testing, and bomb assembly.
  - At the **University of Rochester** personnel conducted experiments on the effects of radioactive isotopes, including plutonium, uranium, and polonium on humans to identify protection measures. Military police guarded the facility.
  - **Project Alberta** designed a weapon shape suitable for delivery via air and procured and assembled the necessary parts. It supported ballistic testing at the **Wendover Army Airfield**, Utah, by the 216th Army Air Forces Base Unit and oversaw modifying Boeing B-29 Superfortress bombers so they could carry the nuclear weapons.
  - In **Pasco, Washington** the Pasco Engineer Depot was one of the largest wartime logistics centers in the nation and received building materials, equipment, scientific apparatuses, and chemicals which were then sent on trains to Hanford. Uranium and plutonium to/from Hanford would have passed through this depot.
  - **Project Camel** at the California Institute of Technology and the Salt Wells Pilot Plant at the Naval Ordnance Test Station at Inyokern, California. Developed detonators and other related weapon equipment and testing weapon shapes dropped from the B-29 bombers. The pilot plant housed the manufacturing of nonnuclear explosive components for nuclear weapons.

Military Assignments at Statement of Task Sites

- Manhattan Engineer District (MED) personnel were assigned to one of three units:
  - **9812th Technical Service Unit**: MED headquarters staff, along with the majority of technical personnel in the Special Engineer Detachment (SED).
  - Eighth Service Command:
    - **1467th Service Command Unit**: Provisional Engineer Detachment (PED), military police, and Women's Army Corps (WACs; not assigned to Oak Ridge)
    - **4817th Service Command Unit**: WACs assigned to Oak Ridge

Military Roles

- **Manhattan Engineer District (MED)**
  - Responsible for process development, materials procurement, engineering design, site selection and use of military personnel and private contractors to construct development and production facilities for the Manhattan Project.
  - Identified, recruited, and trained the technical personnel needed to develop a nuclear weapon.
- **Special Engineer Detachment (SED)**
  - Served multiple roles and functions, including as lab technicians, weapons designers, engineers, and scientific lab staff, depending on their skill sets and the needs at the time. They often worked in tandem with their civilian counterparts.
- **Provisional Engineer Detachment (PED)**
  - Performed roles in construction, operation, and maintenance of Los Alamos and Alamogordo. Including roles in operating the power plant, steam plant, motor pool, garage, and mess halls. They repaired and maintained all the buildings and roads, assumed positions in the commissary, post exchange, and post engineer office that could not be filled by civilians due to security concerns. They were also assigned to firefighting roles.
- **Military Police**
  - Provided security for technical and restricted areas and protected against enemy spies and saboteurs. The military police also guarded classified shipments between sites (such as plutonium or uranium hexafluoride).
- **Women's Army Corps (WAC)**
  - Served as librarians, clerks, telephone operators, cooks, drivers, hospital technicians, scientific research staff, and teletype operators. Some had technical expertise and others handled highly classified documents in support of MED operations.

Identification of a roster

- Beyond enumeration, demographic and military characteristics (Subtask 2) can only be described if a roster of individual service members is available
- Conducted extensive research, sent numerous information requests to locate a roster
  - VA does not maintain complete rosters of veterans who served in military units over the entire course of any conflict or for the Manhattan Project
  - DoD does not appear to maintain copies of unit records, especially dating back to the Manhattan Project.
    - Information-gathering sessions with people familiar with unit records, morning reports
    - information requests to Army Dosimetry Center and the U.S. Army Center of Military History
    - Defense Threat Reduction Agency, Nuclear Test Personnel Review Program responded to a request from VA in 2022 that it does not hold records for individuals who participated in the Manhattan Project
  - "National Roster of Scientific and Specialized Personnel" not a match for statement of task
- **Committee ultimately determined that no roster of Manhattan Project veterans exists**

Potential Sources and Methods for Creating a Roster: Sources of Military Records

- **NARA**
  - Determined to be best source for military records and information for creating a roster
  - Stored in multiple locations, NARA holds Manhattan Project-related materials including:
    - Handwritten and typed records, ranging from wartime and postwar military documents
    - Memorandums
    - Reports
    - Contemporary histories
    - Research data files
    - Letters
    - Logs documenting daily activities, protocols, and procedures
    - Still and moving-image sources
    - Interviews with Manhattan Project researchers
  - National Archives at St. Louis manages all military files for veterans with a rolling separation date ≥ 62 years.

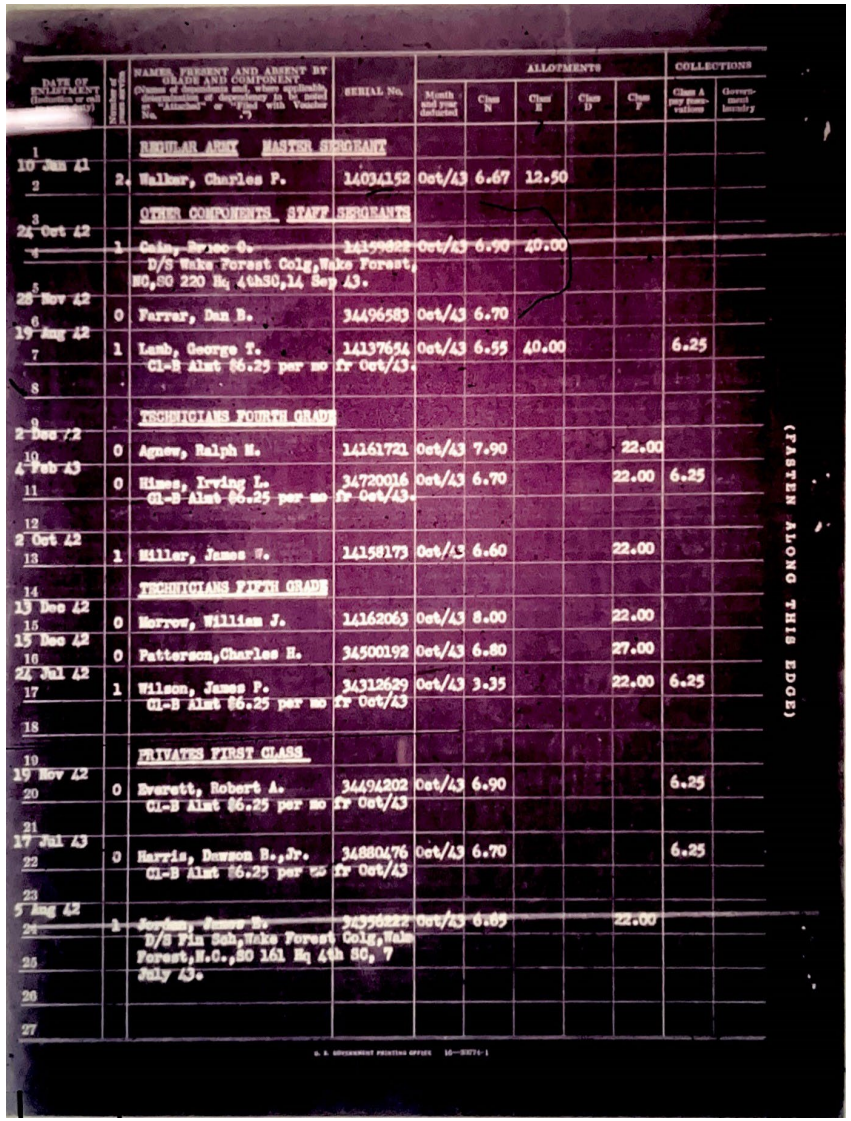
Potential Sources and Methods for Creating a Roster: Sources of Non-military Records

