SURVEILLANCE OF FORMER CONSTRUCTION WORKERS AT OAK RIDGE RESERVATION:

A REVISED NEEDS ASSESSMENT*

December, 1997

Dr. Eula Bingham, P.I.
University of Cincinnati

*This revised needs assessment reflects and addresses comments from the NIOSH review of our original needs assessment, July, 1997.

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Principal Investigator Eula Bingham

1. Introduction - Need for Establishing Medical Evaluation and Notification

a. Medical Surveillance

Surveillance, or continuous vigilance of health status, is the ongoing, systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of the data to those who need it. In the occupational setting, the two distinct components of an effective surveillance program include monitoring of hazards in the workplace and monitoring of health effects in the workforce. To be effective, surveillance systems must be tailored to the specific disease or injury that is to be prevented. Linkage of data derived from health effects monitoring and hazard surveillance then defines areas for intervention. Effective surveillance must be directly linked to preventative action. Surveillance programs (secondary prevention) should be designed to support programs to control workplace hazards (primary prevention). Actions prompted by medical surveillance can be directed at workplace factors, at groups of workers, or as health interventions for an individual worker.

Historically, medical surveillance programs have most often been designed to protect the health of current workers in a certain industrial setting or experiencing a common exposure (Mintz, 1986). In this setting, "surveillance is essential to successful sustained public health intervention for the purposes of prevention" (Halperin, 1996). Data obtained through surveillance of the environment is used to establish quantitative levels of exposure, both day-to-day (average or real-time) and over time (cumulative), associated with specific industrial processes and work tasks, and with notation of the presence or absence of engineering controls and protective equipment. Data from ongoing environmental surveillance should drive interventions to reduce or eliminate exposures and ensure the use of protective devices. Sustained public health interventions for workers also are driven by medical surveillance data. These data are used to recognize new diseases caused by an exposure, and to advance the precision of quantitative risk assessment.

Medical surveillance activities justified by this needs assessment, however, are for former construction workers at DOE sites, and frequently are directed toward exposures incurred many years ago. With this cohort of workers, the concept of medical surveillance as a public health activity must put emphasis on different dimensions. Although the primary public health focus is still the need is to reduce the frequency of work related disease, the focus will be entirely on medical monitoring and risk communication, since the opportunity for hazard surveillance and workplace interventions for this cohort of workers no longer exist. Efforts of these surveillance programs can only be directed at the distal levels (biological monitoring, preclinical medical examination, diagnosis, therapy and rehabilitation) of the cascade of prevention described by Halperin. Data obtained through occupational histories and medical exams of former workers may be used to motivate interventions for current workers (hazardous waste cleanup at DOE sites or in energy related industry, or those exposed to specific hazards in other industries), but the primary goal of this medical surveillance program will be to direct interventions that will improve the health of individual construction workers.

Former construction workers at DOE sites experienced exposures to a wide variety of toxins as well as ionizing radiation, at levels that would place them in populations at *increased risk* or at *high risk* (Samuels, 1986). As former employees of subcontractors, they no longer have access to occupational medicine physicians at the workplace; primary care health providers often lack information on work-related disease leading to incomplete diagnoses of medical conditions in a timely fashion. Interventions of secondary prevention, which recognize disease at the preclinical stage, will decrease the rates of illness, disability or death related to workplace exposures. Specifically, the needs of these workers are to 1) develop an individual profile of past potential exposures, 2) identify disease at the pre-clinical stage (where possible), 3) diagnose clinical disease at an early stage, 4) assist the worker in identifying resources for further diagnosis and medical treatment, and 5) provide documentation necessary for obtaining compensation/benefits for work-related disease.

Individual occupational histories, linked to institutional histories, will be used to define potential exposures profiles for each worker. Tests of biological markers of exposure, where they are relevant many years post-exposure, will measure the more relevant internal exposure. Documentation of exposure profiles of individual workers will prevent unnecessary testing and reduce the volume of interventions necessitated by "false positive" test results. A graded response to medical surveillance is necessary to conserve valuable resources (Samuels, 1986) required to deliver a medical monitoring program to a target population of former DOE workers. Evaluation of potential exposure will determine selection of appropriate screening tests for individual workers.

This linkage of work history and institutional history will provide each worker a written record of all of their work-related activities and potential exposures. Primary health care providers frequently are unaware of a patient's exposure history, and patients frequently are unable to specify exposures during history taking. A written record of exposures may improve the accuracy of diagnosis and selection of appropriate medical therapy. A worker needs to know the risks associated with the level of his/her exposures, to make informed decisions about future participation on medical monitoring and to develop an awareness of sentinel symptoms for which he/she should seek medical attention (Bayer, 1986). Former workers need to be informed that future occupational activities or hobbies may increase levels of cumulative exposure to an agent where he/she already has achieved a level of increased risk (Millar, 1988).

Medical surveillance is most effective when the tests chosen have high specificity, reducing allocation of resources for repeat testing and communication of significance of "non-normal" test results. The screening test cannot be an end in itself, but should be a means to direct the worker to additional diagnostic testing and medical treatment, if needed. Workers are more likely to comply with post-screening recommendations if implications of test results are explained clearly. Workers also need assistance in identifying resources for tests and/or treatment.

b. History of Site, Oak Ridge Reservation

Until 1942, the area that is now the Oak Ridge Reservation was a relatively sparsely populated region dotted with family farms, and small communities. In early 1942, the Army Corps of Engineers would change the landscape, the lives of the region's residents, and the outcome of World War II when it bought 59,000 acres south of Black Oak Ridge and north of the Clinch River. Approximately 3,000 people had to sell their land to the government and vacate the area, without knowing the true reason the -government wanted the land. Even the vast majority of the thousands of people hired to build and operate the three secret government facilities did not know the purpose of their work.

The purpose, of course, was to create an atomic bomb. When it started to look like scientists in Chicago were making great headway toward a nuclear chain reaction, technology which could be used to create an atomic bomb capable of determining the outcome of the war, the army created the Manhattan Engineering District (MED). This organization was run by the Army Corps of Engineers, and was to manage the effort to produce the world's first atomic bomb. In addition to Oak Ridge, MED sites were also constructed at Hanford, Washington, and Los Alamos, New Mexico. The site in Tennessee was among those chosen because it met all of the army's requirements for a secret production facility: it was isolated, electricity was readily available from the Tennessee Valley Authority, and water was in full supply. Despite its isolation, the area's proximity to Knoxville and other major towns and small cities made transportation by highways and railroads possible, and provided a large work force.

The Oak Ridge Reservation was divided into four sections, and construction of each was underway in 1943 and 1944. The three secret facilities were K-25, built on the western edge of the site, Y-12, to the south, and the much smaller X-10, which was built about ten miles from Y-12, in the southwestern corner of the Reservation.

The town of Oak Ridge was built on the northern edge of the Reservation. Ten miles long and two miles wide, the town reached a peak population of 75,000 in its first two and a half years, which made it the fifth largest city in Tennessee. Life in Oak Ridge was unlike anything most of its residents had ever experienced before. During the war years, all residents, even children, had to wear identification badges and pass through guarded gates to enter or exit the town site. In dry weather the ever present dust coming off the dirt roads could virtually choke a person, while in wet weather the roads turned to mud, making transportation extremely difficult. The housing accommodations were far from luxurious -- most of the single workers were housed in trailers and dormitories, while workers with families had access to small cemesto houses.

K-25, also known as the Oak Ridge Gaseous Diffusion Plant, cost $500 million and required 12,000 workers to operate it. These production workers separated uranium-235 from uranium-238, using a gaseous diffusion process. The enormity of the wartime construction process is shown by the amount of materials and construction workers needed to construct the original buildings: 350,000 cubic yards of concrete, 40,000 tons of structural steel, 15,000 tons of sheet steel, and 5 million bricks. In 1945 the construction forces at K-25 reached a peak of 25,000 workers.

The main building at the K-25 plant was also named K-25. The U-shaped building, which covers 44 acres, was the largest building in the world under a single roof when it was built. The entire site would eventually consist of 5 massive process buildings (K-25, K-27, K-29, K-31, K-33), as well as approximately 70 auxiliary buildings, spread over 600 acres. The largest addition to the site came in 1954, with the building of K-33 by Maxon Construction Co. Ten years later, in 1964, K-25 and most of K-27 were shut down. In the 1970s, more of K-27 was shut down, and the entire cascade ceased operations in 1985. Since 1985, work at K-25 has consisted mainly of clean-up efforts and administration.

Y-12 was the first and only electromagnetic processing plant for the separation of uranium. The electromagnetic process involves the ionization of uranium particles in a mass spectrometer, at a velocity close to the speed of light. The process required the use of magnets 100 times larger than any ever made up to that point. The magnets used in the electromagnetic process were so large, and so strong, that workers found it difficult to walk through the plant because of the magnetic tug on the nails in their shoes, and workmen had to be given non-magnetic tools so they could keep hold of them. Copper normally would have been used for the magnets, but because it was so scarce during the war, Y-12 had to borrow 14,000 tons of silver from the U.S. Treasury, which was worth 400 million dollars.

The construction of Y-12 required 275,000 cubic yards of concrete, and almost 38 million board feet of lumber. The construction force reached its peak in 1945, with 13,000 workers. When completed, the original Y-12 plant had 170 buildings on 500 acres. Many more buildings were added during the 1950s, and several more have been constructed in recent decades, and of course some of the original wartime structures have been refurbished or replaced. Today Y-12 has approximately 300 major buildings, plus many small structures.

After the war, the electromagnetic process was discontinued, but Y-12 continued to have important functions. By the 1960s, Y-12 work included making nuclear weapons components, developing reactor fuels, and machining beryllium. Work done at Y-12 was essential to the defense industry during the cold war.

The X-10 site, now named Oak Ridge National Laboratory, is significantly smaller than both K-25 and Y-12. It was designed to be a pilot plant for the huge plutonium processing plant at the Hanford site in Eastern Washington state. The original facilities at X-10 consisted mainly of the Graphite Reactor and a radiochemical pilot plant. The Graphite Reactor, which was the first reactor in the world to produce plutonium, has been designated a national historic landmark because of it's significant role in the wartime effort to create the first atomic bomb.

The smaller scale of X-10 compared to the other two Oak Ridge sites is evident in the fact that its peak wartime construction force was only 3,247. The original X-10 plant had about 150 buildings, and today ORNL has about the same number, but only 17 of the current buildings date back to the war days. There was significant construction at the X-10 site in the 1950s, because the wartime buildings had been constructed on a temporary basis and were not suitable for long-term use. The fate of X-10, originally named Clinton Laboratories, was unsure after the war, but in 1949 the site was designated a national laboratory, and re-named Oak Ridge National Laboratory. The site then needed permanent buildings, so in 1949, a $20 million program of construction and improvement was begun. Later, in the 1960s, much work was done to make permanent structures that remained from the early 1940s.

Since the site became a national laboratory, a wide variety of scientific work has been performed at ORNL. Several types of experimental reactors have been designed, built, and tested at ORNL, biologists have used mice to study human health problems, and ecologists have looked for new ways to protect and clean up the environment, to name just a few of the programs at ORNL since the end of the Manhattan Project.

c. The Case for Surveillance of Building Trades Workers at Oak Ridge

Our project is limited to building and construction trade workers who have been employed mainly by Maintenance and Operations Contractors and their subcontractors at DOE sites. We begin by acknowledging that very little systematic information exists for Oak Ridge, which quantifies "biologically significant" exposures to toxic materials for construction workers. This is a well known problem across the DOE former weapons complex. As stated in *Hazards Ahead: Managing Cleanup Worker Health and Safety at the Nuclear Weapons Complex* (U.S. Congress, Office of Technology Assessment, 1993): "DOE and its contractors still have very limited ability to monitor worker exposure to toxic materials. This is true even for weapons production workers, whose exposures are technically and administratively much less difficult to track than those of cleanup workers." (Those same "administrative and technical" difficulties also apply to construction workers.) But we do not believe that Congress, in passing Section 3162, intended that DOE should withhold medical surveillance from workers on the grounds that their previous employers, in addition to not doing a good enough job in protecting their health, also did not do a good enough job in documenting their exposures.

NIOSH itself has established ample precedent for surveillance activities for "high risk" worker populations for which there was little or no quantification of worker exposures. [Examples from the 1980s include a bladder cancer intervention in Georgia, where it was assumed-- by virtue of having worked anywhere in the plant-- that workers had been exposed to sufficient levels of beta-napthylamine to warrant a fairly intrusive procedure; and a program in Port Allegheny, Pennsylvania, where all former workers in a plant where asbestos products had once been manufactured were offered asbestos medical exams, even if they had not been directly involved with that manufacturing process.] In fact, the NIOSH protocol for high risk notification does not require a quantification of the "biologically significant risk" to workers in order to trigger notification.

We have approached this project from the very beginning-- in our initial proposal for Phase 1 funding-- with the understanding that there is not good documentation of past exposures for construction workers. It is this lack of good documentation which makes our approach to medical surveillance necessary. Our protocol involves conducting a work and exposure history interview with the worker, which is then used as the basis for "triage" to determine what, if any, medical surveillance procedures are appropriate for that individual.

Building Trades Workers at DOE Sites

The building trades have a long history of concern for their members on DOE sites, and have been pushing DOE and Congress to see health monitoring programs created for these workers. Building and construction trades workers pose a number of unique challenges which cannot easily be addressed in general programs aimed mainly at permanent site production and management employees:

- According to DOE, it is likely that the greatest risks to workers on its sites involve mainly the construction workers, including those who are involved in decommissioning, dismantling of facilities, and in maintenance or repair activities (O'Toole, 1994).

- To the extent that historical construction exposures at Oak Ridge and other DOE sites differed from those of the non-DOE construction industry nationally, there is reason to believe that the DOE conditions may have been more dangerous: **"The Secretary of Energy has acknowledged that DOE and its predecessor agencies have historically embodied an institutional culture that valued weapons production over the protection of human health and the environment. Multiple expert and government reports have documented DOE's past inattention to occupational health and safety and to environmental protection. DOE's past failures in these realms have been pervasive and serious."** (U.S. Congress, Office of Technology Assessment, 1993)

- The fact that some construction workers at Oak Ridge may have experienced exposures to such atypical hazards (for construction workers) as mercury, beryllium, and ionizing radiation simply compounds the importance of medical surveillance for a population of workers for whom surveillance would have been warranted even if only based on the needs of construction workers generally.

- The buildings trades workers on DOE sites fall into two categories.

  The first consists of those with security clearances. They have tended to stay in mostly permanent employment at DOE sites, employed by the construction subcontractors.

  The second category consists of workers brought in temporarily and frequently for short periods of time to perform specific tasks. Many of them have repeat temporary employment at DOE sites, and may have been involved in similar civilian construction (e.g., nuclear power plants) or entirely different work between engagements on DOE sites, each of which may pose unique and serious health risks. It is, therefore, much harder to determine the risk for these workers, especially the risk attributable to work on a particular site.

- Because building trades workers were employed by many subcontractors, records of their employment histories on the sites may be virtually non-existent. Indeed, it has frequently been argued that DOE and its site M&O contractors sought to use subcontractor workers for the most dangerous tasks because they would not leave behind an easily traced paper trail.

- Building and construction trades workers are members of fifteen different unions which have traditionally operated autonomously and separately from the industrial workers on site with jurisdictional disputes over clean-up work creating a climate of conflict in recent years. Our consortium is in the unique position of being able to create programs that have the broad support of all the building trades unions who will be required to trace and notify the workers who have been employed in the past. For Oak Ridge Reservation, the Knoxville Building and Construction Trades Council represents the construction locals who worked at Oak Ridge and are involved with this program.

- Exposure data, even if available, does not generally cover incidents where construction workers "discover" contamination or are on-site during unplanned releases. For example, from interviewing carpenters we know of an instance where a flood of mercury actually carried tool boxes some distance. In another example, it has been reported that a number of workers experienced flu-like symptoms after shoveling "white stuff" from a building. It is likely that the material contained pigeon droppings. We have exposure (badge) data for one emergency response that included construction workers. However, due to re-use of badge numbers, we cannot assume that badge data will be traceable to all parties.

- The reality of a construction worker's role in building Oak Ridge is described in a history of the ORNL Chemical Technology Division, 1950-1994:

  Finding enough construction workers to build all the plants of the Clinton Engineer Works plus the town was a chronic problem in 1943. The construction fell behind schedule by several months because of the shortage of workers. Since part of the trouble was lack of living quarters close to the job, the Scarboro School was once again brought into use for a while as a barracks for workers. To recruit a labor force, John Fiser, at that time a Clinton Labs personnel officer, drove a bus through rural areas of Georgia, Alabama, Mississippi, and Tennessee, not only signing people up to work in Oak Ridge, but bringing them back with him in the bus as well (Jolley et al, 1994).

Construction Health Hazards at Oak Ridge

The situation with regard to past asbestos exposure is a good departure point for a discussion of construction health hazards at Oak Ridge, because it demonstrates both that construction workers at DOE facilities face the same hazards as other construction workers, and that DOE policies regarding construction subcontracting present unique challenges for medical surveillance. It is well recognized that there was substantial asbestos exposure in construction at Oak Ridge over the years, in pipe covering and other thermal insulation, in transite building materials, and in many other applications. (For documentation of the use of transite and other asbestos building materials, see: "ORNL Building Directory", Civil and Architectural Engineering Dept., 1989 and 1994; "ORGDP Building Directory", Civil and Architectural Engineering Dept., 1978 and 1989; "Inventory of ORNL Remedial Action Sites: Radwaste Facilities", July 31, 1996;and R.M. Tuft, ed., "K-25/K-27 Buildings Historical Characterization", Process Engineering Department, September 1992.) There is a substantial body of literature on the health outcomes for construction workers exposed to asbestos. If necessary, this literature would enable us to predict the outcome of medical surveillance for virtually every separate construction trade.