- **Department of Energy Records Managers**
  - Manhattan Project–era site records management is split between the Records Management Office, the National Nuclear Security Administration, and the Office of Legacy Management, which maintain these records through the various field offices at those sites.
  - Each site contains different records which may provide more information
  - Many of the records do not have an indicator of military service
  - Some sites required a security clearance to access records
- **Lists of Veterans Compiled by Researchers**
  - Hanford Veterans Cancer Mortality Study: compiled a list of 23,000 names of military personnel stationed at 11 bases including Hanford, across eastern Washington and northern Idaho from 1943–1962.
  - Oak Ridge Associated Universities: Epidemiologic research performed by the Oak Ridge Institute for Science and Education (ORISE) on DOE nuclear workers, specifically for individual cohorts in the Million Person Study.
- **The Atomic Heritage Foundation**
  - Created the Manhattan Project Veterans Database, which allows users to search for individual names and provides numbers of veterans who worked at specific Manhattan Project locations.
  - Use of “veteran” in the database does not indicate only individuals who served in the military but rather someone who worked on the Manhattan Project as a civilian or military employee.

Creating a Roster

- Steps to create a roster:
  - Request the relevant unit records from January 1942 through August 1947 from NARA via the National Archives at St. Louis
  - Names and service numbers from January 1942 unit records would be beginning of roster
  - Each monthly report thereafter would be used to build out a full roster
- **Challenge:** National Archives at St. Louis indicated that unit records for all three relevant units for 1944–1946 (the height of Manhattan Project activities) were destroyed in 1975, so that the information from this source is incomplete
- To address missing information, committee considered **morning reports**
  - Daily reports documenting status changes for individual service members
  - However, many of these appear to also be missing

Example of Monthly Unit Records



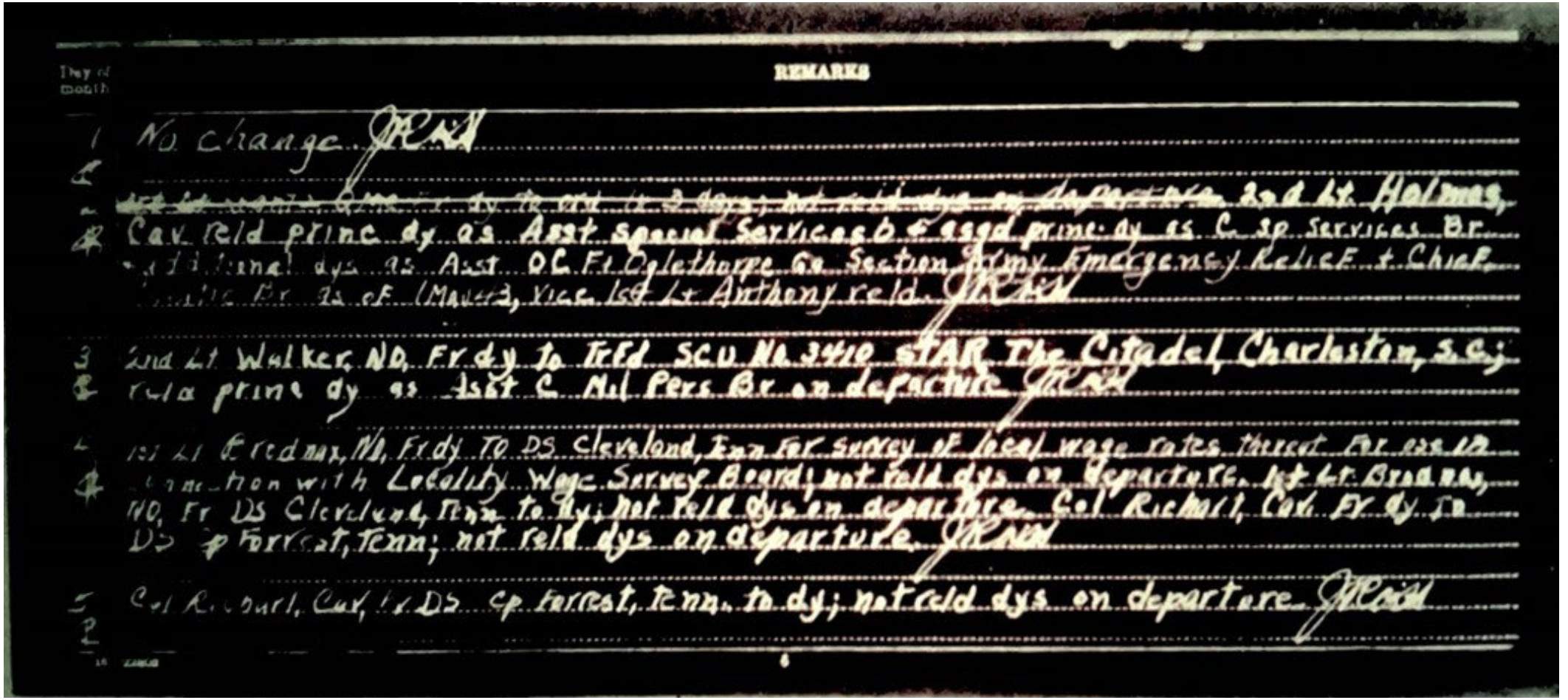
DATE OF ENLISTMENT		NAMES, PRESENT AND ABSENT BY GRADE AND COMPONENT	SERIAL No.	ALLOTMENTS					COLLECTIONS	
				Month and year dedicated	Class N	Class E	Class D	Class F	Class A pay reservations	Government laundry
		REGULAR ARMY MASTER SERGEANT								
10 Jan 41	2	Walker, Charles P.	14034152	Oct/43	6.67	12.50				
		OTHER COMPONENTS STAFF SERGEANTS								
24 Oct 42	1	Caldy, Bruce O. D/S Wake Forest Colg, Wake Forest, NC, SO 220 Hq 4th SO, 14 Sep 43.	34199822	Oct/43	6.90	40.00				
28 Nov 42	0	Farrar, Dan B.	34496583	Oct/43	6.70					
19 Aug 42	1	Lamb, George T. Cl-B Allot $6.25 per mo fr Oct/43.	14137654	Oct/43	6.55	40.00			6.25	
		TECHNICIANS FOURTH GRADE								
2 Dec 42	0	Agnew, Ralph M.	14161721	Oct/43	7.90			22.00		
4 Feb 43	0	Himes, Irving L. Cl-B Allot $6.25 per mo fr Oct/43.	34720016	Oct/43	6.70			22.00	6.25	
2 Oct 42	1	Miller, James W.	14158173	Oct/43	6.60			22.00		
		TECHNICIANS FIFTH GRADE								
13 Dec 42	0	Morrow, William J.	14162063	Oct/43	8.00			22.00		
15 Dec 42	0	Patterson, Charles H.	34500192	Oct/43	6.80			27.00		
24 Jul 42	1	Wilson, James P. Cl-B Allot $6.25 per mo fr Oct/43	34312629	Oct/43	3.35			22.00	6.25	
		PRIVATES FIRST CLASS								
19 Nov 42	0	Everett, Robert A. Cl-B Allot $6.25 per mo fr Oct/43	34494202	Oct/43	6.90				6.25	
17 Jul 43	0	Harris, Dawson B., Jr. Cl-B Allot $6.25 per mo fr Oct/43	34880476	Oct/43	6.70				6.25	
5 Aug 42	1	Jordan, James D. D/S Fin Sch, Wake Forest Colg, Wake Forest, N.C., SO 161 Hq 4th SO, 7 July 43.	34296222	Oct/43	6.69			22.00		

(FASTEN ALONG THIS EDGE)

- Each report lists name, rank, service number, unit designation, geographical location, and map coordinates for each veteran.
- These only include individuals with changes and so are not a roster themselves.
- Stored on microfilm so are commonly degraded and difficult to read
- Contain abbreviations that need to be decoded
  - These qualities affect readability and the time to extract relevant information.

This example is from the 1467th Service Command Unit Roster for October 1943 and is enhanced for readability

Example of Daily Morning Report



This example comes from the 1467th Service Command Unit for May 1943 and is enhanced for readability

Linking to Military Personnel Files

- Every member of the armed services has an **official military personnel file**
- National Archives at St. Louis manages all official military personnel files for veterans with a separation date of 62+ years ago
- Sections of these records are publicly available from the National Archives at St. Louis.
- No indicator identifies individual personnel associated with the Manhattan Project in any of the World War II records.
- Using a roster of names compiled from unit records and morning reports, individual military personnel files can be requested.
- The quality and types of records available for an individual vary widely, but may contain:
  - Basic demographics
  - Job titles (military occupation specialty)
  - Training
  - Performance
  - Assignments, locations, and dates of service for each unit in which they served
  - Qualifications
  - Birth certificates
  - Marriage certificates
  - Divorce decrees
  - Letters
  - Photographs
  - Awards and decorations
  - Disciplinary actions
  - Administrative remarks
  - Military health records from military facilities

Linking to Military Personnel Files

- Access to and completeness of personnel records may be compromised by the July 1973 fire in the National Archives at St. Louis Military Personnel Records building
  - Destroyed approximately 17 million official military personnel files, including 80% of files for World War II and post–World War II Army personnel discharged between September 8, 1939, and December 31, 1959.
- After the fire, NPRC initiated several records recovery and reconstruction efforts
- As no duplicate copies of these records were ever maintained, nor any indexes created before the fire, no complete listing of records that were lost exists
  - Therefore, it is unknown how many records for individual service members who worked on the Manhattan Project were affected by the fire

Summary of Key Findings for Identifying the Veteran Population

- A complete roster of Manhattan Project veterans does not exist.
- Numerous barriers, such as fragmented and incomplete data sources, and impediments to cross-agency collaboration, limit compiling a roster.
- Comprehensive research involving substantial human and financial resources would be needed to identify individuals assigned to MED units to create a roster. Such historical research is compromised by the 1973 fire at the National Archives at St. Louis and the scheduled destruction of morning reports from 1944–1946 that constrain using the standard methodologies for constructing rosters.
- The process for creating a partial roster based on information available for the few years where unit records or morning reports exist would be lengthy, time consuming, and costly, would require interagency support and cooperation for records access, and would ultimately be incomplete.
- Due to the incomplete unit records and morning reports available at the National Archives at St. Louis, secondary sources, such as the Atomic Heritage Foundation, DOE site-specific records for personnel who had careers in DOE after the Manhattan Project, and obituaries may be used to verify or supplement information missing from official military personnel records at the national archives.