Rust Engineering was the M&O (Maintenance and Operations) contractor for construction at Oak Ridge from 1966 until 1990. In essence, this means that it was a direct contractor to the Department of Energy and its predecessors, rather than a subcontractor through the main M&O contractor. (This type of arrangement persisted at Oak Ridge with Rust's successor, MK-Ferguson, until 1996.) The Construction M&O contractors performed most construction work with "direct hire" employees on their own payrolls. Personnel records from Rust's 24-year tenure as Construction M&O contractor are stored at the Federal Records Center in Atlanta, Georgia. A preliminary check of a sample of these records revealed forty cases of asbestosis which were diagnosed in the 1980s. We believe that these forty cases in the initial sample indicate that we are likely to find many more cases, and they offer clear confirmation that asbestos exposures occurred which warrant medical surveillance now. Most cases involved pipefitters or sheet metal workers, but carpenters and laborers were also included. Certainly, in the absence of industrial hygiene data documenting exposure levels, the fact that the records document cases of asbestosis distributed across trades suggests that biologically significant asbestos exposures occurred-- significant enough to warrant medical surveillance now for workers with similar work histories.

The Peter Angelos Law Firm, a nationally known leader in litigation on behalf of asbestos-exposed construction workers, maintains a branch office in Knoxville, Tennessee. The firm offers free medical examinations related to asbestos exposure for construction workers with experience at Oak Ridge, and provides legal representation for those with positive findings. Members of our team (McDougall and Welch) have met with the lead attorney in the Angelos office to discuss the firm's experience in operating a monitoring program, and the possibility for cooperation between our team and the Angelos firm, in order to avoid duplicative testing for the effects of asbestos exposure in Phase II.

There is an unfortunate distinction between compliance with regulatory requirements and sensible occupational safety and health practice that is being played out currently at Oak Ridge. This is rooted in the requirement in the OSHA asbestos standards for medical surveillance, which says that an employer is only required to provide medical exams to a worker if that employer exposed the worker to asbestos on the job. In Oak Ridge substantial numbers of construction workers were exposed to asbestos in the 1960s, 70s, and 80s, but not by M-K Ferguson, the current major construction contractor, which arrived in 1990. These workers are not in any asbestos surveillance program. (Some construction workers have had potential asbestos exposure while employed by MK-Ferguson, such that the medical exam provision of the OSHA asbestos standard is triggered. These workers do receive medical examinations as outlined in the OSHA asbestos standard.) Even though the previous construction contractors, which were major employers during these years of asbestos exposure were, in a sense, proxies for the Department of Energy and its predecessors, no one is presently providing medical surveillance for these workers. In our view, <u>this is precisely the kind of situation that Congress intended to address with Section 3162</u>.

Similar arguments can be made for medical surveillance related to other occupational exposures which are known to be typical of the construction trades. For example, painters may present themselves with histories of daily exposure to mixed solvent vapors, extending over two decades or more. If such an exposure history warrants a neurological evaluation, based on the general needs of construction workers for medical surveillance, and the exposure occurred at Oak Ridge, the painter is entitled to medical surveillance pursuant to Section 3162.

2. <u>Size of Construction Workers Target Population (Since 1943)</u>

<u>Major construction contractors</u>

From 1990 until 1996, MK-Ferguson was the M&O contractor for construction activities at Oak Ridge. The largest number of construction activities during that time were performed by direct-hire employees of MK-Ferguson. This number of direct-hire construction workers employed by MK-Ferguson ranged from 240 to over 600 (Personal communication, M. Joyce, MK-Ferguson, 1997), and currently stands at 350. In 1996, MK-Ferguson was converted from being an M&O construction contractor to being a subcontractor to Lockheed-Martin Energy Systems. At about that time, the number of direct-hire construction workers began to diminish, and an increasing share of work was performed by subcontractors to M-K Ferguson. MK-Ferguson has been extremely cooperative in making available to us records of its direct hire employees as well as certified payroll records from its subcontractors. MK-Ferguson estimates that the total number of different individuals whom it has employed since its arrival in Oak Ridge in 1990 is over 1000 (Personal communication, M. Joyce, MK-Ferguson, 1997). With subcontractor employees, we estimate that the total number of construction workers employed at Oak Ridge since 1990 is approximately 2,000.

From 1966 to 1990, Rust Engineering was the M&O contractor for construction at Oak Ridge. During this time, the majority of construction work at the site was performed by direct-hire employees of Rust. With the help of MK-Ferguson, we have located and examined the Rust personnel records from this period, which are housed at the Federal Records Center in Atlanta, Georgia. While we have not yet completed an exhaustive, detailed review of these records, our work to date shows that approximately 7,000 different individuals worked for Rust during this period. Based on our ongoing analysis, we anticipate that these 7,000 individuals will be divided by occupation approximately as follows:

588	Carpenters
455	Ironworkers
1400	Electricians
294	Painters
189	Asbestos Workers/Insulators
1351	Pipefitters /Steamfitters
70	Cement Masons
861	Laborers
84	Bricklayers
140	Boilermakers
203	Mechanics/Millwrights
350	Operating Engineers
574	Sheet Metal Workers
98	Roofers
301	Truck Drivers

A copy of the log sheet our team is using to abstract necessary information from these records is found in Figure 1.This is offered as an indication of the quality and type of information available from this source for constructing the worker population for our outreach efforts. This record also demonstrates an employment pattern that was not atypical for a construction worker at Oak Ridge, with jobs measured in weeks, in months, and in years, and with gaps between jobs at Oak Ridge that also range from a few months to a few years. (This individual had four different periods of employment, adding up to about 17 years of experience at Oak Ridge, over a span of just over 23 years.)

From 1956 until 1966, H.K. Ferguson was the major construction contractor at Oak Ridge. Its work was also done primarily through direct-hire of construction workers. We have located records from this time period at the Oak Ridge Records Holding Center in Oak Ridge, Tennessee. We have not yet been able to access these records because of security requirements, but are hopeful that with DOE's help this problem will be resolved soon.

Maxon Construction was a major subcontractor on the site from 1949 to 1955, and constructed Buildings K-27, K-29, and K-33 at the K-25 Gaseous Diffusion Plant. Records from Maxon's tenure at Oak Ridge are also at the Oak Ridge Records Holding Center.

Figure 1: Log Sheet for Extracting Data from Federal Records Center

BOX NO.: 33 of 63

OAK RIDGE RECORDS

NAME: ______ SSN: ______

LATEST ADDRESS & DATE: BADGE NO.: ______

BOX

Caryville, TN 37714

RUST NO.: ______

MMES NO.: ______

PHONE: —

DATE: 9-28-90

WORK LOCATION: —

EMPLOYEE CLASSIFICATION: Laborer CODE: ______

DATE OF BIRTH: 10-14-34 SEX: M RACE: —

IN CASE OF ACCIDENT NOTIFY:

MRS.

S/A

RELATION: Wife

PHONE: ______

EMPLOYMENT HISTORY:

BEGIN DATE	END DATE	JOB TITLE	CODE
6-15-67	7-12-67	Laborer	
6-10-68	1-23-73	"	
5-14-73	1-9-76	"	
2-28-77	9-28-90	"	

ABSTRACTOR: Kelli DATE: 1-5-97

It is important to remember that there were also smaller subcontractors performing work at Oak Ridge over the years. In another project, funded by NIOSH, the members of this team from the University of Cincinnati and the UBC Health & Safety Fund have identified several subcontractors based on interviews with a relatively small number of carpenters. These contractors typically got their employees from the same labor pool by using union hiring halls or lists (Personal communication, L. Hobson, Charles Hobson Construction, 1997). Given that carpenters and millwrights (also members of the UBC) constituted only 10-15% of the construction workforce over the years, the number of subcontractors from all trades was probably in the hundreds, and the number of construction workers-- beyond those who were direct-hires to the large contractors-- in the thousands. The best hope for identifying them may be through pension funds of the individual trade unions. (Typically, the record from which an individual's eligibility for pension benefits is determined lists the contractors which submitted pension contributions on that individual's behalf, and the time periods covered by those contributions.) This will be one of the avenues of outreach which we plan to pursue in Phase II to find construction workers who may be eligible for medical surveillance but do not show up on the documentation in archived materials available to us.

The early construction workforces at the Oak Ridge facilities during World War II were very large. From historical accounts, we know that the construction workforce at the K-25 plant reached 25,000, and that the peak construction workforce at Y-12 numbered approximately 13,200. X-10, now the Oak Ridge National Laboratory, had a peak wartime construction workforce of 3,247. (*AEC Handbook on Oak Ridge Operations*, 1964, pages 13, 15, and 19) Accounting for turnover, a conservative estimate of the total number of construction workers who passed through Oak Ridge during World War II would be 50,000.

It is assumed that the vast majority of these original construction workers were beyond draft age at the time they helped build Oak Ridge. That means that they were at least 30 to 35 years old in 1943-44. So by the time they can be reached with a "3162" medical surveillance program, the youngest of the WWII construction workforce will be around 85 years old, and the average age is likely to be over 90. These original construction workers would, of course, be eligible for the 3162 medical surveillance program, and should definitely be afforded the opportunity if they come forward as a result of the outreach efforts planned by our team as part of Phase 2. However, most are presumed to have died, and those who are still alive are expected to be difficult to find and unlikely to avail themselves of the medical surveillance program if we do find them. For planning purposes, we can expect fewer than 1,000 WWII construction workers from Oak Ridge to take advantage of a 3162 medical surveillance program.

Summary Discussion of Target Population

The target population for this Phase I needs assessment can be viewed in two ways:

1. The totality of individuals who ever worked construction at Oak Ridge; and

2. The subgroup of that overall population which can reasonably be reached with information about the 3162 medical surveillance program.

Employment estimates-- extrapolated from Rust records:

The Rust records give us the best basis for estimating the target population. They cover nearly half the history of Oak Ridge. From them we can generate a rough statistic that for every year of operation, there are approximately 300 construction workers in the target population. (This assumes that once the initial construction was completed, peaks and valleys in construction employment were about the same as during the 24 Rust years. This technique may produce a somewhat low estimate because there was apparently fairly heavy construction employment in the 1950s.) This figure of about 300 workers added for every year of operation is consistent also with the information we have from MK-Ferguson for its employment in the 1990s. Using this figure for extrapolating to periods where we have relatively little information about employment figures, we can estimate the total historic employment of construction workers at Oak Ridge as follows:

Totality of Individuals Who Worked at Oak Ridge-- Estimates

1943-45	Peak 41,447 (per AEC report) plus turnover	50,000
1946-55	Extrapolate from Rust data from 1966-90	3,000
1956-66	H.K. Ferguson era (extrapolate from Rust)	3,000
1966-90	Rust Engineering	7,000
1990-97	MK-Ferguson and subs	2,000
Subs, end of WWII to 1990, est. at 25% of direct hire workforce		3,000
Total	(round estimate)	70,000

As we have described above, the totality of individuals who ever worked construction at Oak Ridge appears to be approximately 70,000. If it were feasible, and important to the purposes of Section 3162, we could probably-- with time and money-- develop a more precise estimate. But it is not important to DOE's or Congress' goals for this program to do so, because what we are really interested in is the subgroup which may be reasonably reached. That subgroup is substantially smaller than the overall population.

The 7,000 individuals whose records reside in the Federal Records Center in Atlanta constitute the core of the subgroup. We know that at the time Rust came on the scene some of these people already had several years of experience at the site, so their tenure (for some) dates back to the 1950s. We also know that many workers whose records are included in the 7,000 stayed at the site when MK-Ferguson took over from Rust in 1990. So a significant percentage of the target population members who are, or have been, employees of MK-Ferguson or its subcontractors, are also captured within the 7,000 Rust records in Atlanta. Because of the time frame covered by the Atlanta records, we also believe that these will be the most likely members of the target population to actually avail themselves of the Section 3162 medical surveillance program. The current age distribution of these 7,000 workers is:

19%	over 80
28%	66 to 80
53%	65 and under

If we take 1956 (the beginning of the H. K. Ferguson era) as the beginning of the time on which we should realistically focus, then, as shown in the table above, the probable target population is approximately 12,000 direct hire construction workers.

Numbers of construction workers employed by subcontractors are harder to estimate. At most times during the operation of the Oak Ridge site, subcontractor employees were small in number compared to those directly hired by the major construction contractors. However, due to the nature of their employment relationships-- they were released and returned to the union hiring hall or list whenever a job was finished-- turnover was much higher. We estimate that these subcontractor employees add 25%, or 3,000 subcontractor workers, to the population that realistically may be reachable.

We therefore estimate the number of construction workers who have worked at Oak Ridge since about 1956, at 15,000.

Of course, the number who can be reached and who then are likely to avail themselves of the medical surveillance is significantly smaller. For one thing, many of these workers are deceased. Assuming that the H.K. Ferguson workforce (1956-66) was similar to the Rust workforce, then about half of them would be over 80 years old. Research by a member of our team has shown that a former worker's likelihood of participating in a medical surveillance program is related to various factors measuring social contacts and communications and transportation options (Houts, and McDougall, 1988). Also, from the other (NIOSH funded) study by the University of Cincinnati and the UBC Health & Safety fund, we know that a very high percentage of addresses and telephone numbers for the target population are no longer accurate. So, while significant efforts will be made in Phase II to locate these individuals, and to fashion other outreach tools to notify them through the public media of this program, a substantial portion are likely to be lost to follow-up..

With the foregoing considerations, we expect for planning purposes that, after accounting for those who are deceased, those otherwise "lost to follow-up," and those who decline to participate, approximately one-third of the 15,000 target population may eventually be reached and take advantage of the medical surveillance program, and that these will be augmented by approximately 1,000 who worked at Oak Ridge in the 1940s and early 1950s. This means <u>a total of 6,000 construction workers are likely to be served.</u>

<u>Preparing a List of Construction Workers at the Oak Ridge Reservation</u>

Developing a list of actual workers' names with current addresses and dates of employment to go along with the numbers discussed above is a challenge! In the past the Department of Energy did not keep lists of construction employees hired through a construction contractor. While many workers received security clearances, it has been reported to us that sometimes a truckload of construction workers came on site with the crew leader having the only security clearance. Turnover was high, similar to some of the production plants (e.g., K-25 where 44% of the cohort for one epidemiology study worked one year or less. See CEDR ORK25A02).

Development of a list of former construction workers can be approached in two basic and complementary ways:

1. Develop a list of workers' names through construction contractor employment records, union records, e.g. dispatch cards, membership lists, pension records, and data tapes of records from DOE or its contractors.
2. Use traditional Outreach techniques (Tillet, Ringen, Schulte) to contact workers not on the lists described above, using radio, television, newspapers, union magazines, internet, retirees' social events, etc.

Development of an Initial List

Even with the lists of workers from sources described above, social security numbers, current addresses or other critical information may not be available. Union records at Locals are a source of names and addresses for current workers, but access to these lists is frequently limited. Union and Welfare Benefit Funds can be used as the source of certain information but it is usually necessary to have the person's name or social security number to access information. Even then, the Trustees must agree and appropriate financial arrangements must be made because these Funds have a specific purpose, i.e. administering the health, welfare, and pension funds.

One of the potentially useful sources for current addresses is union newsletters or magazine mailing lists. These are sometimes at the state level, but are mostly at the international union's office.

At many local union offices there are rolodex files of members, dispatch cards, or other similar files. With the cooperation of the various building trades' locals these sources will provide a list of construction workers for that trade. The addresses may or may not be accurate and the workers may or may not have worked at the site. The results of using such sources of information are described below and were developed during a NIOSH funded grant titled "Work Histories -- Evaluating New Participatory Methods" (Grant # R01CCR512026).

Our experience with this NIOSH-funded grant on developing participatory methodologies for work histories among carpenters indicates that developing as many sources of information as possible is important, and then great deal of sorting and checking is required to verify information. For example we developed a list of over 800 carpenters who had reportedly worked at the Oak Ridge Reservation. We attempted to test the validity of the list by sending a joint letter from the United Brotherhood of Carpenters (UBC)/University of Cincinnati (UC) to each of the 800 carpenters. We had developed this list from construction contractor records, union records, and tapes of construction worker records (Donna Cragle, ORISE). The UBC/UC newsletter was sent first class mail with the assurance that those with improper addresses would be returned - about 20 were returned. We naively assumed that the newsletter had been received by 780 carpenters.

We proceeded to send the first questionnaires out with a letter requesting participation in the study. The results are shown in Table 1. We concluded that either few carpenters wanted to participate, or we had many wrong addresses and the post office only returned to us a portion of the undeliverable questionnaires.

We then sent out a first class double post card with questions as to whether the individual had worked at Oak Ridge and whether he or she needed a questionnaire. The results of this test were revealing, as shown in Table 2. First, half (379/750) never responded, either because of "mail overload," or again we had incorrect addresses and the post office did not return the mail. Of the cards that were returned because of incorrect addresses, we were able to look up 58% (116/200) on the World Wide Web telephone directories and resend them. A large percentage, 31% (53/171) of final respondents never worked at the Oak Ridge site. We track information sources on a database constructed at U.C. so we can take information from the most accurate list(s).

We have learned several lessons that will help us as we develop lists of former construction workers to use in a surveillance program:

- Check the addresses with the World Wide Web and CD-Rom phone and address databases.
- Use a "tear-off" postcard with a few questions as a source of first information.
- Plan for follow-up telephone calls.

Of those initially listed who responded, 79, or 11% (79/750), had worked at Oak ridge and agreed to participate. Seventy-five had been interviewed by June 1997. As shown in Table 3, participants tended to have worked many years at the Reservation. Thirteen percent reported working less than five years, while 51% reported 20 or more years of employment. We believe that workers with 20 years of work are most likely to be interested in a medical surveillance program.