Conclusion for Identifying the Veteran Population

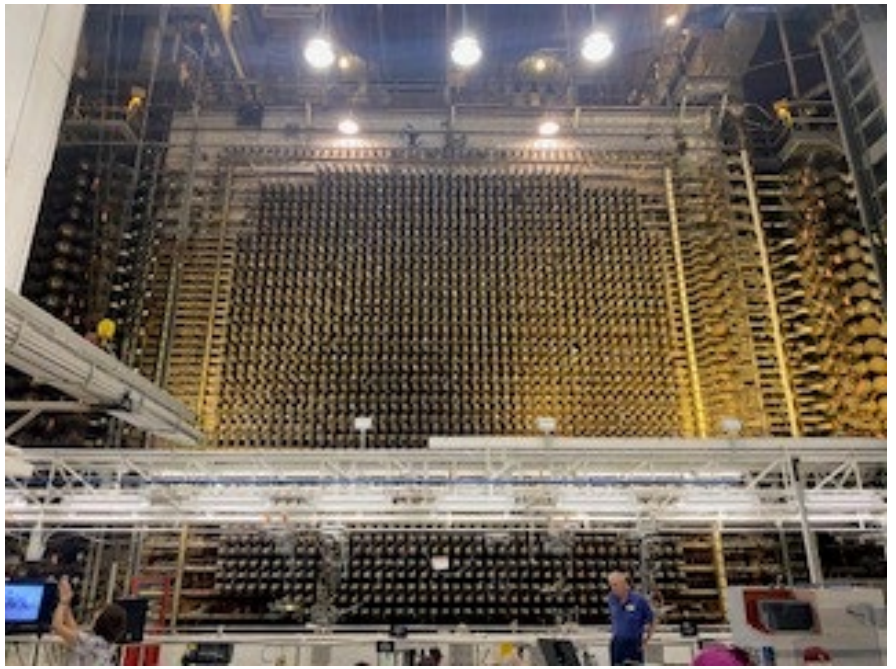
Conclusion 4-1: The committee concludes that the approximate quantification of Manhattan Project military veterans is possible. However, given the missing unit records and morning reports for several years, especially the lack of unit rosters for 1944–1946—the years of highest Manhattan Project activity—the committee further concludes that the creation of a near-complete roster of individuals with identifying information based only on military records available through the National Archives is unlikely to be possible.

Manhattan Project Exposures and Associated Records

- Potential military veteran exposures included chemical, radiological and mixed.
  - Exposure typically refers to the contact between a substance and the human body. The definition of dose depends on the context; radiation dose is generally related to energy absorption, whereas the relevant property for most chemical substances is mass.
- The level of uncertainty in an exposure assessment, along with the ability to draw conclusions about exposure–health relationships, strongly depends on data availability and quality.
- Exposures and their associated records were grouped into three broad categories: external radiation, internal radiation, and chemical. The quantity and quality of those records were assessed with respect to use in exposure and dose reconstruction methods.

Exposure Monitoring

- Many processes were being performed for the first time under strict time constraints
- Standards and practices for monitoring and recording worker exposures were being refined and developed in tandem with nuclear weapon development process
- Chemical exposures were not well documented and usually were only reported for a high exposure; estimating chemical exposures and subsequent dose is complex and requires knowledge of the processes performed by the worker.
- Radiological exposures were documented more frequently



Picture of the B Reactor at Hanford, the first large- scale nuclear reactor used to produce Pu-239

The committee found that there is little information that describes Manhattan Project-specific chemical exposures and such exposures were infrequently recorded. Moreover, the chemicals and processes involved in the Manhattan Engineer District activities and weapons manufacturing process are sensitive in nature, and access to these records and information is likely to be restricted.

Exposure Records: Dosimetry

- A radiation dosimeter [see figure] can provide information on a worker's external exposure to radiation (within its design and calibration parameters).
- Quantifying internal exposure (e.g., following inhalation or ingestion) is more challenging because internal dose is not directly measurable. Rather, techniques such as bioassays can be combined with computational models to estimate intake and dose.
- Rollout of the Health Division's protocols varied by site (with some common practices).
- The availability, type, and accuracy of dosimeters varied, particularly in the early years of the project.
- External radiation exposure records evolved in their formats in the early years of the project.

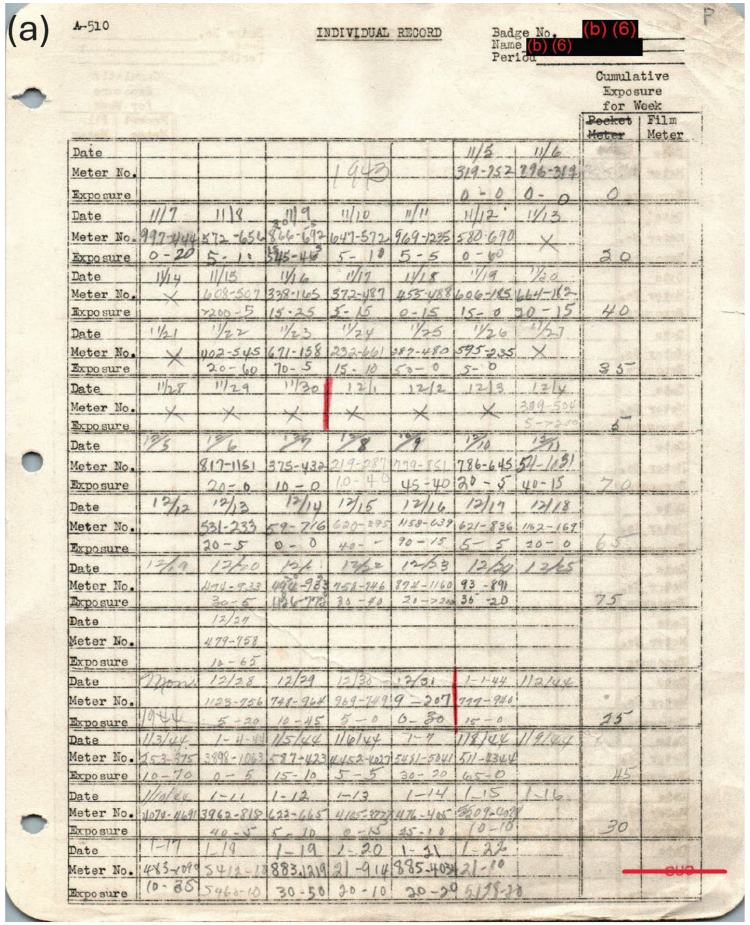
Example of how early dosimeters were worn; Auxier, 1980

External Dosimetry Record Examples

Examples of individual dosimetry records (Clinton Engineer Works [Oak Ridge]) illustrating change in record format

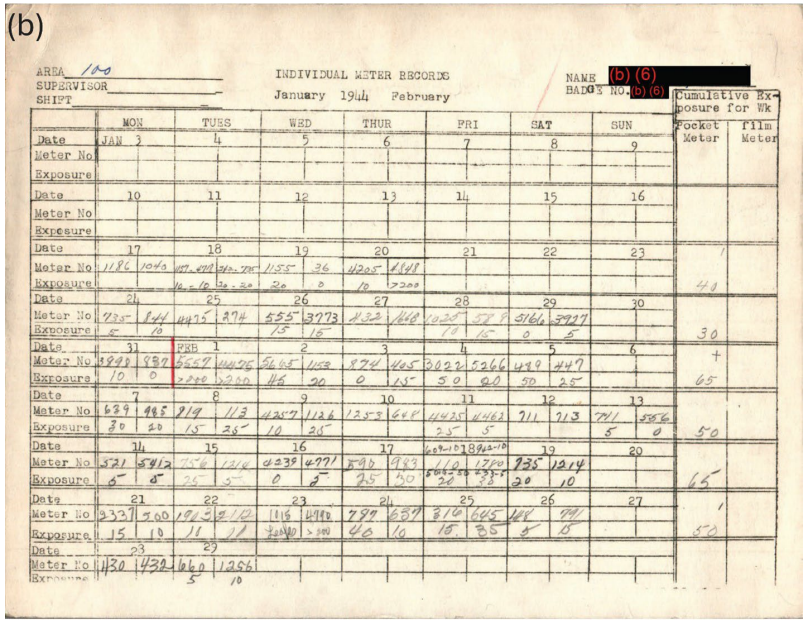
December 1943

(a)