Another very useful source of information for compiling workers' names has been a data tape given to us by ORISE. This database was originally developed from personnel records of Tennessee Eastman Corporation, K-25, Y-12, X-10, and Rust Construction, which were used for an epidemiological study. Examination of this database has provided us with important information for estimating numbers of workers at risk. There are listings for the Rust workers and included among these lists are building trades, i.e. electricians, millwrights, carpenters, etc. (see Table 4). One of the files on the database has vital status information, which revealed that 20% of the workers were dead as of 10/21/93, the last time it was updated. The number currently dead is likely to be 25% or greater. On this particular data set about 85% of the hires were between 1960 and 1979. This would indicate that a large percentage of these workers would be in their late 50s, 60s, and 70s.

A sample of the data available from Rust Contractor Records available at the Atlanta Records Center, discussed in some detail above, has been reviewed. A sample log sheet used for reviewing the records was presented above in Figure 1. The profile of trades is shown in Table 5 for 2,044 construction trade employees. The distribution of crafts is similar to those described by the ORISE/Cragle data file (Table 4). Analysis of the first 2,044 records indicates that 552 construction workers were employed by Rust for greater than 5 years. Another 1,492 workers worked less than five years according to these records. However, a check of current and recently retired carpenters' records that we have compiled for the NIOSH-funded study reveals that several carpenters who are recorded on the Atlanta Records List as <5 years actually continued to work off and on for M. K. Ferguson, and when we interviewed the workers they gave us additional work periods. This means that workers listed as <5 years have to be contacted to ascertain whether we should proceed with a worker history interview and possible medical examinations. As mentioned above, approximately 19% of the population is over 80 years old. While we do not have up-to-date vital statistics, we expect more than 25% to be dead.

<u>Outreach to Augment Lists of Workers</u>

The second method of reaching former workers will be through outreach techniques described above, i.e. through a local office that will coordinate radio, newspaper, etc. announcements, an 800 number and an office with a person in the community who will work with the local advisory committee to reach workers and retirees.

Even extensive outreach approaches among Oak Ridge former employees may not result in high participation. For example, in the Y-12 Beryllium Worker Enhanced Medical Surveillance Program, a participation rate of less than 50% was achieved with widespread publicity and vigorous contact methods (personal communication, K. Rosenman, 1996).

Table 1: Returns (n=115) from Mailing 800 Initial Questionnaires - Oak Ridge Carpenters Study

	Number
Undeliverable	18
Never Worked at Oak Ridge	32
Death	7
Refused	2
Usable	56

Table 2: Results of Postcard Survey of Carpenters on Initial List C Oak Ridge

Postcards sent		750
Postcards with incorrect addresses returned by post office		200
Found on WWW & resent		116
Postcards returned by neither post office or intended recipient		379
Postcards returned		171
Deaths	30	
Never at Oak Ridge	49	
Refusals	7	
Needed a Questionnaire*	61	
Other	10	

Table 3: Number and Percent of Carpenters Working For Various Time Periods : Results of Oak Ridge Carpenter Interviews Through June 1997

Years	Number (and Percent) of Years Worked
<1-5	10 (13)
5-10	4 (5)
10-20	18 (24)
>20	38 (51)
don't know	5 (7)
Total	75 (100)

Table 4: Number and Percent of Job Titles Listed for 2,415 Workers in the Rust Construction-Oak Ridge File (obtained from ORISE/ Donna Cragle)

Job Title	Number	Percentage
asbestos worker	57	2
boilermaker	49	2
brick mason	26	1
carpenter	211	9
cement finisher	29	1
electrician	458	19
ironworker	130	5
engineer	117	5
laborer	326	14
mechanic	17	1
millwright	44	2
oiler	6	<1
operating engineer	101	4
painter	78	3
pipe fitter	39	2
plumber	10	<1
rod man	21	1
roofer	15	1
sheet metal worker	193	8
steam fitter	419	17
truck driver	69	3

Table 5: Data from 2044/7000 Employee Records (Rust) from Federal Records Center

Employee Classification/Job Title	%	Employee Classification/Job Title	%
Asbestos Worker	1.5%	Mechanic	1.3%
Boilermaker	2.0%	Millwright	1.6%
Brick Mason	1.2%	Operating Engineer	5.0%
Carpenter	8.4%	Painter	4.2%
Cement Finisher	1.0%	Pipe fitter	5.0%
Electrician	20.0%	Roofer	1.4%
Insulator	1.2%	Sheet metal Worker	8.2%
Ironworker	6.5%	Steam fitter (incl. Sprinkler fitter)	14.3%
Laborer	12.3%	Truck Driver	4.3%

Crafts at less than 1%:

- Groundman
- Inspector
- Plumber
- Warehouse

3. Specific Hazards and Degree of Potential Exposures/Institutional History Books (X-10, K-25, Y-12 sites)

a. Sources of Information

Databases of pertinent historical information about each Plant (K-25, Y-12, X-10/ORNL) have been created, using a variety of sources to determine when buildings were built, renovated, added to, or torn down; what processes went on in each building, including descriptions of the process, start and stop dates, and decommissioning of buildings; incidents, accidents, spills, and leaks in particular buildings, including the date of occurrence, type of hazard, and extent of contamination; and physical descriptions of buildings, including construction materials and distinguishing features. These databases have been printed and bound, and act as important references for building information.

In order to determine the functional history of the buildings and land at each of the three Oak Ridge Reservation sites, several research avenues were explored. These included looking at declassified documents, publications meant for public distribution that were created at Oak Ridge, photographs of the sites, Department of Energy documents available on the World Wide Web, maps and building lists from Martin Marietta, and the research of other companies and organizations working on related studies of the Reservation.

Much of the most useful information was found at the Oak Ridge Public Reading Room, which houses all documents pertaining to the Reservation that have been declassified according to the Freedom of Information Act. Many of the documents were declassified at the request of the Tennessee Department of Health, and later, ChemRisk, each of whom is working on epidemiological studies of the Reservation. Their efforts provided us with a large selection of documents pertaining to the three sites. In addition to indirectly providing a wealth of declassified documents, ChemRisk and the Tennessee Department of Health aided this research through their detailed progress reports, which include a great deal of information about processes within buildings (especially at K-25 and Y-12), and potential hazards relating to them.

Publications from various departments at each site and from the Department of Energy were also very useful. Several departments have written their own histories and analyses of potential hazards. Departments at ORNL, in particular, have used major anniversaries of the lab as an opportunity to recount their past accomplishments. In addition, ORNL has published a journal (ORNL *Review*) since 1963, which includes a yearly feature, "State of the Laboratory" which recounts major developments over the past year. The World Wide Web provided direct access to numerous Department of Energy documents related to the three sites, particularly K-25, as well as a database of documents available at DOE sites throughout the country.

Photographs of the three sites have been made available through the DOE photography department in Oak Ridge. These include many aerial photos from different periods that correspond well to building maps and aided in determining how close buildings are or were to possibly contaminated sites. Some photos of building interiors, construction sites, and processes were also accessible through this department, and were used both for the institutional histories and as memory triggers for initial interviews.

The Y-12 and K-25 sites have undergone growth, but their primary functions have changed relatively little over the past 50+ years. Detailed maps and building lists from several years between 1947 and 1995 clearly revealed areas where there has been growth and change. In addition, several sources are available with detailed descriptions of processes within most of the major buildings, as well as hazard evaluations for these major buildings. A particularly useful resource for K-25 has been the report of its Environmental Restoration Program, which is available on the World Wide Web. This report consists of descriptions of each building at the site, including processes, waste practices, history, and potential environmental hazards. Many hazards evaluations of beryllium and mercury have been done internally for Y-12 over the years, and many of these give detailed data about individual buildings. This data has been organized in a Microsoft Access database which shows initial construction date, use, and possible exposures during and after construction for the buildings at K-25 and Y-12. Information about the smaller buildings at each site, which have been largely ignored by previous evaluations, has also been compiled and added to the database.

Facilities at X-10 have undergone a significant number of changes in function through their history due to being a national laboratory designed for research, rather than production, and there has been relatively more new construction at X-10 than at Y-12 and K-25. Along with these rather frequent functional changes, there have been changes in the building numbering system. This presented a unique challenge in constructing a history of the site: each building had to be traced through previous numbering systems and departments housed in it before potential exposure hazards could be determined. This was facilitated by the availability of several old maps of the site and old lists of then current buildings, ranging from 1947 to 1995, which generally give the name or use of the building. Some also include information about the department in charge, what type of materials each building is constructed of, and the original construction date.

In addition, we have collaborated with Dr. Steven Wing and Ms. Suzanne Wolf at the University of North Carolina (Chapel Hill) to access information abstracted by them for other DOE-supported studies. For example, the "Old HEXFILE" was obtained from UNC.

Sample excerpts from these institutional histories are attached as Appendix A. Complete copies of these reports are available from Dr. Eula Bingham, Environmental Health Department, University of Cincinnati, Cincinnati, Ohio, 45267-0056.

Our research at Oak Ridge has been facilitated by the fact that ChemRisk went before us and requested declassification of many pertinent documents, which are readily available at the Public Reading Room. Section 5d includes detailed lists of important sources, both in the traditional printed form, and in the form of helpful people, organizations, and collections, that have been used to determine potential hazards and the institutional history of each part of the Reservation.

b. Data Still to be Reviewed

Several important sources are still being integrated into the Institutional History data base. Exposures to production workers have been measured and will be reviewed to document areas where construction workers would have received "bystander exposure." Other data, not part of CEDR, have been identified by NIOSH and we will collaborate with them to extend this documentation to previously uncomputerized sources. Any film badge data for construction will be accessed through the DOE.

c. Potential Exposures at Critical Times

Exposures to non-radiological health hazards arising from production processes at the Oak Ridge plants may have important health implications for the target populations of construction workers. Yet, as far as can be determined, there was never-- at least until 1990-- any industrial hygiene monitoring consideration given to exposures of construction workers to non-radiological hazards arising out of production processes in buildings where they were working. This is precisely why the University of Cincinnati team members have spent so much time and effort during Phase 1 in reconstructing the processes and materials present in major buildings at the site over time. Examples of these reconstruction efforts are included in the appendix.

Our strategy, which will be laid out more fully in our Phase II proposal, is that in the initial interview process we will gather information from former workers about what buildings they worked in at what times. This information can then be linked to what we already know about the exposures in certain buildings to trigger an alert regarding possible past exposure to important health hazards from manufacturing processes. (This category of exposure information will complement the information we glean about occupational exposures arising directly from construction activities.) This approach of linking worker interview information about having worked in a particular building at a particular time, with information that our team has developed about the processes or chemicals present there at that time, is important because the construction worker himself may well have not known at the time what manufacturing exposures were present.

We do know that construction workers have experienced important exposures to process chemicals that may have important health implications. The most vivid examples relate to mercury. While little industrial hygiene data appears to have survived from contractors on site previous to 1990, there is a plethora of anecdotal information from construction workers about their experiences in the Mercury Building and related buildings at the Y-12 Plant at Oak Ridge. These anecdotes range from those where construction workers encountered large quantities of liquid mercury which contaminated their skin, clothing, and tools, to accounts of pipefitters welding on process piping contaminated with mercury, thereby presumably volatilizing the mercury and making it readily available for inhalation. While one such story might be dismissed by a reader as an interesting, but isolated case, our closer involvement with members of the target population has convinced us that exposures to mercury were significant in their intensity, in the frequency with which they occurred, and in the numbers of construction workers (especially pipefitters) who experienced these exposures. In the 1990s, during cleanup activities in the Mercury Building at Y-12, there has been systematic environmental monitoring, although, in our understanding, this has tended to be primarily area sampling rather than personal dosimetry.

Information about construction worker exposures to manufacturing process hazards is a complement to the information about direct exposures resulting from the construction activities in which our target population engaged. Those direct exposures from construction processes are likely, in most individual cases, to be the primary drivers for triggering medical surveillance. The exposures to industrial process hazards are most often going to be used to determine that additional specific tests are warranted, once a decision is made that surveillance is appropriate for an individual.

The traditional occupational history is a listing of employer, job titles, dates, duties, and materials/exposures. This approach is used by researchers conducting epidemiological studies and by physicians trained to elicit information about occupation as part of the medical examination. Generally, the listing of jobs is restricted to those lasting a minimum duration. For research purposes, the standard set of questions may be supplemented by probes to prompt recall of specific activities. These provide additional information on which to later evaluate the importance of specific exposures, and have provided information to associate many exposures with disease outcomes. This is especially true of persons who have worked in manufacturing or who have performed relatively predictable cycles of activity.

Construction work provides several marked contrasts to manufacturing or other cyclical work schedules. For example, duration of a task/assignment is linked to project size; tasks conducted nearby are scheduled and controlled by other subcontractors; enclosures/obstructions and meteorological conditions affect exposure; and work locations change frequently. Accurate recall of all of the work sites and exposures may be very difficult. Moreover, the documented importance of bystander exposures during construction activities is something of which construction workers may not be fully aware. Because few exposure measurements exist for these types of occupations, the completeness of qualitative data is an important issue in conducting research-- or, in this case, medical surveillance planning.

In the 1970s, Dr. Irving Selikoff provided pioneering insights into the important components of work histories for construction workers and bystanders. Through his work with drywall tapers and spacklers, he illustrated the need to identify key tasks which presented hazards of exposure to asbestos. He then used the duration between the first and last years of performing these tasks in the trades as a surrogate for exposure. In his work in shipyards, Dr. Selikoff showed that the environment where a task is conducted may contribute importantly to a later health outcome. Welders reported working alongside insulators; accountants reported working with their windows open to the yard, and "dusting off papers" depending upon weather conditions. Some employees with these job titles and with no history of work in the yard presented with evidence of asbestos scarring in the lungs (Selikoff and Hammond, 1978). While the welders may have known that asbestos insulation was being torn out, it is possible that an accountant would have no knowledge of the potential for a hazard in the dust coming through the window. These examples illustrate the need to know where the work was conducted (the production building or area) as well as what a worker did. In some instances the worker will be able to identify the potentially hazardous exposure, but reliance on the worker's knowledge alone, especially in consideration of the security precautions that were in place at the time of potential exposure, may result in missing important information. Hence there is a need to document where the work was conducted as well as what was the nature of the work activity itself.

Epidemiological Studies

Epidemiological studies and qualitative exposure evaluations are available to assist in identifying potential exposures. When linked with the Institutional History, these sources provide a useful compendium with which to help construction workers characterize risks.

Plant or process-specific and reservation-wide cohort mortality studies have been conducted at Oak Ridge. Among K-25 employees, excess mortality has been shown among production workers, including statistically significant excess risks of malignant and non-malignant respiratory diseases and bone cancer (unpublished data, see CEDR ORK25A02). Among K-25 personnel exposed to nickel powder in the manufacture of the barrier material, there was no increased mortality; however non-statistically significant mortality due to cancers of the buccal cavity, pharynx and digestive system was observed in nickel workers compared with those not exposed (Cragle et al., 1984). Reservation-wide evaluation of the mortality of welders showed no increase in SMRs for lung cancer and diseases of the respiratory system among those employed at K-25 and presumably exposed to nickel compared with employees at other plants on the Reservation (Polednak, 1981). An update (Watkins et al, 1993) provided evidence of increased risk of lung cancer and prostate cancer, although neither increase appeared to be related to surrogates of nickel exposure, e.g., duration. Evaluation of mortality among X-10 employees (Elghany, 1983; Checkoway et al, 1985; Wing et al., 1991; Wing et al, 1993) indicates an association between cancer mortality and external radiation dose. Excess mortality due to cancer of the lung, brain, and central nervous system has been shown among Y-12 production workers (Checkoway et al, 1988); exposure-response relations were also detected for lung cancer and alpha and gamma radiation dose. White males exposed to mercury were not found to have excess deaths from diseases of the liver and kidney, central nervous system (Cragle et al., 1984); however, there was suggestion of an association between mercury exposure and brain cancer. An excess in lung cancer was not related to intensity or length of exposure in the mercury-exposed cohort study (Cragle et al, 1984). Lung cancer excesses have been noted among Y-12 chemical workers hired at age 45 or later (Polednak and Frome, 1981); more recent analyses show an excess of lung, brain, lymphopoietic, pancreas, prostate and kidney cancer among men and breast cancer among women (Loomis and Wolf, 1996). No statistically significant effects of phosgene exposure at Y-12 on mortality have been identified (Polednak, 1980;

Polednak and Hollis, 1985). Among 106 workers with acute exposures to phosgene, 24% had been diagnosed with pneumonitis; surprisingly, none of this group had died of lung cancer after 33-35 years of follow up. In a case control study of brain cancer among workers at Y-12 and X-10, an increased risk was seen for workers in an intermediate internal lung dose group, not in a dose-response relationship, or in relation to external radiation (Carpenter et al., 1987). Excess mortality primarily due to lung cancer and diseases of the respiratory system has been shown among white males employed at least one month at any of the three Oak Ridge plants (Frome et al, 1990).

While some studies of the effects of specific processes and exposures have been completed at the Oak Ridge Reservation, mortality is the endpoint usually reported. Exposures at each of the Oak Ridge plants could be associated with morbidity, which might not be a cause of death and hence be missed in studies limited to causes of death. For example, nickel is associated with skin disease, which would not be fatal. Not all cancer hazards at the Reservation are from radiation. Known or suspected non-radiation lung carcinogens used at Y-12 include asbestos, beryllium and machining fluids. Brain cancer has been associated with solvents and metal machining operations such as those conducted at Y-12 and among maintenance personnel throughout the Reservation.

Data from the Y-12 Beryllium Worker Enhanced Medical Surveillance Program, funded by DOE, indicated that there were 18 diagnosed cases of chronic beryllium disease, and 70 sensitized workers. The buildings in which these workers reported working included: 9201-5, 9201-5N, 9201-5E, 9201-5W, 9202, Butler Building, 9204-Beta, 9204-2, 9204-4, 9206, 9212, 9766, 9995, and 9998.

<u>Summary of Qualitative Estimates of Exposure</u>
As discussed above, the types of exposures to any potential hazard among construction workers is very dependent upon their trade *and* where they worked at the Reservation. For example, machinists would likely be exposed to a variety of machining fluids, while painters would not; however, painters are likely to conduct abrasive blasting as part of surface preparation, with possible exposure to silica, the pigments in the removed surface coatings and particulate from the underlying substrate (e.g., silica in cement, or asbestos in transite). We have collected a substantial amount of information on the types of exposures at the Oak Ridge Reservation through review of the literature and discussions with carpenters. However, a useful compendium of information on the types of exposures, by trade, in the early years of the Hanford operations has also been reviewed. A summary of the contents of the HEXFILE, referred to as the "old Hex file" is shown in Table 6. Asbestos is a common exposure among the crafts. The hazard rating score is a subjective ranking apparently assigned by those who developed the file. Values range from 0 (little or no hazard or potential for exposure) to 10 (highest value). It is likely that the range of values from the HEXFILE will be similar at Oak Ridge. These data are also valuable in creating an initial profile of activities for each craft at Oak Ridge, for review by Union leaders.

The materials listed in the HEXFILE are direct exposures due to working with the substance listed. In addition, construction workers may be exposed to airborne and surface contamination related to the processes in areas where they come to provide the skills of their trade. For example, at Oak Ridge, we anticipate that construction tradesmen assigned to areas where beryllium was machined will have been exposed to the metal. We have no information on the extent of exposure to these non-radiological hazards among construction workers. Early in Phase II, we will attempt to access the "new Hex file" and also consult with NIOSH researchers and our colleagues at the University of North Carolina to gain a better understanding of the exposure intensity data. Anecdotes from the workers interviewed will be important additions to this effort, as their experience could be very different from that reflected in exposure measurements collected among production workers. Thus we view the information on extent of exposure to be a continuously-evolving qualitative data base.

Table 6: Exposures rated on a scale of 1 to 10 for various crafts at the Hanford Site

Craft	Potential Exposure	Hazard Rating
Asbestos Worker	asbestos	1 - 10 cement 1 - 5
	fiberglass	1
	heat	1-6
	mineral wool	1
	noise	1-7
Carpenter	acetic acid fumes	1
	asbestos	1 - 3
	fabricating PVC/other plastics	1
	wood dust	0 - 3
	noise	1-3
	plexiglass cement	1
Cement masons	cement dust	1
	epoxy resins	1 - 2
	noise	1 - 3
Boilermakers	acetone	1
	aluminum	1
	asphalt	1
	asbestos	1 - 4
	bronzes	1
	carbon steel fumes	1
	carbon tetrachloride	1 - 7
	cast iron	1
	cement	1
	fly ash/soot	1
	heat	1 - 10
	inconel	1
	metal shavings	1
	stainless steel dust/fumes	1 - 3
	methyl ethyl ketone	1
	nickel	1
	noise	1 - 5
	perchloroethylene	1
	stoddard solvent	1
	titanium fumes	1

	trichloroethylene	1 - 3
	vanadium	1
	welding fumes	1 - 4
Electricians	acetone	1
	aerosol varnish	1
	aluminum	1
	asphalt	1
	asbestos	1 - 3
	carbon steel fumes	1
	copper	1
	cleaners/freons	1
	galvanized metals	1
	solder	1 - 2
	heat	1 - 6
	lead	1
	metal shavings	1
	noise	1 - 5
	perchloroethylene	1
	stainless steel fumes	1
	stoddard solvent	1
	trichloroethylene	1
Heavy equipment	kerosene	1
Ironworkers	aluminum	1
	carbon steel fumes	1
	heat	1 - 10
	metal shavings	1
	naphtha	1
	noise	1 - 6
	perchloroethylene	1
	stainless steel fumes	1
	stoddard solvent	1
	welding fumes	1
Machinist	acetone	1
	aluminum	1
	beryllium	0 - 1
	carbon steel fumes	1
	copper	1
	metal fumes	1
	nickel	1

	cutting fluids	1
	stainless steel fumes	1
	stoddard solvent	1
	titanium fumes	1
	trichloroethylene	1
Millwrights	acetone	1
	aerosol spray cleaners	1
	aluminum	1
	carbon steel fumes	1
	cement dust	1
	machinery grout	1
	heat	1 - 6
	metal shavings	1
	stainless steel dust/fumes	1 - 3
	noise	1 - 6
	perchloroethylene	1
	stoddard solvent	1 - 3
	trichloroethylene	1
	welding fumes	1-3
Painters	asphalt	1
	paints/enamels	1 - 9
	thinners	1 - 5
	benzene	1
	methyl ethyl ketone	1 - 3
	neoprene/rubber coatings	1
	removers	1
	sandblasting	1 - 3
	stoddard solvent	1 - 3
	toluene	1
	trichloroethylene	1
	vinyl plastics	1
Plumbers/steam fitters	acetone	1
	aerosol spray cleaners	1
	asbestos	1 - 4
	carbon steel fumes	1
	copper	1
	welding fume	1 - 4
	heat	1 - 5
	lead	1 - 3
	metal shavings/buffing	1

	carbon steel dust	1 - 3
	nickel	1 - 3
	noise	1 - 6
	perchloroethylene	1
	plastics/cement	1
	stainless steel fumes	1 - 5
	stoddard solvent	1
	titanium fumes	1
	trichloroethylene	1
	welding fumes	1 - 3
Sheetmetal worker	acetone	1
	aerosol spray cleaners	1
	aluminum	1
	asbestos	1
	carbon steel fumes	1
	cement/plastics	1
	copper	1
	metal filings/shavings	1
	welding fumes	1
	lead	1
	noise	1
	solder	1
	stainless steel fumes	1
	titanium fumes	1

Source: "Old HEXFILE", identified as HEXCREN (09/23/76), an historical, qualitative assessment of non-radiological hazards by job classification for the years 1944 through 1972.

4. Health Impact - Nature and Extent/Determining Construction Workers at Significant Risk

a. Dates of Work

Based on other surveillance programs with which the team has been involved and an understanding of hiring practices at Oak Ridge, it is believed that the duration of work is a key factor in determining whether a construction worker may have a significant risk of work-related illness or injury.

b. Interview Information

Duration of employment alone will not capture workers who may be at increased risk of disease due to an acute exposure (e.g., high-level radiation) or because of exposure to a severely toxic material (e.g., beryllium). Therefore, the occupational history interview will be constructed to elicit both duration of employment and potential exposure to specific hazards.

For exposures for which specific medical exam modules will be developed (see Appendix B), an instrument will be finalized to catalogue worker recall of duration of exposure (or activities likely to be associated with exposure), the first and last year of exposure, and an estimate of frequency of exposure. For example, an examination to evaluate the impact of asbestos exposure is proposed only if 1) 15 years have elapsed since first exposure and 2) a total of 5 years exposure is documented. Each person who reports working with/near asbestos operations (e.g., pipefitters) will be queried as to determine 1) the first year of such activity, 2) the last year of such activity, and 3) an estimate of how much of that elapsed time was associated with the exposure/activity.

We estimate that some exposures may not be known or for other reasons cannot be recalled. For example, a carpenter working near beryllium machining is unlikely to have known of the hazardous potential exposure. In this case we will rely on linking the Institutional History document (location of potential exposures) and the work history report (of location). In this example, work in an area is a surrogate for potential exposure.

Draft occupational history survey instruments are shown in Appendix C.

c. Health Impacts

The goals of the medical surveillance program are to perform medical evaluations for specific exposure-related adverse effects and illnesses. For this program, the following specific hazards have been selected: asbestos, silica, welding fumes, beryllium, solvents, heavy metals (lead, cadmium, chromium, mercury), ionizing radiation and noise

The long-term effects of exposure to these agents are documented in Appendix B.

d. Example of an Assessment for Risk

TYPICAL CARPENTER INTERVIEWS

ID	AGE	TRADE	WORKER HISTORY BASED ON INTERVIEW	YRS OF WORK	POTENTIAL EXPOSURES BASED ON INTERVIEWS AND SITE
1114	67	Carpenter	X-10 - 2519 Steam plant - possible asbestos - 2013 Hospital - new construction Y-12 - 3017 removed asbestos, tile sawed, ceiling transite work, scooped up Hg- with hands	42 yrs	Asbestos Mercury
1501*	66	Carpenter	Y-12 - 9998 - Ceiling work , Ur, depleted Ur, Pb, Be, - 9201-5 Scaffolding for rad. Barrier, Pb, asbestos siding	41 yrs	Radiation Uranium Asbestos
1278	53	Carpenter	Y-12 - 9212 - Foundry - radiation contamination, built scaffolds Y-12 - Equipment to foundry "hot" K-25 - Told "clean", next day "rad"	9 yrs	Mercury Radiation
1001	50	Carpenter	X-10 - New construction	2.5 yrs	Asbestos

*This person died 2 days after interview from a lung cancer.

5. Summary

a. Target populations

YEAR	CONTRACTOR	ESTIMATED NUMBERS	COMMENTS
1943-1945	**J. A. Jones** **Stone & Webster** **DuPont**	**25,000/K-25** **13,000/Y-12** **3,000/X-10**	Short term employees. Most were >30 years old in 1943 so are >80 years now, many are dead. A few hundred for surveillance. Contact will be through outreach techniques.
1954-1955	**Maxon Construction**	**2,000/K-33**	Short term employees. Contact will be through outreach techniques.
1950-1997	**H-K Ferguson** **Rust** **M-K Ferguson**	**7,000 - 9,000**	Most likely to be among those interested in surveillance, about 50% will have worked >5 years. Longer term employees are most likely to participate. Lists of workers and outreach techniques will be used.

b. Specific Hazards and Levels of Exposure

The following exposures have been selected as posing a long-terms health risk to former construction workers:

- asbestos
- silica
- welding fumes
- beryllium
- solvents
- heavy metals
  - cadmium
  - chromium
  - mercury
- ionizing radiation
- noise

Each of the non-radiation exposures have been rated as a probable exposure for at least one construction trade in the HEX file, or is a component of an exposure included in the HEX file (e.g., lead can be a pigment in paint). Estimates of exposure intensity range from very low (rated at 0 or 1) to very high (rated at 10). It is also likely that as the program evolves, exposures to the hazards will be documented for additional trades. The quantitative intensity of exposures will not be known for most historical work activities, as no measurements were taken. When available, film badge data will be used to describe the range of exposures for activities posing a hazard due to ionizing radiation.

c. Nature of health impacts

The health impacts of each of the specific exposures described in the medical surveillance protocol are summarized below:

- asbestos
  - asbestosis
  - pulmonary function decrements
  - cancer
- silica
  - silicosis
- welding
  - chronic bronchitis
  - asthmatic bronchitis
  - chronic obstructive lung disease
- beryllium
  - chronic beryllium disease
- solvents
  - liver and kidney dysfunction
- heavy metals
  - lead

elevated blood lead
CNS toxicity
peripheral neuropathy
renal insufficiency

cadmium
- altered renal function

chromium
- altered renal function
- allergic dermatitis
- lung cancer

mercury
- neuropsych abnormalities

ionizing radiation
- mutations
- chromosomal damage
- cancer

noise
- deafness

d. Sources of data

<u>**Potential Hazards Source Location List**</u>

Oak Ridge Public Reading Room
: internal and external documents created at the three Oak Ridge sites, Oak Ridge Operations office, and Department of Energy which have been declassified according to the Freedom of Information Act, such as internal correspondence, remedial action site reports, and hazards analyses for specific buildings

ORNL Library
: access to ORNL *Review*, copies of division histories, maps and building lists, advice for other sources

ChemRisk
: California: copies of ChemRisk progress reports, helpful advice for tracking down other sources

Shonka & Associates (Atlanta)
: database of incidents/accidents at the Oak Ridge Reservation

State of Tennessee Department of Health (Nashville)
: copy of contract between State of Tennessee and ChemRisk, access to ChemRisk progress meetings

World Wide Web
: home pages of Oak Ridge sites, site characterization of K-25, which includes hazards information for each building

National Institute for Occupational Safety and Health
: Exposure and monitoring data

Department of Energy
: Exposure and monitoring data

Institutional History Sources

Oak Ridge National Laboratory (X-10)

Miscellaneous ORNL Documents (available at Oak Ridge Public Reading Room):

- "The ORNL Chemical Technology Division, 1950 - 1994"
- "A History of the Metals & Ceramics Division at ORNL: Part 2," Advanced Materials & Processes, 2/95
- Oak Ridge National Laboratory *Review* 25, (1992). (50th anniversary of the lab edition)
- "State of the Laboratory," ORNL Review (yearly feature in ORNL Review)
- Martha Carver and Margaret Slater, "Architectural/Historical Assessment of the Oak Ridge National Laboratory, Oak Ridge Reservation, Anderson and Roane Counties, Tennessee," December 1993

Specific Building Evaluations (available at Oak Ridge Public Reading Room):

- "Handling of Wastes from 205 Building" (Up to May 1, 1944)
- "Historical and Programmatic Overview of Building 3019," 1991
- "Building 3026, Segmenting Facility - Hazards Evaluation, Vol. 8," 1962
- "Hazards Report for Building 3517 (Fission Products Pilot Plant)" 7/1/60
- "Building 3505, Metal Recovery Facility, Hazards Evaluation, Vol. 6," 1962
- "The Oak Ridge National Laboratory Graphite Reactor," ORNL Central Files # 53-12-126, 8/12/87
- "Building 4507, High Level Chemical Development Facility - Hazards Evaluation, Vol. 10," 1962

Potential Environmental Hazard Reports (available at the Oak Ridge Public Reading Room):

- "Historical Chemical Release Report for ORNL," May, 1986
- "Environmental Analysis of the Operation of ORNL (X-10 Site)," ORNL # 5870, 11/82
- "Identification of Low-Level Waste Line Leak Sites at ORNL," January 1986
- Inventories of ORNL Remedial Action Sites, numbers:
    7. Hazardous Waste Sites (2/28/86)
    8. Radioisotope Processing Facilities (8/15/8
    9. Experimental Reactor Facilities (6/30/86)
    10. Radwaste Facilities (7/31/96)
    11. Research Laboratories (6/30/86)
    12. Other Contaminated Sites (8/15/86)

Maps/Building Lists (obtained from Martin Marietta Facilities Management, and ORNL Engineering Records office):

Maps:

- Outside Lines Map, 1943
- ORNL Historic Properties, 1990

- ORNL Perspective (color coded), 1990
- ORNL Black & White map, 1987
- ORNL Map, 1991
- Planning Map, buildings & roads, 1994

Building Lists:
- Monsanto Building List, January 1, 1947
- Oak Ridge National Laboratory Building List, June 15, 1950
- Oak Ridge National Laboratory Building List, February 7, 1961
- Oak Ridge National Laboratory Building List, January 1, 1972
- ORNL Building Directory, Civil and Architectural Engineering Department, October, 1989
- ORNL Building Directory, Engineering Division, October, 1994
- U.S. Department of Energy Facilities Information Management System Owned Building Construction Report, November 14, 1995

Oak Ridge Gaseous Diffusion Plant (K-25)

General Sources:
- M. Tuft, AK-25/K-27 Buildings Historical Characterization," Prepared by Process Engineering Department, Engineering Division, Oak Ridge K-25 Site, September, 1992
- Contract between the Department of Health, State of Tennessee, and Chem Risk Division of McLaren-Hart Environmental Service, October, 1994
- P. L. Goddard et al, "Site Descriptions of Environmental Restoration Units at the Oak Ridge K-25 Site, Oak Ridge, Tennessee," Prepared for the U.S. Department of Energy Office of Environmental Restoration and Waste Management, September, 1995.

Maps/Building Lists (obtained from Martin Marietta Facilities Management office):
Maps:
- General Layout, K-25 Area, 1940s (exact date unknown)
- K-25 & K-27 Plot Plan, 1944
- K-25 & K-27 Plot Plan, 1945
- Location Plan, K-25 Area, 1945
- Plan of Power Area Show, 1945
- K-25 & K-27 Plot Plan, 1951
- K-25 Perspective, 1990
- K-25 Map, 1993

Building Lists:
- Building List as of July 1, 1951
- Building List, Oak Ridge Gaseous Diffusion Plant, As of July 1, 1958
- Building List, Oak Ridge Gaseous Diffusion Plant, As of November 1, 1961
- ORGDP Building Directory, 1978, Prepared by Site Engineering, June 1, 1978
- ORGDP 1989 Building Directory, 1989

- Department of Energy Facilities Information Management System Owned Building Construction Report, November 14, 1995

Y-12 Plant

General Sources (available at Oak Ridge Public Reading Room):

- "Architectural/Historical Assessment of the Y-12 Site, Oak Ridge Reservation" work in progress by Jennifer Webb, Y-12
- "Integrated Mercury Contamination Remediation Plan for the Oak Ridge Reservation," Decontamination and Decommissioning Program, June, 1991
- United States Atomic Energy Commission Report of Investigating Committee, ALoss of Mercury at the Y-12 Plant," May, 1966
- "Investigation of Subsurface Mercury at the Oak Ridge Y-12 Plant," Environmental Sciences Division, November, 1984
- 'Investigation of the Enriched Uranium Chip Fire in Building 9212 on December 27, 1986, at the Oak Ridge Y-12 Plant," February 24, 1986
- "Mercury at Y-12: A Study of Mercury Uses at the Y-12 Plant, Accountability, and the Impacts on Y-12 Workers and the Environment, 1950 - 1983," Compiled by the 1983 Mercury Task Force, August, 1983
- numerous internal memoranda, incident reports, and Health Physics Reports for particular buildings

Maps/Building Lists (obtained from Martin Marietta Facilities Management office):
Maps:

- Fire Fighting Facilities, 1950
- Plant Map, 1988

Building Lists:

- Building Location & Directory, 1995
- Revised Building Index and Area Designations, November, 1945
- Y-12 Building Directory, February, 1988
- Department of Energy Facilities Information Management System Owned Building Construction Report, November 14, 1995

Outside Publications about Oak Ridge:

- Charles W. Johnson and Charles O. Jackson, City Behind a Fence: Oak Ridge, Tennessee 1942 - 1946 (1981: University of Tennessee Press, Knoxville)
- James Overholt, ed., These Are Our Voices: The Story of Oak Ridge, 1942 - 1970 (1987: Children's Museum of Oak Ridge, Tennessee, Oak Ridge)

e. Additional information

Additional data sources will be accessed as they become available through the DOE. We believe that data collection will provide documentation for exposures in routine, but previously unrecognized hazardous situations, and in non-routine activities. Thus the understanding of the work activities of construction tradesmen will become more complete as the program is conducted.