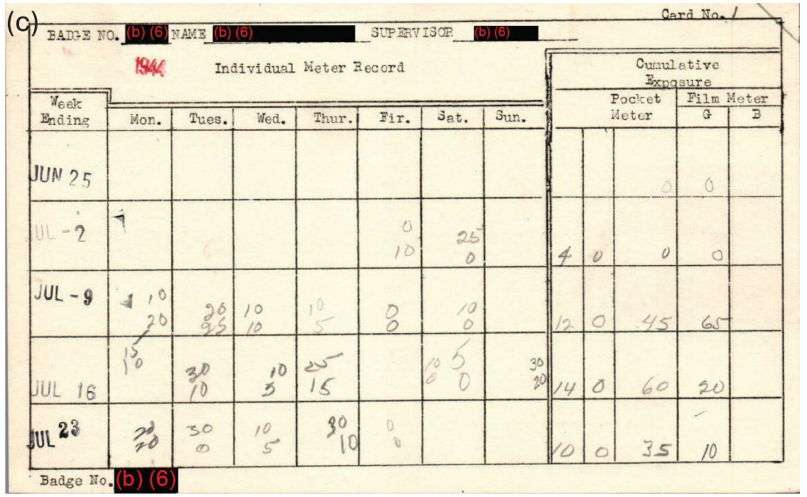
January 1944

(b)



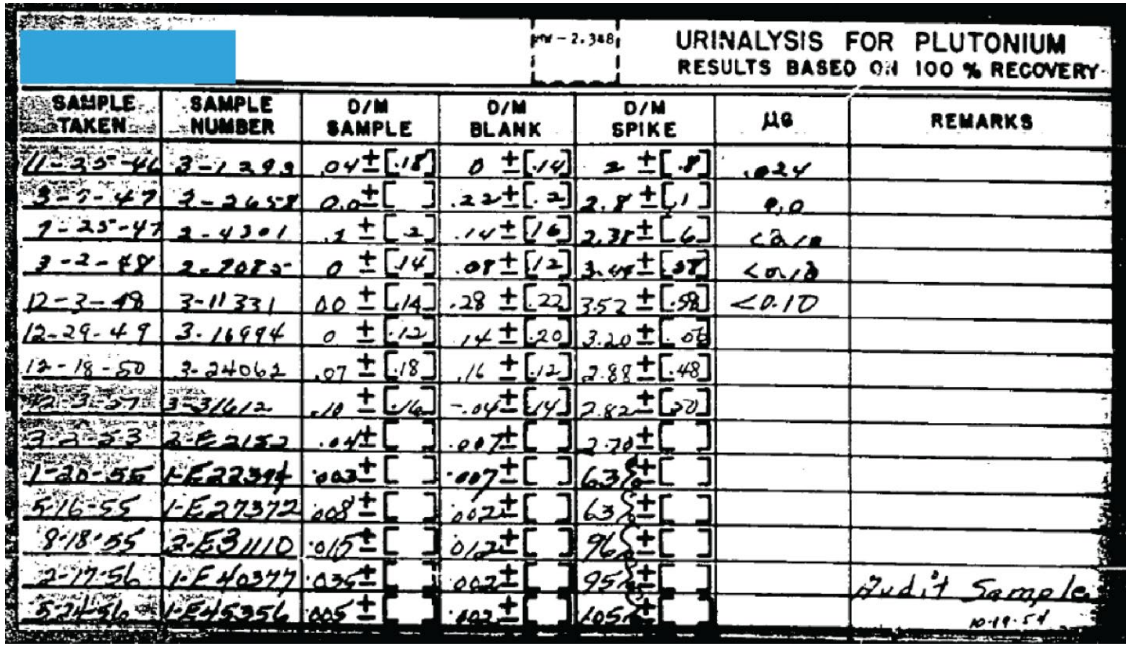
June 1944

(c)



Urinalysis Example

- Records related to internal dosimetry were often in the form of urinalysis or fecal sample results.
- Urinalyses were not conducted on a set schedule.
- Due to the lack of standardized internal radiological exposure monitoring, the ability to determine individual exposure is limited.



URINALYSIS FOR PLUTONIUM
RESULTS BASED ON 100 % RECOVERY

SAMPLE TAKEN	SAMPLE NUMBER	D/M SAMPLE	D/M BLANK	D/M SPIKE	µG	REMARKS
11-25-46	3-1299	.04 ± [.18]	0 ± [.14]	2 ± [.8]	.024	
3-5-47	3-2658	0.0 ± [ ]	.22 ± [.2]	2.8 ± [.1]	0.0	
7-25-47	3-4301	.1 ± [.2]	.14 ± [.16]	2.35 ± [.6]	<0.10	
3-2-48	3-7052	0 ± [.14]	.08 ± [.12]	3.44 ± [.08]	<0.10	
12-3-48	3-11331	.00 ± [.14]	.28 ± [.22]	3.52 ± [.58]	<0.10	
12-29-49	3-16994	0 ± [.12]	.14 ± [.20]	3.20 ± [.08]		
12-18-50	3-24062	.07 ± [.18]	.16 ± [.12]	2.88 ± [.48]		
12-3-51	3-31612	.10 ± [.16]	-.04 ± [.14]	2.82 ± [.20]		
3-3-53	3-E21852	.04 ± [ ]	.007 ± [ ]	2.70 ± [ ]		
1-20-55	1-E22394	.003 ± [ ]	.007 ± [ ]	63 ± [ ]		
5-16-55	1-E27372	.008 ± [ ]	.002 ± [ ]	63 ± [ ]		
8-18-55	2-E33110	.015 ± [ ]	.012 ± [ ]	96 ± [ ]		
2-17-56	1-EH0377	.036 ± [ ]	.002 ± [ ]	95 ± [ ]		
5-24-56	1-EH5356	.005 ± [ ]	.003 ± [ ]	105 ± [ ]		Audit Sample 10-19-54

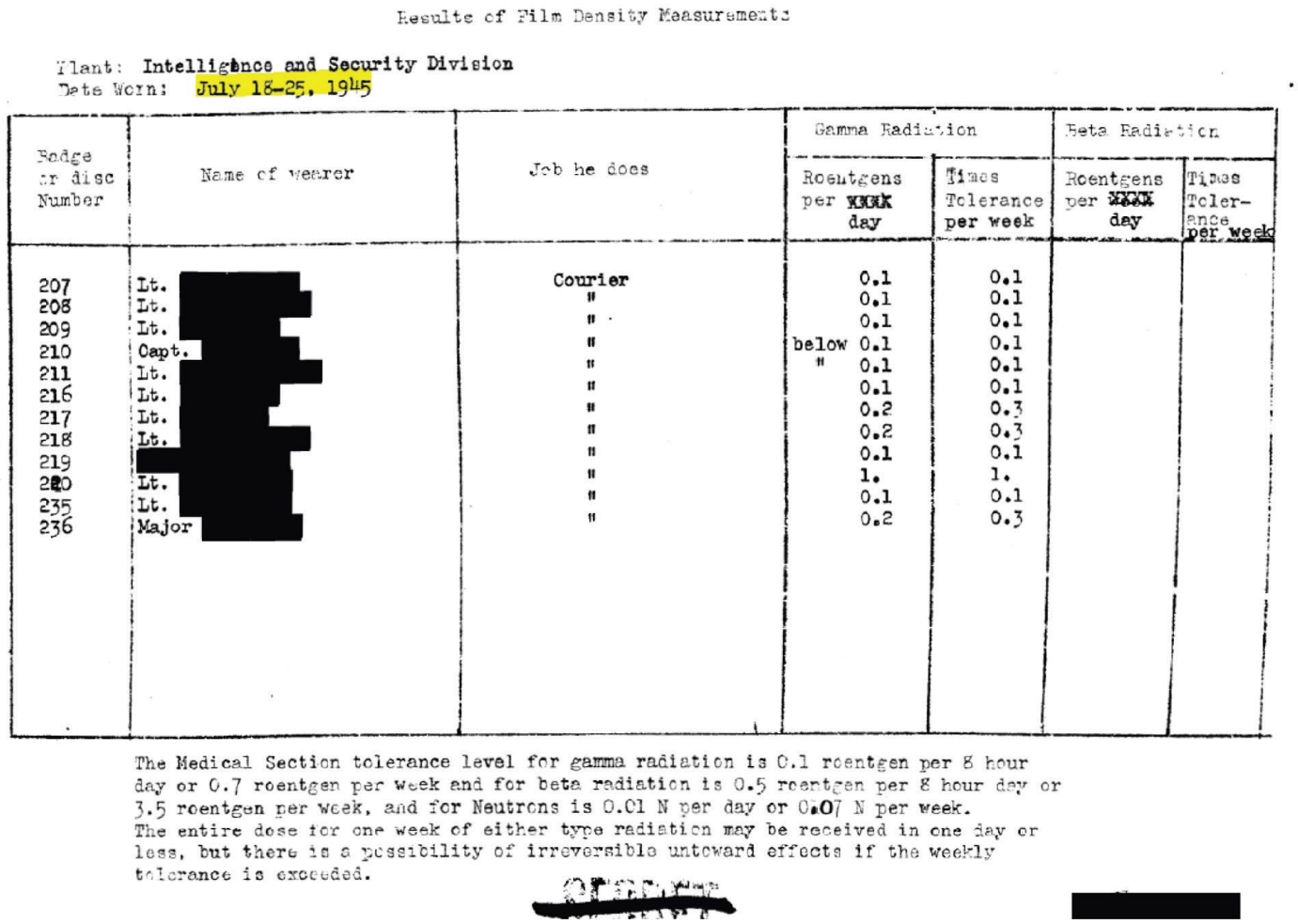
Example urinalysis for plutonium from a Hanford worker in 1946. Figure enhanced for readability.

The committee found that some records exist for radiological exposures for 1942-1947, but record gaps, inconsistent record maintenance, differences across sites, limitations in the dosimetry programs, and changing contemporary technology would all affect the time and effort needed to extract usable information.

Example including Military Rank

- Uncommon examples exist where rank was noted.
- The list is a mixture of civilian and military personnel.

The committee found that, in general, exposure records from 1942–1947 do not often distinguish between civilian and military personnel.



Results of Film Density Measurements

Plant: Intelligence and Security Division
Date Worn: July 18-25, 1945

Badge or disc Number	Name of wearer	Job he does	Gamma Radiation		Beta Radiation	
			Roentgens per XXXX day	Times Tolerance per week	Roentgens per XXXX day	Times Tolerance per week
207	Lt. [redacted]	Courier	0.1	0.1		
208	Lt.	"	0.1	0.1		
209	Lt.	"	0.1	0.1		
210	Capt.	"	below 0.1	0.1		
211	Lt.	"	" 0.1	0.1		
216	Lt.	"	0.1	0.1		
217	Lt.	"	0.2	0.3		
218	Lt.	"	0.2	0.3		
219	[redacted]	"	0.1	0.1		
220	Lt.	"	1.	1.		
235	Lt.	"	0.1	0.1		
236	Major	"	0.2	0.3		

The Medical Section tolerance level for gamma radiation is 0.1 roentgen per 8 hour day or 0.7 roentgen per week and for beta radiation is 0.5 roentgen per 8 hour day or 3.5 roentgen per week, and for Neutrons is 0.01 N per day or 0.07 N per week. The entire dose for one week of either type radiation may be received in one day or less, but there is a possibility of irreversible untoward effects if the weekly tolerance is exceeded.

[redacted]

Breadth of Exposures

- Depending on their job, veterans may have been exposed to a wide variety of toxic exposures.
- Department of Labor's Site Exposure Matrices (SEM) contain information on >18,000 nonradioactive and radioactive chemicals and compounds
  - 9 of the 13 specified sites
- The SEM is not time specific, so it cannot be used to identify when a chemical was present.
- SEM is not specific to the Manhattan Project but highlights the varieties of potential exposures, including possibility of mixed exposures.