References

Atomic Energy Commission. 1963. *Handbook of AEC Operations.*

Bayer, R. 1986. Biological Monitoring in the Workplace: Ethical Issues. *J Occup Med* 28: 935-939.

Carpenter, AV, WD Flanders, EL Frome, DJ Crawford-Brown, SA Fry. 1987. Central nervous system cancers and radiation exposure: A case-control study among workers at two nuclear facilities. *J Occup Med* 39: 601-604.

Checkoway, H, RM Mathew, CM Shy, JE Watson, WG Tankersley, SH Wolf, JC Sith, and SA Fry. 1985. Radiation work experience and cause-specific mortality among workers at an energy research laboratory. *Br J Indust Med* 42:525-533.

Checkoway, H, N Pearce, DJ Crawford-Brown, and DL Cragle. 1988. Radiation doses and cause-specific mortality among workers at a nuclear materials fabrication plant. *Am J Epidemiol*127 (2): 255-266.

Cragle DL, DR Hollis and TH Newport. 1984. A retrospective cohort mortality study among workers occupationally exposed to metallic nickel powder at the Oak Ridge Gaseous Diffusion Plant. *IARC Scientific Pub* 53:57-63.

Cragle, D, R McLain, J Qualters, JLS Hickey, G Wilkinson, WG Tankersley, and CC Lushbaugh. 1988. Mortality among workers at a nuclear fuels production facility. *Am J Indust Med* 14:379-401.

Dupree, E A., JP Watkins, JN Ingle, PW Wallace, CM West, WG Tankersley. 1995. Uranium Dust Exposure and Lung Cancer Risk in Four Uranium Processing Operations. *Epidemiol.*

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

Frome EL, DL Cragle and RW McLain. 1990. Poisson regression of the mortality among a cohort of World War II nuclear industry workers. *Rad Research* 123:138-152.

Halperin, WE. 1996. The Role of Surveillance in the Hierarchy of Prevention. *Am J Indust Med* 29:321-323.

Houts, PS, and McDougall, V. 1988. Effects of Informing Workers of Their Health Risks from Exposure to Toxic Materials, *Am J of Occup Med* 13:271-279.

IARC Study Group on Cancer Risk among Nuclear Industry Workers. 1994. Direct estimates of cancer mortality due to low doses of ionizing radiation: An international study. *The Lancet* 344:1039-1043.

Johnson, CW, CO Jackson. 1981. *City Behind a Fence: Oak Ridge, Tennessee, 1942-1946.* Knoxville, TN: University of Tennessee Press.

Loomis, DP, SH Wolf. 1996. Mortality of workers at a nuclear materials production plant at Oak Ridge, Tennessee, 1947-1990. *Am J Indust Med* 29: 131-141.

Millar, DJ. 1988. Summary of "Proposed National Strategies for the Prevention of Leading Work-Related Diseases and Injuries, Part 1." *Am J of Indust Med* 13: 223-240.

Mintz, BW. 1986. Medical Surveillance of Employees Under the Occupational Safety and Health Administration. *J of Occup Med* 28: 913-920.

O'Toole, T. 1994. Testimony before the Subcommittee on Energy and Commerce, U.S. House of Representatives, March 17, pp. 2-3.

Overholt, J (ed). 1987. *These Are Our Voices: The Story of Oak Ridge, 1942-1970.* Children's Museum of Oak Ridge, TN, Oak Ridge.

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Polednak, AP and EL Frome. 1981. Mortality among men employed between 1943 and 1947 at a uranium-processing plant. *J Occup Med* 23(3):169-178.

Polednak, AP. 1980. Mortality among men occupationally exposed to phosgene in 1943-1945. *Environ Research* 22:357-367.

Polednak, AP. 1981. Mortality among welders, including a group exposed to nickel oxides. *Arch Environ Health* 36:235-242.

Samuels, SW. 1986. Medical Surveillance: Biological, Social, and Ethical Parameters. *J Occup Med* 28: 572-577.

Selikoff, IJ, and Hammond, EC. 1978. Asbestos-Associated Disease in United States Shipyards, *CA- A Cancer Journal for Clinicians*, 28:87-99.

U.S. Congress. 1993. *Hazards Ahead: Managing Cleanup Worker Health and Safety at the Nuclear Weapons Complex* (Office of Technology Assessment)

Watkins, JP et al. 1993. *Data collection, validation, and description for the Oak Ridge Nuclear Facilities Mortality Study.* ORISE 93/J-42.

Wing, S, CM Shy, J Wood, S Wolf, D Cragle, and E L Frome. 1991. Mortality among workers at Oak Ridge National Laboratory. *JAMA* 265 (11): 1397-1402.

Wing, S, CM Shy, J Wood, S Wolf, D Cragle, W Tankersley, and E L Frome. 1993. Job factors, radiation and cancer mortality at Oak Ridge National Laboratory: follow-up through 1984. *Am J Indust Med* 23: 265-279.

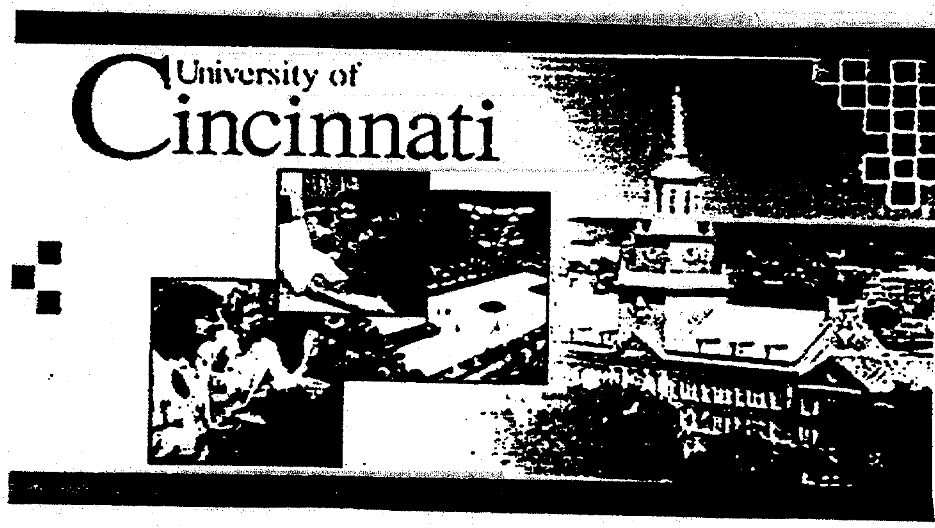
Appendix A

Excerpts from Institutional History Documents

X-10

Y-12

K-25



OAK RIDGE NAT'L LAB (X-10)
SELECTED BUILDINGS

Oak Ridge Reservation
Oak Ridge, Tennessee

Prepared under the direction of
Dr. Eula Bingham and Dr. Carol Rice
June, 1997

NIOSH Grant No. R01CCR512026
DOE Grant No. DE-FC03-96SF21263

Report of Building No *9202*

Date Constructed: 1/1/40 **Year Closed:**

Construction Type: masonry, reinforced concrete, poured concrete fndn & loading dock, tar & gravel roof (2)

Size:

Unique Features:

Renovations: 1943, 1944

Process-Table

From year	To year	Process
1/1/40	12/1/45	Electromagnetic Chemistry Prep (D10)
1/1/40	12/1/45	Electromagnetic separation charge preparation of isotopes (D10)
1/1/43		Electromagnetic chemistry prep (1943)" *completed November, 1943 by Stone & Webster and Giffels & Rosetti; between 1944 and 1945 received and chemically purified a shipment of dilute solution of uranium called "gunk"; *extension added fall 1944. (2)
1/1/51	12/1/54	OREX (D1, D3, D38, D52)
5/1/53		radioactive particle counting lab (D48)
1/1/58	12/1/95	Be op'ns (D5, D10)
1/1/60	12/1/72	thorium op'ns (D3)
1/1/60		depleted U op'ns (D3)
2/1/88		chemical devel, chemical engineering, metallurgical development (D11)
2/1/88		ceramics & plastics (D11)
1/1/90		metallurgy, metallography, welding, wet & dry chemistry, corrosion testing, plating, ultra-clean room, plastics & ceramics fabrication, chemical engineering, electronics; budgets (2, D1, D2)
11/14/95		dev labs & offices (D13)
12/5/95		devel facility (D15)

Hazards: Physical: radiation (uranium (2)); chemical: Hg (50,000 lbs Hg lost here (D1)), Be (1), Li (D1) (CS)

Inferred hazards: solvents, EMF, acids, silica, welding fumes, metal alloys, polymer fumes,/adhesives (CR)

References

2	Welsh, Teresa, Laboratory Records, ORNL, "Y-12 Architectural/Historical Assessment of the Y-12 Plant, Oak Ridge, TN," late 1996.
D1	"Description of Current Conditions" (a chapter of a longer document), no date (post 1989). Describes mercury use at Y-12.
D10	Bean, G.L., University of Texas, "Questionnaire: Chemical Hazards at the Y-12 Plant," Y/TS-1382, August 1995.
D11	Martin Marietta, "Y-12 Building Directory," February 1988.
D13	US Department of Energy, Facilities Information Management System, Owned Buildin Construction Report, 11/14/95 (pages missing)
D15	Y-12 Building Database, 12/8/95
D3	Chemrisk, Oak Ridge Health Studies, Phase 1 Report: Volume II, Part A, Dose Reconstruction Feasibility Study, Taks 1 & 2, A Summary of Historical Activities on the Oak Ridge Reservation..., September 1993.
D38	History Associates Incorporated, "Y-12 Mercury Task Force Files: A Guide to Record Series of the Department of Energy and its Contractors", Based on Research Completec June 1994
D46	"Unclassified Version of mercury Inventory at Y-12 Plant 1950 through 1977", Document Number MS/ChR-502383/K-25, June 9, 1977
D48	Y-12 Plant, A Division of Union Carbide and Carbon Corporation, Oak Ridge, Tennessee, Health Physics Progress Report, July 1, 1952 - December 31, 1952
D5	Morehead, J.F. (Union Carbide Nuclear Company) memo to R.C. Olsen, "Beryllium Contamination in Buildings 9202, 9203, and 9205 for the Month of December," Januar 4, 1959.
D52	The 1983 Mercury Task Force, Mercury at Y-12: A Study of Mercury Use at the Y-12 Plant, Accountability, and Impacts on Y-12 Workers and the Environment - 1950 to 1983

Report of Building No *9204-4*

Date Constructed: 1/1/40 **Year Closed:**

Construction Type: reinforced concrete and structural steel; masonry walls, cast conctrete fndn (2)
Stone & Webster

Size:

Unique Features:

Renovations: 1948, 1952, 1970-79, 1980-89

Process-Table

From year	To year	Process
1/1/40	12/1/45	Calutrons (alpha/beta) (1, D3, D10, D12)
1/1/43	1/1/46	U enrichment by electromagnetic separation (2)
1/1/46	12/1/60	COLEX (D10)
1/1/46		Li 6 isotope prod'n (1)
1/1/46	12/1/60	Machine Shop (D10)
1/1/48	12/1/92	depleted U op'ns (D3)
1/1/48		*major renovation by Vitro&Catalytic Construction (2)
1/1/50	12/1/75	thorium op'ns (D3)
1/1/50	9/1/93	Lead arc-melting, forging, rolling, milling, machining (D3)
10/1/50		Area to W stores of empty Hg flasks (D1)
1/1/53	12/1/56	ELEX, Li isotope separation (2, D3, D38, D46)
10/1/56		building stripped by HK Ferguson Construction (2)
1/1/61	12/1/95	U machining (1, D10)
1/1/70	12/1/79	major renvovations (including 1970 extension of W side) (2)
1/1/80	12/1/89	renovations (2)
2/1/88		physical testing radiography, assembly op'ns, eng'g, fabrication systems, dispatching, tool design, heavy machining, metal working, pressing & forming, machine tool (D11)
1/1/90		nuclear weapons production, depleted U op'ns, retired weapons disassembly, heat treat, forging, machining (D1)
11/14/95		production (Beta-4) (D13, D15)

Hazards: Physical: radiation (U in 40's (2), general in 90's (2, D1, D2)). Chemical: Hg, Li since 50's (D1) (CS); lead (D3) (CR)

Inferred hazards: EMF, machining fluids, metal alloys, silica, noise (CR)

References

1 Process list for Y-12 buildings, faxed from Buck Cameron to Carol Rice, June 3, 1996.

2 Welsh, Teresa, Laboratory Records, ORNL, "Y-12 Architectural/Historical Assessment of the Y-12 Plant, Oak Ridge, TN," late 1996.

D1 "Description of Current Conditions" (a chapter of a longer document), no date (post 1989). Describes mercury use at Y-12.

D10 Bean, G.L., University of Texas, "Questionnaire: Chemical Hazards at the Y-12 Plant," Y/TS-1382, August 1995.

D11 Martin Marietta, "Y-12 Building Directory," February 1988.

D12 Bowles, J.C., Revised Building Index and Area Designations, November 5, 1945.

D13 US Department of Energy, Facilities Information Management System, Owned Buildin Construction Report, 11/14/95 (pages missing)

D15 Y-12 Building Database, 12/8/95

D21 Ellis, E.C., Memo to P.J. Pryor, "Distribution of Costs", Y/HG-0003/2, January 11, 1957

D3 Chemrisk, Oak Ridge Health Studies, Phase 1 Report: Volume II, Part A, Dose Reconstruction Feasibility Study, Taks 1 & 2, A Summary of Historical Activities on the Oak Ridge Reservation..., September 1993.

D38 History Associates Incorporated, "Y-12 Mercury Task Force Files: A Guide to Record Series of the Department of Energy and its Contractors", Based on Research Completec June 1994

D46 "Unclassified Version of mercury Inventory at Y-12 Plant 1950 through 1977", Document Number MS/ChR-502383/K-25, June 9, 1977

D49 Inter-Company Correspondence to A.A. Groppe and C.B. Newman, Solvent Urine Program for Maintenance Personnel, Carbide and Carbon Chemicals Company

D52 The 1983 Mercury Task Force, Mercury at Y-12: A Study of Mercury Use at the Y-12 Plant, Accountability, and Impacts on Y-12 Workers and the Environment - 1950 to 1983

Report of Building No *9419-1*

Date Constructed: 1/1/40 **Year Closed:**

Construction Type: steel frame, metal panels, gable roof (2), Stone & Webster

Size:

Unique Features:

Renovations:

Process-Table

From year	To year	Process
1/1/40	1/1/90	housed beryllium (2, D11, D13, D15)
11/5/45		distilled water preparation & treatment (D12)

Hazards: Chemical: Beryllium (2) (CS)

Inferred hazards: metal alloys (CR)

References

2	Welsh, Teresa, Laboratory Records, ORNL, "Y-12 Architectural/Historical Assessment of the Y-12 Plant, Oak Ridge, TN," late 1996.
D11	Martin Marietta, "Y-12 Building Directory," February 1988.
D12	Bowles, J.C., Revised Building Index and Area Designations, November 5, 1945.
D13	US Department of Energy, Facilities Information Management System, Owned Buildin Construction Report, 11/14/95 (pages missing)
D15	Y-12 Building Database, 12/8/95
D2	Raymer, K.M., "Radiological Control: Y-12 Site Radiological Buildings and Boundary Control Stations" (Map), August 31, 1995.

Report of Building No *9998*

Date Constructed: 1/1/46 **Year Closed:**

Construction Type: structural steel skeleton, masonry walls, brick veneer, cast concrete fndn (2)

Size:

Unique Features:

Renovations: prior to 1954, the building served as a maintenance and machine shop for Building 9212; in 1956 it was renovated to be a free-standing building as 9998.// 1970, 1979, 1983, 1988, 1989

Process-Table

From year	To year	Process	Ref
1/1/46	1/1/96	Machine Shop (2, D10)	
1/1/48	12/1/92	depleted U op'ns (D3)	
1/1/50	9/1/93	Lead arc-melting, forging, rolling, milling, machining (D3)	
1/1/56		annex constructed (2)	
1/1/61	12/1/95	U machining (1, D10)	
1/1/76	12/1/95	Carbon foam/Epoxy op'ns (1, D10)	
1/1/76	12/1/95	Be op'ns - machining & processing (1, D10)	
2/1/88		production machine shop, metallurgical devel., maint., H-1 foundry (2, D11)	
11/14/95		maint., machine shops (D13, D15)	

Hazards: Physical: radiation (U in 40's); chemical: beryllium (1) (CS), lead (D3), epoxy (1, D10)

Inferred hazards: Welding fumes, metal alloys, solvents, machining fluids, noise, EMF (CR)

References

1 Process list for Y-12 buildings, faxed from Buck Cameron to Carol Rice, June 3, 1996.

2 Welsh, Teresa, Laboratory Records, ORNL, "Y-12 Architectural/Historical Assessment of the Y-12 Plant, Oak Ridge, TN," late 1996.

CS (from D3)

D10 Bean, G.L., University of Texas, "Questionnaire: Chemical Hazards at the Y-12 Plant," Y/TS-1382, August 1995.

D11 Martin Marietta, "Y-12 Building Directory," February 1988.

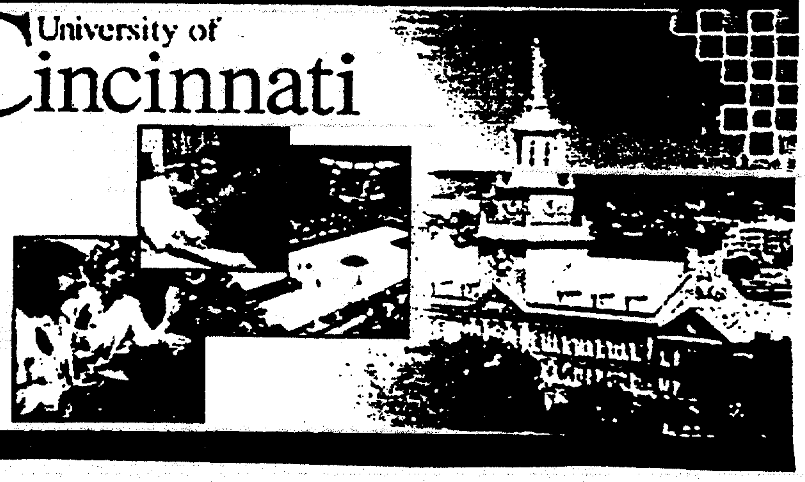
D13 US Department of Energy, Facilities Information Management System, Owned Buildin Construction Report, 11/14/95 (pages missing)

D15 Y-12 Building Database, 12/8/95

D2 Raymer, K.M., "Radiological Control: Y-12 Site Radiological Buildings and Boundary Control Stations" (Map), August 31, 1995.

D3 Chemrisk, Oak Ridge Health Studies, Phase 1 Report: Volume II, Part A, Dose Reconstruction Feasibility Study, Taks 1 & 2, A Summary of Historical Activities on the Oak Ridge Reservation..., September 1993.

University of Cincinnati



OAK RIDGE GASEOUS DIFFUSION PLANT (K-25)
SELECTED BUILDINGS

Oak Ridge Reservation
Oak Ridge, Tennessee

Prepared under the direction of
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Report of Building No *305-1*

Date Constructed: 1945 **Year Closed:**

Construction Type: corr. transsite

Size:

Unique Features: ID 33, former ID numbers: 780.67 (basement), 795.67 (alley)

Renovations:

Function-Table

Year	Function
1/1/51	Area IV - Process
1/1/58	Area IV - Process
1/1/61	K-25 - Process
1/1/78	K-25 - Process
1/1/89	K-25 Process

Process-Table

From year	To year	Process
1/1/45	1/1/64	1. Gaseous diffusion (entire K-25 building process shut down in 1964)

Hazards: 1. radiation: UF6, technetium-99, cesium-137, UO2F2, UF4/UF5, U-235;chemical: PCB's, lube oils; Coolants: perfluorodimethylcyclohexane (C-816), trichloroheptafluorbutane (B-437);fluorine

Inferred hazards: mercury, welding fumes (CR)

References

1 Building List, July 1, 1995

Report of Building No *402-3*

Date Constructed: 1945 **Year Closed:**

Construction Type: corr. transite

Size:

Unique Features: ID 64

Renovations:

Function-Table

Year	Function
1/1/51	Area I - Process
1/1/58	Area I - Process
1/1/61	K-27 Process
1/1/78	K-27 Process
1/1/89	K-27 Process

Process-Table

From year	To year	Process
1/1/45	1/1/64	1. Gaseous diffusion (until all of K-25 shut down 1964)
1/1/45	1/1/64	1. Gaseous diffusion (until all of K-27 shut down 1964)

Hazards: 1. radiation: UF6, technetium-99, cesium-137, UO2F2, UF4/UF5, U-235;chemical: PCB's; lube oils; coolants: perfluorodimethylcyclohexane (C-816), trichloroheptafluorbutane (B-437);fluorine;

Inferred hazards: welding fumes, mercury (CR)

References

1 Building List, July 1, 1995

3 Building List, November 1, 1961

Report of Building No *502-1*

Date Constructed: 1943 **Year Closed:**

Construction Type: Insulated Metal

Size:

Unique Features: ID 73

Renovations:

Function-Table

Year	Function
1/1/51	Area VI - Process
1/1/58	Area VI - Process
1/1/61	K-29 Process
1/1/78	K-29 Process
1/1/89	K-29 Process

Process-Table

From year	To year	Process
1/1/45	1/1/64	1. Gaseous diffusion (until 1964 when all of K-25 was shut down)

Hazards: 1. radiation: UF_6, technetium-99, cesium-137, UO_2F_2, UF_4/UF_5, U-235; chemical: PCB's; lube oils; coolants: perfluorodimethylcyclohexane (C-816), trichloroheptafluorbutane (B-437); fluorine.

Inferred hazards: mercury, welding fumes

References

1	Building List, July 1, 1995
3	Building List, November 1, 1961

Report of Building No *601*

Date Constructed: 1945 **Year Closed:**

Construction Type: Conc. block and concrete

Size:

Unique Features: ID 79, former ID 795.67

Renovations:

Function-Table

Year	Function
1/1/51	Area II - Process
1/1/58	Area II - Process
1/1/61	K-25 Process
1/1/78	Weld Training Facilities
1/1/89	Maintenance Training Facility

Process-Table

From year	To year	Process
1/1/45	1/1/64	3. Gaseous diffusion (until all of K-25 process shut down in 1964)
1/1/70		(since 1970's) welding and maintenance training

Hazards: 1. radiation: UF6, technetium-99, cesium-137, UO2F2, UF4/UF5, U-235; chemical: PCB's; lube oils; coolants: perfluorodimethylcyclohexane (C-816), trichloroheptafluorbutane (B-437); fluorine;

Inferred hazards: welding fumes, degreasers, asbestos, heavy metals (later years -1970 +)

References

1 Building List, July 1, 1995

3 Building List, November 1, 1961

Report of Building No *1025-D*

Date Constructed: 1945 **Year Closed:**

Construction Type: Corr. transite

Size:

Unique Features: ID 611

Renovations:

Function-Table

Year	Function
1/1/51	Warehouse Shipping Drums
1/1/58	Warehouse Shipping Drums
1/1/61	Warehouse Shipping Drums
1/1/78	Radiation Source
1/1/89	Radiation Source Control Building,
1/1/91	Radiation Source Control Building
1/1/92	Drum Storage Building

Process-Table

From year	To year	Process
1/1/45	1/1/90	(until 1990's) storage of radiation sources

Hazards: radiation: possible radionuclides:UF6, TC-99, CS-137, UO2F2, UF4/UF5, U-235

Inferred hazards: asbestos (see 1025-E)

References

1 Building List, July 1, 1995

Report of Building Number: *3026-C*

Construction Year: 1945 **Closure Year:**

Construction Type: metal-sided/steel frame (1000); hazards eval says original bldg was wooden frame structure that as of 1962 has received only necessary maintainance to keep the structure habitable (54)

Size: 8,376 square feet (1000)

Unique Features: Built in 2 sections - 1st in 1944, 2nd in 1945. 1st section now (1962) has only limited usage

Renovations: 1959 - major changes made to second section of the bldg (55)

Function-Table

Year	Function
1950	not listed
1961	Radioisotope Development Lab -B (Isotopes; Radioisotope Research & Development)
1972	Radioisotope Development Lab-B (Isotopes)
1987	Radioisotope Development Lab -B
1989	Radioisotope Development Lab -B
1991	Radioisotope Development Lab -B
1995	Radioisotope Development Lab -B

Process-Table

From year	To year	Process
1944		1st part of orginal bldg completed for the separation of radioisotopes for biology and weapons development
1945	1952	(1945-52) reprocessing of Ra La (57)
1945		2nd section of original bldg completed for the separation and isolation of Ba-140 for the weapons program
1962		**Liquid Waste Systems: "Liquid wastes consist largely of condenser cooling water, steam condensate,sodium and potassium hydroxide from the decomposition of the NaK, and some mineral oil. Filters are provided to prevent any fuel particles, radioactive scale, or active metal fragments from entering the waste system. All liquid waste is decharged to the radiochemical waste system and is collected in tank W-16 (800 gallon) in the waste tank farm.. Waste is monitored and jetted to an appropriate tank in the ILW system when the level reaches 600 gallons" //** Gaseous Waste Systems: see attached diagrams.

1962	(as of 1962) **Process Description: "the mechanical processing program for the SRE fuel involves removal of the end hardware of the element and the fuel rod cladding, disposal of the NaK bonding, washing of the uranium slugs, and canning the slugs in aluminium cans for storage until required by the chemical procesing plant. The duel is received in a carrier with a maximum capacity of 10 elements. One element at a time is charged to the cell from the carrier through a charging port in the cell door. Jigs and fixtures position the element under an abrasive wheel saw, which cuts the end hardware from the element and allows separation of the element into 7 individual rods. The rods are placed one at a time in a mechanical decladding machine of unique design which operates under a bath of mineral oil to avoid exposure of the NaK to moisture. Roll cutters remove the end plugs from the cladding. The cladding is hydraulically expanded to free warped or swollen slugs, and the fuel and NaK are expelled from the cladding by either hydraulic pressure or a mechanical pressure screw. The slugs are collected in a basket and transferred to a steam-operated cleaner to remove the residual NaK and mineral oil. The clean slugs are canned in aluminium cans and transferred in a critically safe storage rack through an undergound transfer tunnel to the storage cell, where they are stacked in a critically safe array to await chemical processing. The NaK is decomposed by steam by a controlled reaction in a special reacttor operating under an inert nitrogen blanket. Stainless steel inert end hardware and cladding which has been wound into a flat spiral by the decladding machine is placed in a scrap container and removed, through the underground transfer tunnel, to a bottom-loading carrier on the operating floor and thence to the burial grounds. An auxillary decladding device is used for jammed slugs. Future plans for mechanical processing involve the use of a hydraulically operated shear of 250 tons capacity, which is capable of reducing the majority of power reactor fuel elements into discrete 1-inch lengths for subsequent leaching of the fuel by acid. The stainless steel scrap would be discarded without dissolution. For the shear and leach program the vessel off-gas system and possible the cell off-gas system will receive limited quantities of Kr-85 and iodine" (58)
9999	(date really was misc) fission product separations - included the discovery of technetium; how personal decontamination was done in the early days - "go home & wash the dishes" (56)

Accident-Table

Year	Accident

1950 (1950's & 60s) "the ground beneath and around bldg 3026 is likely to be contaminated from leaks and spillages which occurred from operations during the 1950s and 1960s. Little quantitative data were found; however, the site has suspect contamination based on [ref] from Operations Division reports. From the nature of operations during its long history, bldg 3026 area contamination could include isotopes of uranium, fission products, and transuranics (59)

1958 "unusually high activity in WOC, caused by the effluent from the sewage disposal plant, led to the discovery of a broken weld in the "hot" waste line between the Radioisotope Area and the tank farm. The leak was...in Central Avenue in front of bldg 3026, where the sewer line and the "hot" waste line run parallel within several feet of each other. The active solution was seeping into the sewer through loose joints in the pipe. The leak has been repaired and precautions taken to prevent recurrences of this nature in the future" (July - Sept 1958) (60)

1969 "activity in the storm sewer discharge seeped into an abandoned section of clay pipe from contaminated soil around the process waste equalization basin. The activity in the sanitary sewer came mainly from inleakage under Central Avenue in front of bldg 3026, although some traces of activity have also been found in the sewer running east to west on the north side of bldg 4508. The leak into the sewer in front of bldg 3026 was undoubtedly from earth contaminated by an old oil line that leaked and was taken out of sevice years ago" (61)

Hazards: Chemical: mineral oil, Na K, Na O H, K O H, steam condensate, radiation: Kr-85, I, ILW (58); radiation: isotopes of U, fission products, transuranium (59)

Inferred Hazards: Chemical: mercury, acids, asbestos (CR)

References

54 Building 3026, Segmenting Facilities - Hazards Evaluation, Vol. 8, 1962, p. 3.

55 Building 3026, Segmenting Facilities - Hazards Evaluation, Vol. 8, 1962, p. 3.

56 The ORNL Chemical Technology Division, 1950-1994, p. 4-19.

57 The ORNL Chemical Technology Division, 1950-1994, p. 4-66.

58 Building 3026, Segmenting Facilities - Hazards Evaluation, Vol. 8, 1962, p. 9.

59 Identification of Low-Level Waste Line Leak Sites at ORNL, Jan., 1986, p. A5-6 (see source for several specific leaks and spills)

60 Identification of Low-Level Waste Line Leak Sites at ORNL, Jan., 1986, p.

61 Identification of Low-Level Waste Line Leak Sites at ORNL, Jan., 1986, p. A17.

1000 p. ~~13.~~

Report of Building Number: *3042*

Construction Year: 1958 **Closure Year:**

Construction Type: Metal-sided steel frame (1000)

Size: 8,185 square feet of floor space, 2 floors (1000)

Unique Features:

Renovations:

Function-Table

Year	Function
1947	not listed
1950	Transformer Station F/3012
1961	Oak Ridge Research Reactor
1987	Oak Ridge Research Reactor
1989	Oak Ridge Research Reactor (Research Reactor)
1991	Oak Ridge Research Reactor
1995	Oak Ridge Research Reactor

Process-Table

From year	To year	Process
1959		starting in 1959, several experimental facilities have been installed at ORR for "testing of various materials, analysis of liquid and gaseous coolant systems, and transfer of irradiated samples. Six of the facilities have been designated as surplus...Each facility includes, or once included, an in-reactor section with associated piping, instrumentation and controls leading to processing or experimental areas located wither immediately adjacent to the reactor or at more remote locations, primarily in the basement of ORR"///ORR Molten Salt Loop installation began;"its purpose was to investigate the behavior of aqueous homogenous fuel solutions and potential construction materials under thermal neutron radiation. The facility has not been used since 1967."(77)
1960		(1960s) ORR Gas-cooled Reactor Loops A9, B9, and C1: consisted of in-pile radiation loops connected to the ORR, designated A9, B9 & C1, installed in the early 1960s to provide facilities in which feed materials could be irradiated to determine their ability to retaiin gaseous fission products during irradiation. They continued to be used until the late 1960s.

1982	(as of 1982) "operates at 30 MWt using enriched uranium fuel in the form of aluminum-uranium alloy fuel plates; it is light water moderated and cooled, beryllium- and water-reflected. Refueling requires 12 kg of uranium annually..approx 4480 PBq of mixed fission products & 11 PBq of 65Zn and 115Cd from shim rods & end boxes are generated annually" (Env An 2-9)
1986	(as of 1986) "Following completion of the respective experiments, the in-reactor portions of the facilties were usually removed and the remaining systems placed in standby. Most of the facilities remain as left, with only limited removal of equipment..the abondoned experiments [are described as being] in various states of disrepair and deterioration." The six facilities designated as surplus are: ORR Gas-cooled Reactor Loops A9, B9, and C1: ORR Molten Salt Loop; ORR Maritime Ship Reactor Loop;; Pneumatic Tube Irradiation Facility; ORR Gas-cooled Reactor Loop I, and Loop II (79)
1987	ORR shut down because of concern about management & oversight (SOL87,22)

Accident-Table

Year	Accident
1959	(fall of 1959) contamination found on west side of 3042 & in area of LITR - result of accident in 3019; contamination was blocked off & cleaned up (ORNL 61-8-30)
1974	"Surveillance and assistance were provided during the excavation of the 11,000 gallon Decay Tank for repair of a leak. The leak had been releasing primary coolant water at a rate of 1.5 gal/min. Radiation levels to 2R/hr were encountered along with levels of transferable contamination up to 35 mR/hr at 1 inch. The contamination was effectively confined to the immediate work area. Internal exposures were avoided by the use of plastic suits with positive air supply. The external exposure was kept well below the permissable limits." (83)
1974	11,000 gallon Decay Tank leaked 7 contaminated surrounding soil, "The leak had been releasing primary coolant water at a rate of 1.5 gallons/minute. Radiation levels up to 2 R/hr were encountered along with levels of transferable contamination up to the immediate work area. Internal exposures were avoided by the use of plastic suits with a positive air supply. The external exposure was kept well below the permissible limits." (80) Another source: "The ORR Decay Tank, Dwg. 10000-T-0460-D, sheet 30, coordinate N-2273388 E31660, was ruptured and in March, 1974, it's contents were found to be leaking into the surrounding earth./// The tank was removed, repaired, and reinstalled during April 1974." (81) Environmental considerations: "Transport of contaminants by groundwater is the major environmental concern for this incident. Excavation performed in this area could cause surface water transport if contaminants were exposed; therefore, provisions for diverting runoff or surface water should be included in any plans for excavation in the area." (82)
1974	ORR had an escaped capsule (SOL 74,18)

1986 (as of 1986) Maritime Strip Reator Loop: scattered low level beta-gamma contamination throughout the equipment room, no alpha contamination; "the sample station in the control room was more heavily contaminated, with transferable beta-gamma contamination levels varying form 720 to 782,000 dpm/100 cm squared with an average of 18,000 dpm/100 cm squared beta-gamma, indicating the likelihood of spills or leakage in the sample station during the operation.///Gas-cooled Reactor Loops a9, B9, and C1: "The accessible piping associated with the A9-B9 experiment remains highly contaminated internally, primarily with Co-60. No alpha contamination was detected. The control room is free of contamination other than that associated with the piping."///ORR Molten Salt Loop: A "survey of the external areas of the MSL indicated no radiation hazards and no transferable contamination.'(84)

Hazards: radiation: mixed fission products, chemical: Be alloys (78).