Site	Number of Chemicals
Oak Ridge Gaseous diffusion plant K-25	**1,371**
Oak Ridge Institute for Science Education	**1,131**
Oak Ridge National Laboratory (X-10)	**2,274**
S-50 Oak Ridge Thermal Diffusion Plant	**536**
Y-12 Plant	**1,106**
Hanford (1943–present)/PNNL (1965–2004)	**3,102**
Los Alamos, NM	**2,666**
Lake Ontario Ordnance Works (Niagara Falls Storage Site)	**540**
University of Chicago, IL (Argonne National Laboratory-East)	**1,727**
Iowa State, Ames, IA (Ames Laboratory)	**5,417**
Dayton Project	**597**
Uranium Mill in Monticello, UT (remediation)	**293**
Uravan, Montrose County, CO (Uravan #2)	**30**

SEM chemical categories: acids/caustics/reducing and oxidizing agents; dusts/fibers; explosives and explosive components; gases; metals; other materials; pesticides, herbicides, fungicides, and rodenticides; radiation and radioactive substances; and solvents

Databases and Sources Containing Exposure Information

- Databases that may contain information on Manhattan Project exposures or aggregate information including the specified sites and timeframe of interest:
  - Comprehensive Epidemiologic Data Resources (CEDR),
  - NIOSH Special Exposure Cohort (SEC) Technical Documents,
  - DOL Site Exposure Matrices (SEM) [previous slide],
  - Radiation Exposure Monitoring System (REMS),
  - Radiation Exposure Information Reporting Systems (REIRS),
  - United States Transuranium and Uranium Registries

- None of the databases the committee assessed are specific to veterans or to 1942-1947.
- Site-by-site access to dosimetry records may be possible but would require extensive levels of approval, time, and effort.

Summary of Committee's Exposure and Dose Assessment Tiers

- The committee created a 3-tiered approach to exposure assessment, with **each tier representing a different level of data availability and completeness** to help frame what designs may be feasible.
- The quality and quantity of exposure data determine the type of study that can be conducted.
- Radiological and chemical exposures had to be considered separately because the records did not record mixed exposures

TABLE 5-1 Summary of the Committee's Tiers of Exposure and Dose Assessments

	Tier 1	Tier 2	Tier 3
Description	Assign an estimate of exposure to each individual in a study population based on individual exposure measurements.	Assign an estimate of exposure to each individual in a study population based on group-level exposure estimates.	Assign an estimate of exposure to a study population based on group-level exposures estimates through a risk assessment.
Data required	Individual exposure measurements Defined cohort	A) Exposure estimates for groups (e.g., each job and location) based on area monitoring or models Individuals' employment and job histories Defined cohort	Exposure estimates for a group (facility average) or groups (e.g., job and location) from area monitoring data or models No defined cohort
		B) Estimates of group-level exposure limited and primarily based on duration of exposure as a surrogate No direct exposure information	

Conclusion for Exposure Records

Conclusion 5-1: Given limitations of exposure records and lack of indication of military status, the committee concludes that individual exposure estimates (tier 1) would not be possible for the Manhattan Project. Group-based exposure assessments (tier 2) could cover all chemical, radiological, and combined exposures. A risk assessment (tier 3) may be used if veterans' job histories cannot be determined.

Identifying Relevant Health Outcomes of Radiological and Chemical Exposures

- Statement of task highlighted cancer and cause of death as health outcomes of interest.
- Committee did not identify any epidemiologic studies that specifically examined the health outcomes of these exposures among military personnel who were part of the Manhattan Project at the sites of interest.
- Identified other epidemiologic research:
  - Workers at the Manhattan Project sites of interest during the same period.
  - Populations with known exposure to the same hazards → provided insight into what health outcomes could be most relevant to a future study.
  - Several systematic reviews of health effects of exposure to ionizing radiation.
  - ATSDR toxicology profiles describe the health effects of exposure to many of the chemical hazards.

Overview of Health Outcomes of Radiological and Chemical Exposures

- The committee found published evidence of associations between
  - Exposure to ionizing radiation and multiple cancers and some nonmalignant diseases.
  - Exposures to chemicals and heavy metals and some cancers and nonmalignant diseases.

- Limitations of generalizing these published findings to Manhattan Project veterans
  - Several similar health effects associated with exposures to each—ionizing radiation, chemicals, and heavy metals.
  - Exposure to one can affect the effects of exposure to another.
  - Veterans were likely exposed to more than one type of hazard and likely had combined exposures.
  - Impractical to identify effects of each individual and combined exposure.

Potential Sources of Veteran Health Records

- The committee considered many sources for health records to identify health outcomes for the veteran population of interest
  - VA records
  - DOE site-specific records (including records from on-site hospitals)
  - EEOICPA compensation program
  - CMS
  - ORAU CEDR
  - DOL site exposure matrices
  - Special exposure cohorts
  - Military personnel records
  - Cancer registries

None of these sources were found to hold a comprehensive collection of medical records for the veteran population of interest.

Health Outcomes for Manhattan Project Veterans

- Cause of death
  - Less than 1% of World War II veterans were alive in 2024.
  - Death certificates are available for essentially all deaths in the U.S.
  - NDI has cause of death from death certificates for majority of deaths beginning in 1979.
  - Death certificates predate all other potential sources.
- Key considerations for this approach
  - Relies on availability of a roster of individual veterans.
  - Need to contact individual states for pre-1979 death certificates.
  - Death certificates have varying levels of detail for cause of death.
  - Need to combine death certificate data with other sources, such as VA records for accuracy.

Key Findings for Health Outcomes

- The availability of military and VA administrative medical records and supplemental sources such as cancer registries is limited particularly for 1942–1947.
- The committee was unable to find a comprehensive source of veteran-specific health outcome information.
- The committee found that while there are no comprehensive sources of health outcome records, death certificates are systematically available (obtained individually either through NDI or the individual states) for Manhattan Project veterans.

Conclusion for Health Outcomes

Conclusion 6-1: Given the lack of health records available for individual veterans covered by the statement of task and the lack of nationwide, comprehensive cancer incidence data, the committee concludes that cancer incidence is not a feasible health outcome for an epidemiologic study of Manhattan Project veterans. However, mortality is a feasible outcome for such a study given the systematic surveillance of death in the United States.

Feasibility Assessment

- Using five key elements needed to conduct an observational epidemiologic study, committee assessed extent to which each was met by the records or information available.
  - Identification of a **population of interest** from which a representative sample can be drawn;
  - Individual-level **exposure assessment** of adequate quality;
  - Individual-level health **outcome assessment** of adequate quality;
  - Identification of an appropriate **comparison group** and ability to control for contributing factors that might be related to the exposures and the health outcomes of interest;
  - Sufficient **sample size** for precise estimation.
- **In sum, committee found that key information that would be needed to conduct an observational epidemiologic study on health outcomes in veterans resulting from radiological and chemical exposures during Manhattan Project activities is not available at the individual level or at a level of detail necessary for epidemiologic analyses.**

Availability of Each Statement of Task Element By Site

Site	Military presence identified between 1942–1947	Demographic and military characteristic information		Types of known exposures (radiation, chemical, combined)			Other military missions and exposures	Health outcomes and cause of death[d]
		Demographic	Military	Internal Radiation[b]	External Radiation	Chemical		
Oak Ridge, TN	Yes	Limited	Limited	Limited	Possible[c]	Unknown	Unknown	Possible
Hanford, WA	Yes	Limited	Limited	Limited	Possible[c]	Unknown	Unknown	Possible
Los. Alamos, NM	Yes	Limited	Limited	Limited	Possible[c]	Unknown	Unknown	Possible
Dayton Proiect, OH	Yes	Unknown	Unknown	Limited	Possible[c]	Unknown	Unknown	Possible
Uravan, CO	Yes	Possible[a]	Limited	Unknown	Unknown	Unknown	Unknown	Possible
Alamogordo, NM[e]	Yes	Limited	Limited	Unknown	Unknown	Unknown	Unknown	Possible
Lake Ontario Ordnance Works, NY	No evidence of military presence							
Coldwater Creek, St. Louis County, MO	No evidence of military presence							
St. Louis Airport Project Site, MO	No evidence of military presence							
West Lake Landfill, St. Louis County, MO	No evidence of military presence							
University of Chicago, IL	No evidence of military presence							
Iowa State, Ames, lA	No evidence of military presence							
Monticello, UT	No evidence of military presence							

Feasibility Assessment – Cross Cutting Issues

The complex history of the Manhattan Project impacts the collection, maintenance, and feasibility of access to records, including:

- Number of chemical, radiological, and mixed exposures – with limited documentation
- Multiplicity of qualitative and quantitative record formats
- Top-secret character
- Complexity of movement of military personnel between sites
- Millions of individual official military personnel files destroyed in St. Louis fire of 1973
- Military unit records and morning reports are missing for 1944-1946

Feasibility Assessment – An illustrative example

- Committee visit to Los Alamos, NM, yielded a highly relevant example of the effort required to search, identify, access, and synthesize hundreds of thousands of documents and records
- Los Alamos Historical Document Retrieval and Assessment (LAHDRA) Project
  - Objective was to identify all available information concerning past releases of radionucleotides and chemicals from Los Alamos National Laboratory and their possible public health effects, beginning with the Manhattan Project
  - 10-year, multimillion dollar effort
  - Involved more than 30 full-time researchers from a variety of fields, all of whom possessed security clearances
- Demonstrates massive, multimillion-dollar effort that needed to characterize relevant information for just one site, let alone all 6 that had a documented military presence.

Overall Conclusion Regarding Feasibility of an Epidemiologic Study

Overarching Conclusion 1: The committee considered several aspects of feasibility for conducting an epidemiologic study and concluded that such a study on the relationships between radiological and chemical exposures from Manhattan Project activities and health outcomes in veterans who worked on the project is not feasible. This conclusion is based on the following:

- *the incomplete availability of unit records and official military personnel files to create a full roster of individual veterans who served at the Manhattan Project sites of interest;*
- *the lack of systematically collected exposure information that can be linked to individual veterans; what information is available is limited to only some radiological exposures and no chemical exposures (except for accident reports which are high dose);*
- *the only systematically available health outcome is cause of death; and*
- *finally, other key elements, such as individual-level demographics and confounders, that would be needed to conduct an observational epidemiologic study are not available or severely limited.*

Alternative Study Design Considerations

- As committee concluded that an epidemiologic study as directed in PL 117-168 section 506 is not feasible, the final subtask of the statement of task requires that "the committee will explore possible alternative options for understanding the health effects on the veterans due to exposures from the Manhattan Project."
- Based on lack of complete exposure and health data, no type of study (epidemiologic or alternative design) could provide evidence of causal relationship between individual exposures and outcomes.
- Any research study would be expensive and resource intensive.
- A **mortality study** could be possible if a roster could be developed with sufficient personal identifier information.
  - Limited use in this context because of lack of adjustment for confounding and no adequately comparable reference population is available.
- While limited in comparison, a **risk assessment** could provide some approximate bounds on potential health outcomes for veterans of the Manhattan Project, even if there are large uncertainties.

Alternative Study Design – Risk Assessment

- In a risk assessment, exposure data at the **individual or group level** are combined with **known exposure-outcome relationships (**obtained from other data sources and contexts) to predict potential health impacts of the exposures.
  - A risk assessment is a “systematic approach to organizing and analyzing scientific knowledge and information for potentially hazardous activities or for substances that might pose risks under specified conditions.”
  - It draws on existing information regarding exposure–health outcome associations (e.g., risk models). A risk assessment does not rely on known or identified individuals and their exposure status and can be conducted for a specific or hypothetical population.
- Key elements of a risk assessment depend in part on its nature and scope.

Alternative Study Design – Risk Assessment

Overarching Conclusion 2: With careful consideration of the strengths and weaknesses of the exposure and health data, the committee ***concludes that a risk assessment could be conducted to estimate the potential health risks for Manhattan Project military veterans.***

This conclusion is not an indication or endorsement that a risk assessment should be undertaken, especially without careful weighing of how a risk assessment will be used and the resources required, which was beyond the committee's task.

Final Observations

- The committee's determination that an epidemiologic study is not feasible should not be taken as an indicator that the Manhattan Project did not have long-term adverse impacts on the many workers and surrounding communities or that long-term studies of such exposures on communities are impossible.
- It is likely, however, that fully understanding and remedying the health and environmental impacts of the many Manhattan Project exposures may require approaches that differ greatly from those of classical epidemiology.
- The sources described in this report that identify the veteran population and individual exposures and health outcomes, and information about the custodial organizations of those records and the general processes that would be required to access them, may also be of utility to other scientific or historic endeavors.
- The committee's experience with information gathering and substantial difficulties in engaging the appropriate offices or personnel for these information sources to understand the content and state of the many historical records—even with a congressional mandate—led it to find that obtaining records and extracting needed information from them would require substantial resources and interagency cooperation.

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