Inferred Hazards: welding fumes, EMF, mercury (CR)

References

77 Inventory of ORNL Remedial Action Sites: 9. Experimental Reactor Facilities." (6/30/86), p 69 70: 76.

78 Inventory of ORNL Remedial Action Sites: 9. Experimental Reactor Facilities." (6/30/86), p. 7:

79 Inventory of ORNL Remedial Action Sites: 9. Experimental Reactor Facilities." (6/30/86), p. 7(

80 Health Physics, Applied Health Physics and Safety Annual Report for 1974, quoted in "Inventory of ORNL Remedial Action Sites: 12. Other Contaminated Sites, 1986

81 note accompanying ORNL Drawing A-90015-0-063 F, rev 5, quoted in note accompanying ORNL Drawing A-90015-0-63 F, rev 5, quoted in "Inventory of ORNL Remedial Action Sites 12. Other Contaminated Sites, 1986

82 Inventory of ORNL Remedial Action Sites: 12. Other contaminated Sites, 1986

83 Identification of Low-Level Waste Line Leak Sites at ORNL," Jan., 1986, p. A12.

84 Inventory of ORNL Remedial Action Sites: 9. Experimental Reactor Facilities." (6/30/86), p. 72, 76, 77.

1000 p.14.

Report of Building Number: 3503

Construction Year: 1948 **Closure Year:**

Construction Type: metal sided/steel frame (1000)

Size: 12,206 square feet of floor space, 4 floors (1000)

Unique Features:

Renovations:

Function-Table

Year	Function
1947	not listed
1950	Solvent Column Building (formerly 706-HB)
1961	High Radiation Level Chem Engineering Lab (Chem Tech)
1972	High Radiation Level Chem Engineering Lab (Chem Tech)
1987	High Radiation Level Chem Engineering Lab
1989	High Radiation Level Chem Engineering Lab (Chem Tech)
1991	High Radiation Level Chem Engineering Lab
1995	High Radiation Level Chem Engineering Lab -

Process-Table

From year	To year	Process
1950		(1950s & 60s) - processes involving mercury to support Y-12 thermonuclear weapons program (97)
1950		(1950s) Unit Operations section for Chem Tech (3502 & 3503); "started chemical engineering studies of radiochemical processes involving evaporation, solvent extraction, and ion-exchange and continued unit operation-scale studies of theTBP process and RaLa process (96).
1952		reprocessing of TBP-Interim-23 (95)
1980		(mid-1980s) soil samples around bldg contained mercury concentrations ranging from .8 to 25 ppm (98)

Accident-Table

Year	Accident
1954	"..activity was the result of a series of operating accidents at the Solvent Column Pilot Plant bldg (3505). One of the accidents was the leaking of a discharge line

from a waste tank. The other was a spill at the thorium waste tank which overflowed and contaminated the surrounding ground and groundwater. The groundwater surrounding these tanks is pumped to the settling basin." (December, 1954) (99)

1960 (early 1960s) unknown quantity of mercury was spilled in early 1960s. 1983 soil samples showed mercury concentrations ranging from 0.8 to 25 ppm. Mercury soil concentrations were above the area mercury background level and the State of Tennessee's maximum mercury soil level concentrations guideline. Exact locations of samples are not specified, but the following concentrations are for general areas south of bldg 3503: storage area #1 = 25 ppm; storage are #2 = 3.2 ppm; storage area #3 = 6.5 ppm; storage area #4 = 0.8 ppm. (100)

1986 (as of 1986) Storage Pad Southwest of Bldg 3503: approx. 12 m by 15 m, "The pad, built in the late 1950s, has been used as storage for containers of radionuclide contaminated materials, scrap material, and metal recovery operations equipment. A portion of the pad has covering over two areas which are used for storage of barrels and 'surplus' miscellaneous equipment and crates. The two areas have metal tray floorings..The major radioactivity present is believed to be associated with the storage of U-233 and Pu-239. Prior to the addition of a 10-cm layer of concrete to the pad in the 1970s, the surface contamination was estimated at 100,000 d/m/100 sq cm..the most recent survey..shows detectable radioactivity in the areas under the shed and within approximately 1 m of the south and west side of the pad at ground level. No alpha radioactivity was detected during the last survey. Although the major radioactivity beneath the top layer of concrete is believed to be U-and the metal trays has not been determined. In addiition, although the extent of lateral surface contamination has been determined, the amount of subsurface contamination is not known." (101)

Hazards: radiation (50s): TBP, Ra La, Th, chemical (50s): solvents, ion exchange cpds (96); chemical (50s - 60s): Hg (97); radiation (exterior): U-233, Pu-239 (101)

Inferred Hazards: EMF, lead, Ba-140, acids, nitric acid (CR)

References

95 The ORNL Chemical Technology Division, 1950-1994, p. 4-66

96 The ORNL Chemical Technology Division, 1950-1994, p. 2-11

97 Historical Chemical Release Report for ORNL, May, 1986

98 Historical Chemical Release Report for ORNL, May, 1986

99 Identification of Low-Level Waste Line Leak Sites at ORNL, January, 1986, p. A19

100 Inventory of ORNL Remedial Action Sites: 7. Hazardous Waste Sites, 2/28/86, p. 10-11

101 Inventory of ORNL Remedial Action Sites: 12. Other Contaminated Sites, 8/15/86.

1000 p.18.

Report of Building Number: 3505

Construction Year: 1951 **Closure Year:**

Construction Type: Metal sided/ steel frame (1000); steel-frame/metal siding bldg w/numerous windows & roof of mild steel decking covered w/ 2 in of glass fiber batting insulation toped w/ sand & gravel (1002)

Size: 6,550 square feet of floor space, 2 floors (1000)

Unique Features:

Renovations: 1950, 1951, 1962

Function-Table

Year	Function
1947	not listed
1950	Metal Recovery Building (Proposed)
1961	Reactor fuels Reprocessing Plant (I) (Chemical Technology)
1972	Fission Product Development Lab Annex (Isotopes)
1987	Fission Product Development Lab Annex
1989	Fission Product Development Lab Annex (Environment & Health Protection)
1991	Fission Product Development Lab Annex
1995	Fission Product Development Lab Annex

Process-Table

From year	To year	Process
1948	1953	reprocessing of TBP-25 (inc. Homogenous Reactor Fuel Reprocessing)
1948	1958	metal recovery
1949	1960	Purex (102)
1950		(1950s) Americium processed in 3505 by solvent extraction (by '58 40g); solvent extraction of neptunium (670 g by '58) (105)
1950		(1950s) chemical process to recover uranium from tank from wastes by continuous extraction w/TBP in kerosene-type diluent (Amsco); plant expanded (?) - dissolver for solid materials (greatest source of radioactivity), 2 more solvent-extraction cycles, plutonium isolation equip, & piping changed to permit processing of various feed materials for recovery of plut, americium, neptunium & uranium (103)

1950	1960	('50s - '60s) several additions added b/w 1951 & 1962; contaminated canal waste of bldg (1002)
1954		fused salt fuel processed to recover uranium - open top cans (104)
1962		(as of 1962(radioactive material content: isodine-131;kypton-85; Pu-239; U-233; U=235; U-238; Th-232; Am-241 (1002)
1962		(as of fall ,'62) Low enrichment uranyl nitrate solution resulting from fuel dissolution, a uranium-plutonium partitioning & second uranium solvent extraction cycle, & evaporation at 3019 is transferred by undergound pipes to 3505; solution is further purified & concentrated by cycle of solvent extraction, evaporation & silica gel adsorption or Zirconium-niobium activity; purified product is stored in extemal tank (1002)
1962		plans said operations would be limited to less than 250 curies of beta-gamma activity & 1 g plutonium or its hazard equivalent; still calls 3505 Metal Recovery Plant; uranyl nitrate solution is received in batches from 3019 through underground pipline (1002)

Hazards: radiation: Pu, Np, Am, U-233, U-235, Th, U-232; chemical: solvent extractants, uranyl nitrate

Inferred Hazards: TBP, nitric acid, hexone, EMF, mercury (CR)

References

102 The ORNL Chemical Technology Division, 1950-1994, p. 4-66.

103 The ORNL Chemical Technology Division, 1950-1994, p. 2-30.

104 The ORNL Chemical Technology Division, 1950-1994, p. 2-34.

105 The ORNL Chemical Technology Division, 1950-1994, p. 2-37.

1000 p.18.

1002 Building 3505, Metal Recovery Facility - Hazards Evaluation, vol. 6, ORNL/Union Carbide Corp., Aug.21, 1962, pp 5-16.

Report of Building Number: *3508*

Construction Year: 1952 **Closure Year:**

Construction Type: Metal sided/steel frame (1000); 2 story, removable corrugated metal panels over rigid steel framework, covered w/class II built-up tar & gravel roof

Size: 13,950 square feet of floor space, 2 floors (1000)

Unique Features: located in security area w/patrolled access at the west side; all operating facilities are on 1st floor; 2nd floor is used for housing the building service equipment; entry into the bldg is through the office area; access to and from the contamination zone (the remainder of bldg) is through the change room; operations on alpha emitting material are performed in labs 1 & 2, labs 1,3,5 are the ancillary facilities providing support. "Interior walls of 1st floor facilities (except utility room) are of metal panel construction. The entire first floor (excluding utility room) has a continuous suspended ceiling..lighting is daylight flourescent type, and the fixtures, along with the air conditioning inlet diffusers, are recessed and sealed into the suspended ceilings. Floor coverings in the general purpose labs and the ancilliary facilities are asphalt tile. In the alpha labs 2 & 4, a continuous surface of Fiberglass-cloth-reinforced liquid tile terminating in a 6 inch high curb around the perimeter of the room contains activity and facilitates decontamination (109)

Renovations:

Function-Table

Year	Function
1947	not listed
1950	Transformer Station F/3503
1961	Chemical Technology Alpha Lab (Chemical Technology)
1972	Chemical Technology Alpha Lab
1972	Chemical Technology Alpha Lab (Chemical Technology)
1989	Chemical Technology Alpha Lab (Chemical Technology)
1991	Chemical Technology Alpha Lab
1991	Chemical Technology Alpha Lab
1995	Electrical Services

Process-Table

From year	To year	Process
		hazards eval for 3505 calls 3508 Chemical Isolation Lab (114) haz eval for 3508 calls it Alpha Isolation Lab; designed for working w/ high-level alpha, low-level beta, and gamma emitting materials & is

		primarily a development & service facilitiy for chemical & analytical work; all operating facilities on 1st floor, operations on alpha emitting material are performed in labs 1 & 2, labs 1,3, 5 are the ancilliary facilities providing support (115) // --Process Description-- (as of '62); solvent extraction & ion exchange used most for developing processes for separating & isolating alpha-emitting material (116); -- Radioactive Material Content: U-233; Am-241; Cm-242 (117)
1950		(late 1950s) purified americium by ion exchange; neptunium purified by alternate oxidation & reduction in flouride solution (112)
1952		occupied by Chem Tech for work w/high alpha activities (110)
1954		R & D to remove plutonium from HRE blanket solutions started 1954 or later
1957		some lab scale developments reported, studies made in 3508 where some steel cells were built to protect personnel (111)
1961	1976	reprocessing of TRUG (incl TRAMEX, CLEANEX, BERKEX, PLURIX and others) (113)// -- First Floor Facilities: Lab 1: Low-level alpha development lab; Lab 2: High-level alpha development lab; Lab3: Low-level (<10 ug Pu) analytical lab; Lab 4: High-level alpha analytical lab; Lab 5: Alpha spectrophotometric and high-pressure lab; Utility Room: Material receiving, air conditioning, and electrical equipment; Offices 6, 7, 8: Contaminated zone administration; Change Room: Isolation barrier between contamination zone and unlimited access zone; personnel clothes-changing facility; Counting Room: Radiochemical analytical counting operation; pulse-height analyses : Instrument Lab: Spectrophotmetric investigation on natural uranium solution (118)

Accident-Table

Year	Accident
1962	(as of 1962) all areas of the building except offices and utility room; the contaminated area is operated at a pressure negative with respect to non-contaminated areas, thus providing leakage into the controlled zone at all times (119)

Hazards: radiation: U-233, Am-241, Cm-242; chemical : solvent extraction chemicals (116-117); chemical: ion exchange media (116)

Inferred Hazards: EMF, freons, mercury (CR)

References

109 Building 3508, Alpha Isolation Laboratory, Hazards Evaluation, vol. 9, 1962, p. 26

110 The ORNL Chemical Technology Division, 1950-1994, p. 2-1.

111 The ORNL Chemical Technology Division, 1950-1994, p. 2-34.

112 The ORNL Chemical Technology Division, 1950-1994, p. 2-37.

113 The ORNL Chemical Technology Division, 1950-1994, p. 4-66.

114 Building 3505, Metal Recovery Facility, Hazards Evaluation, vol. 6, 1962, p.3

115 Building 3508, Alpha Isolation Laboratory, Hazards Evaluation, vol. 9, 1962, p. 3

116 Buildiing 3508, Alpha Isolation Laboratory, Hazards Evaluation, vol. 9, 1962, p. 11

117 Buildiing 3508, Alpha Isolation Laboratory, Hazards Evaluation, vol. 9, 1962, p. 21

118 Buildiing 3508, Alpha Isolation Laboratory, Hazards Evaluation, vol. 9, 1962, p. 27

119 Building 3508, Alpha Isolation Laboratory, Hazards Evaluation, vol. 9, 1962, p. 26, 29

1000 p. 18.

Report of Building Number: *3592*

Construction Year: 1955 **Closure Year:**

Construction Type: metal-sided/steel frame (1000)

Size: 1,200 square feet of floor space (1000)

Unique Features:

Renovations:

Function-Table

Year	Function
1947	not listed
1950	not listed
1961	Unit Operations Volatility Lab (Chemical Technology)
1972	Unit Operations Volatility Lab (Chemical Technology)
1987	Unit Operations Volatility Lab
1989	Coal Conversion Facility (Chem Tech)
1991	Coal Conversion Facility
1995	Coal Conversion Facility

Process-Table

From year	To year	Process
1950	1960	(1950s & '60s) processes involving mercury to support Y-12 thermonuclear weapons program (146)
1950		(late 1950s) unit operations studies for fluoride volatility program (145)
1960		(early 1960s) engineering-scale studies on fluoride volatility program - "short sections of full-size zirconium- and later aluminum-clad fuel elements were dissolved in fused fluoride salts and the salt subsequently fluorinated" (147)

Accident-Table

Year	Accident
1954	in 1954, component development work was done in 3592 in conjunction with the OREX process, and large quantities of mercury were used at this facility with some spillage. One large spill is known to have seeped through the building into the ground. There is no accurate measure of mercury loss at 3592, but operating personnel have estimated a total of approximately 2,000 - 3,000 pounds lost due

to spills and leakage (148)

1980 (mid 1980s) soil samples around bldg contained mercury ranging from 4.1 to 320 ppm (149)

Hazards: radiation: radionuclides from dissolved fuel elements; chemical: Fl salts, Hg, LiCl (147)

Inferred Hazards: coal, PAHs, solvents, EMF, asbestos (CR)

References

145 The ORNL Chemical Technology Division, 1950-1994, p. 25

146 Historical Chemical Release Report for ORNL, May, 1986

147 The ORNL Chemical Technology Division, 1950-1994, p. 4-45

148 Inventory of ORNL Remedial Action Sites: 7. Hazardous Waste Sites, 2/23/86, p. 10.

149 Historical Chemical Release Report for ORNL, May, 1986, and Inventory of ORNL Remedial Action Sites: 7. Hazardous Waste Sites, 2/28/86, p.10

1000 p. 20.

Report of Building Number: *7810*

Construction Year: **Closure Year:**

Construction Type: Non-structure (1000)

Size:

Unique Features:

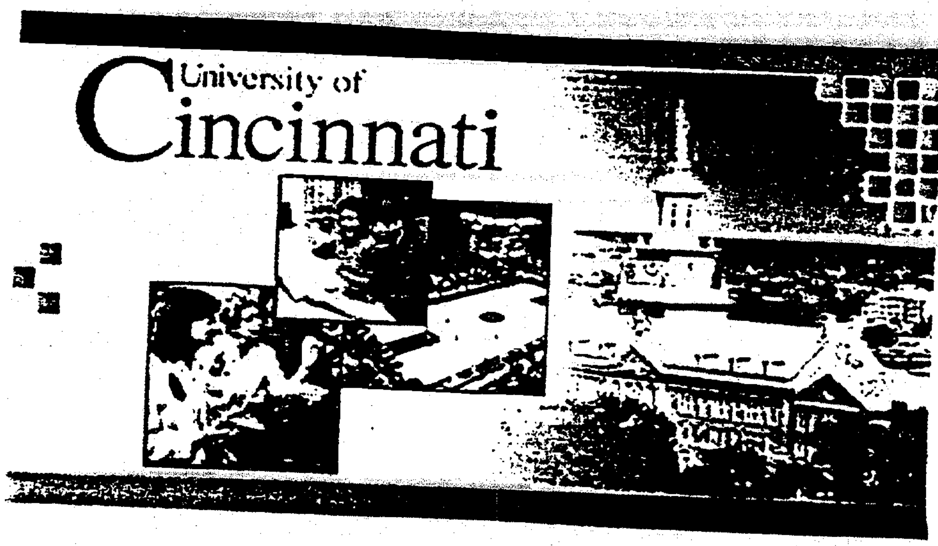
Renovations:

Function-Table

Year	Function
1947	not listed
1950	not listed
1961	Chemical Waste Pit #6 (proposed) (Operations; Lab Facilities Dept.)
1972	Chemical Waste Pit #6 (Operations)
1987	not listed
1989	Waste Trench #6 (abandoned) (Environmental & Health Protection)
1991	not listed
1995	not listed

Accident-Table

Year	Accident
1980	(1980s) Entombment of contaminated sites near 7810 and 7852 (described above): "two impermeable barriers were constructed over each site: a bentonite clay cap and an asphaltic-concrete pavement cover..After removal of the ILW piping in the area and clearance of the sites and their surrounding areas of vegetation (which resulted in the removal of 100 cubic yeards of vegetation and contaminated soil), and herbicide application, clean clay fill was placed over the sites. Next bentonite clay was mixed with the fill. Earth fill was applied, and 1.5 inches of asphaltic concrete was applied and sealed. The leak areas were fenced, rip-rapped around the asphalt base with gravel, and the remaining disturbed areas were seeded and stabilized (196)



Y-12 PLANT
SELECTED BUILDINGS

Oak Ridge Reservation
Oak Ridge, Tennessee

Prepared under the direction of
Dr. Eula Bingham and Dr. Carol Rice
June, 1997

NIOSH Grant No. R01CCR512026
DOE Grant No. DE-FC03-96SF21263

Report of Building No *9201-1*

Date Constructed: 1/1/40 **Year Closed:**

Construction Type: reinforced concrete w/masonry walls, cast concrete fndn (2)

Size:

Unique Features:

Renovations: 1943, 1973 (2)

Process-Table

From year	To year	Process
1/1/40		constructed by Stone & Webster Eng'g Corp, cooling towers along S facade at least 43-46, Alpha processing building, uranium isotope separation using electromagnetic separation to enrich uranium to weapons grade (1943) (2); Machine shop (1946) (1)
1/1/40	12/1/45	Calutrons (alpha/beta)(D10)
1/28/44	9/22/45	Alpha-1 calutrons (D3)
11/5/45		Alpha process (D12)
1/1/46		Machine Shop (D10)
1/1/50		tooling & testing/ weld op'ns (2)
1/1/60		variety of tooling and testing/weld operations (2)
1/1/60		tooling & testing/weld op'ns (2)
1/1/70		variety of tooling and testing/weld operations"; additions, renovations, and new equipment installations have occurred since construction, including an expansion in 1973 (2)
1/1/80		tooling & testing/weld op'ns (2)
2/1/88		machine tool design, utilities, tool crib, inspection, physical testing-weld shop (D11)
1/1/90		Alpha-1 Machine Shop and Tool Design Facility (related to weapons program), general shops, Stores Tool Crib, Dimensional Inspection, Physical Testing/Weld Shop (2); on 8/95 map (D2)
11/14/95		Alpha 1 production (D13)

Hazards: physical: radiation (2,D2), welding fumes (2) (CS)

Inferred hazards: machining fluids, mercury, solvents (CR)

References

2	Welsh, Teresa, Laboratory Records, ORNL, "Y-12 Architectural/Historical Assessment of the Y-12 Plant, Oak Ridge, TN," late 1996.
D10	Bean, G.L., University of Texas, "Questionnaire: Chemical Hazards at the Y-12 Plant," Y/TS-1382, August 1995.
D11	Martin Marietta, "Y-12 Building Directory," February 1988.
D12	Bowles, J.C., Revised Building Index and Area Designations, November 5, 1945.
D13	US Department of Energy, Facilities Information Management System, Owned Buildin Construction Report, 11/14/95
D2	Raymer, K.M., "Radiological Control: Y-12 Site Radiological Buildings and Boundary Control Stations" (Map), August 31, 1995.
D3	Chemrisk, Oak Ridge Health Studies, Phase I Report: Volume II, Part A, Dose Reconstruction Feasibility Study, Tasks 1 & 2, A Summary of Historical Activities on the Oak Ridge Reservation, September 1993.

Appendix B

Draft Medical Surveillance Protocol

Appendix B: Medical Surveillance Protocol
Draft for Review and Comment

a. Goals of medical surveillance program
   1. Perform medical surveillance for specific exposure-related adverse effects and illnesses, as specified under Public Law 3162.
   2. Create a database which may be used to prevent adverse health outcomes from specific exposures encountered in DOE facilities.
   3. Create a database that will be useful for quality assurance and program evaluation.

b. Basic structure of medical surveillance program
   1. A construction worker must have worked a minimum of five years at DOE facilities to be eligible for an examination, unless entry into the program is triggered by site specific exposure data or one of the substance-specific criteria below.
   2. All eligible workers will undergo a core examination consisting of medical history, physical examination, and laboratory tests.
   3. All eligible workers will complete an exposure questionnaire prior to examination. This questionnaire will be compared to a job-exposure matrix to help determine possible significant exposures. Such significant exposures (eg., lead, asbestos, external radiation) will trigger additional testing modules to be scheduled at the time of the general surveillance examination.
   4. Additional modules may also be triggered by specific findings on medical history and physical examination. Examples might include a history of lung cancer, or findings of peripheral neuropathy or interstitial lung disease.
   5. Findings from the examination and laboratory evaluation will be given verbally to the worker at the time of the exam (to the extent that results are available) and conveyed in writing when testing is completed. A set of risk communication materials will be developed to try to standardize interpretation of tests.
   6. Quality assurance activities will be incorporated at all levels of the process.

c. Core examination
   1. Complete medical and occupational history.
   2. Physical examination, with particular emphasis on skin, lung, musculoskeletal and neurological systems.
   3. CBC with differential, electrolytes, BUN, Glucose, AST, ALT, Alkaline phosphatase, bilirubin.

d. Specific Modules
   1. Asbestos

      Chest x-ray and spirometry for workers over 40 years old with >15 years since first exposure and at least 5 years exposure at DOE facilities

Rationale for Five Year Duration, 15 Year Latency

Data from medical examinations of construction trades gives us a basis for establishing these entry criteria. Among sheet metal workers with 25 years of work in construction and 25 years of latency, 31% had some asbestos-related disease on chest x-ray. Of this 31%, one third (11% of the total group) had evidence of parenchymal disease, and 2/3 had pleural disease only. This prevalence was lower in younger men with 25 years in the trade (Welch et al 1994). Similar rates of disease have been reported for electricians (Hodgson 1988), plumbers and pipefitters (Sprince 1985), and for construction workers in general (Kilburn 1989), with higher prevalence rates for insulators (Kennedy 1991, a reference from Selikoff).

Based on this data, 5 years of exposure and 20 years of latency would be expected to result in a 10-15% prevalence of asbestos-related changes, primarily pleural disease. This is a reasonable target for medical surveillance.

2. Silica

Chest x-ray and spirometry for workers over 40 years old with 5 years of exposure in listed occupations, plus 15 years since first exposure.

Occupations: sandblasting, rock drilling, concrete removal and demolition work, bridge, railroad and road construction, tunnel construction, concrete or granite cutting. (Removal/disposal of silica filter material could pose a special hazard at Hanford.)

Occupational exposure to silica occurs in the construction industry among workers employed in concrete removal and demolition work, bridge and road and railroad construction, tunnel construction, concrete or granite cutting, drilling, sanding, and grinding. The highest exposure jobs are in sandblasting and rock drilling. More than 1/3 of the respirable crystalline silica compliance measurements taken at construction sites exceeded the prevailing exposure limit (p. 325 in STAR). There are no prevalence rates from the US for silicosis in construction workers, but in China 84% of a group of tunnel construction workers had silicosis on chest x-ray (p. 326, STAR).

Most forms of silicosis develop slowly, and require years of exposure and a long latency. The disease can progress after cessation of exposure as well. Given the scant data on prevalence of silicosis in construction workers in particular, it is reasonable to use the dose and latency as for asbestos, and to target the higher risk occupations and tasks.

3. Welding

Welding can cause a chronic bronchitis, asthmatic bronchitis, and possibly cause chronic obstructive lung disease. We are recommending that surveillance for welding-related lung disease be triggered after an initial history and physical examination, to target surveillance a those with clinical disease. Abnormal lung function in the absence of cough or wheeze would not be attributable to welding as the exposure, so lung function screening in the absence of symptoms is not indicated where exposure has ended.

4. Beryllium

Lymphocyte proliferation test and chest x-ray **are recommended** for any worker identified as exposed by our exposure matrix, even if they do not meet the five year general entry criteria. After one year this data will be re-evaluated and the protocol adjusted.

Rationale

DOE's current beryllium protocol at Rocky Flats and Y-12 at Oak Ridge is finding chronic beryllium disease in former workers, including those for whom an initial exposure assessment would have classified them as unexposed. A draft DOE document (Medical Evaluations for Former DOE Workers - a Working Paper, March 1995, Office of Health Studies, p. 10) states that self-identification of beryllium exposed workers is an appropriate step for initial screening. We will include those for whom we think a significant exposure may have taken place, and use the results of the LPT and chest x-ray to refine the protocol.

5. Solvents

a. Surveillance for liver and kidney function is included in the core.
b. Exposure to a range of chlorinated solvents alone would require five years of exposure if exposure ceased more than 1 year before examination.
c. If exposure is on-going, enroll in surveillance if the estimated solvent exposure is above the action limit.
d. Neuropsych testing if suggested by history and physical exam.

e. EMG/NCVs if suggested by history and physical exam.

Rationale for requiring five years of exposure for remote exposures:

Acute exposure to a range of solvents can cause heptatotoxicity, generally manifest as an elevation in liver transaminases. It is generally agreed that most of this inflammation ceases after exposure stops (Harrison 1990). In some cases and with some solvents, on-going exposure with resultant on-going inflammation can lead to a permanent injury. This permanent injury is a chronic hepatitis or cirrhosis. The examination is designed to find those with permanent injury from remote exposures.

It has been reported that 5-7% of workers without occupational hepatoxin exposures will have elevations of liver function tests (Hodgson 1989, Wright 1988), and it is well known that many other substances and medical conditions can cause such elevations. These tests are not specific for occupational exposures, nor diagnostic of liver disease. Because exposures in construction are hard to characterize, we have chosen a five year dose as a reasonable one.

6. Heavy Metals

a. Lead

1. blood lead level, ZPP in workers with five years of known or presumed exposure to lead through high risk tasks and exposure within the last year. High risk tasks are included in demolition of metal structures: sandblasting, burning, cutting or welding on steel structures coated with lead paint. These high risk tasks are expected to be found among ironworkers, painters and laborers, and possibly among sheet metal workers, welders and boilermakers.
2. attention to neurological system on medical history and physical examination in anyone exposed to lead.
3. for initial group of 100 workers who have had substantial exposure to lead in the past but have not been exposed within the past year, add challenge testing with DMSO. This, in combination with the lead levels on workers with more recent exposures, will allow re-assessment of the criteria for entry into this specific module.

Rationale for requiring five years of exposure for blood lead testing

In adults exposed to lead in an occupational setting, we can expect to find both an increased body burden of lead and residual health effects after exposure stops, if that lead exposure was of sufficient magnitude and duration. The health effects we could detect from remote exposures are:

- CNS toxicity, manifest as memory loss, mood instability, and impairment of psychomotor testing
- peripheral neurophathy
- renal insufficiency

Construction workers who demolish metal structures are at risk for overt, symptomatic lead poisoning caused by extremely high burst of lead exposure (Landrigan 1982, NIOSH 1991, Osorio 1995). Lead paint coating these structures becomes airborne during sandblasting, rivet removal, and similar tasks, and airborne exposure can reach tens of thousands of ug/M3 (Sokas 1997). Sustained, prolonged exposure such as that found in classic lead industries is not usually found in construction work, and blood lead levels return to "normal" within a month of cessation of exposure as lead moves into long term storage compartments in bone and is excreted.

In laborers and ironworkers who were not performing lead work at the time of the survey, the median whole blood lead was 7 ug/dl, with a range of 2-30 ug/dl (Sokas 1997). Workers who had worked in demolition, burned paint and metal, or welded outdoors had higher levels (mean of 8.6 vs. 6.8 ug/dl). This study was undertaken in a state which has regulated lead exposure in construction since 1984, so these levels may not be representative of all construction workers. They do suggest that sustained elevation of blood lead levels will be uncommon after cessation of exposure. Because of this we are initially requiring five years of work in tasks or occupations with known or likely lead exposure. This entry criteria may be adjusted based on the findings of the first year of surveillance.

Rationale for requiring exposure within the past year

Blood lead levels represent acute and recent exposures most accurately. Over time after exposure has ceased, the lead transfers into long term compartments in bone and other organs. This body burden is to some degree in equilibrium with the blood lead, but as the lead is stored in larger compartments the amounts in circulation decreased. Assessment of body burden due to remote exposures would require challenge testing or x-ray fluorescence.

Challenge testing is added as a refinement of the exposure assessment for 100 initial examinations of lead workers. If these challenge tests do not show significant body burden of lead in workers whom we have assessed to be at risk we will re-adjust our exposure assessment and re-adjust the criteria for entry into the lead module. This will mean that the lead levels done after the initial phase will be more specifically targeted to the at-risk group of workers.

b. Cadmium

1. Attention to neurological exam on medical history and physical examination in any one exposed to cadmium.
2. For an initial group of 100 workers who have had substantial exposure to cadmium appropriate biomarkers will be used: urinary beta-2-microglobulin or retinol binding protein, followed by metallothionein if beta-2-microglobulin (or retinol binding protein) is elevated.

Rationale for requiring five years of exposure for cadmium testing

Following exposure to cadmium, kidney cadmium increase progressively up to a critical level and then kidney dysfunction develops. Depending on the susceptibility of the individual, this critical level of cadmium is 215-385 ppm (Roels 1981). Our goal for this program is to find workers with health effects from prior exposures, and so we will choose to monitor those whose renal burden of cadmium is in this range, and use a marker of effect that is sensitive to the earliest changes in renal function induced by cadmium.

c. Chromium

for any history of exposure:

- Renal function testing is included in the basic examination
- Attention on physical examination to skin for any worker with chromium exposure, looking for allergic dermatitis
- risk communication about risk of lung cancer

d. Mercury

1. Attention to neurological and psychological responses on medical history and physical examinations in any one exposed to mercury.

2. For an initial group of 100 workers who have had substantial exposure to mercury, EMG/Nerve Conduction Velocity (NCV) will be considered.

- neuropsych testing if suggested by history and physical exam
- EMG/Nerve Conduction Velocity (NCV) if suggested by history and physical exam

e. Ionizing Radiation

External and Internal Radiation

Construction workers could have been exposed to various forms of external radiation from contamination sources and process activity releases, including beta radiation to the skin and gamma ray, and possibly neutron exposures would come from film badeges and historical records and reports. Internal exposure could also have taken place to a variety of radio-isotopes including those of uranium as well as various fission products by inhalation and ingestion. The two primary biomonitoring methods for internal exposure are whole body gamma ray counting and urinary radioactivity, gross or speciated according to the type of isotope. Biomonitoring methods for radiation damage, e.g., mutations, chromosomal damage and micronuclei in blood cells. The major concern with the late effects of ionizing radiation is cancer, of which many types are induced, none of which are unique to radiation.

Sufficient time has passed to allow for radioactive decay and excretion of internally deposited isotopes so that exposure biomonitoring is not indicated other than in cases of exceptionally high exposure.

Our strategy therefore is to rely on film badge records, when available, and the history of unusual radiation exposure, accidental or in decontamination operations, to identify individuals who might require special studies for radiation injury and enrollment in a monitoring program for cancer.

7. Noise

audiometry as triggered by history and physical exam, not included as a routine part of the examination

We are recommending that hearing surveillance be triggered after an initial history and physical examination, to target surveillance at those with clinically significant hearing loss. Workers with asymptomatic hearing loss do not need to take any action; surveillance is not indicated in the setting where exposure has ceased and screening results would not trigger any action.

8. Quality Assurance Activities

   a. History and Physical Examination
      - ongoing chart review for incorporation of all information
   b. Laboratory Evaluation
      - ongoing data query for known associations (ie, hematocrit and hemoglobin levels and sex, FEV1 and sex, height and age, FEV1 % predicted and smoking) (Olson et al., 1991)
   c. Risk Communications
      - post exam random sample survey

Appendix C

Occupational History Survey Instrument
(Currently being used for NIOSH - supported project)

Occupational History
Carpenter Task Checklist

University of Cincinnati - Department of Environmental Health

PHASE I - OCCUPATIONAL HISTORY DATA COLLECTION
OAK RIDGE PROJECT
Data Recording - Telephone Interview

Name: ______________________________________

Date: ________________ **Interviewer Name:** ________________

Start Time: __________

1. On the questionnaire you mailed back to us that you did most of your work at _____ (X-10, Y-12, or K-25).
Do you work at ______ (X-10, Y-12, or K-25) now?

CURRENT OR LAST JOB:

Now, I would like you to think about your current/last job at _______(X-10, Y-12, or K-25). I have some questions about this job. By job I mean work on one project in one location.

Specific questions:

1. **Are/were you working in a specific location? Where?** (If in or around a building)

   What was the number of that building? __________

   Did you work inside the building or on the outside? What was the name of the outside zone?

2. **Tell me a little about what you do at your current job (did at your last job) at___ _________.** By asking this general question, you have some information to use to assess the necessity of rephrasing or reordering the questions below.

3. **When did you start this job?** (Try to obtain month and year. If they cannot recall the month, try to get year.)

(If finished with this assignment:) **When were you finished with this job?**

Now I'm going to ask you some very specific questions about where you are/were working. Answer as best you can. If you are not reasonably sure of the answer, don't guess. As you ask these questions, keep reminding the carpenter that you are asking about his/her current or last job, not his/her experience through all jobs at (X-10, Y-12 or K-25).

4. (If inside a building) **On this job at Building _______ in what area are/were you working?**

Is this near any piece(s) of equipment?

5. **Do you know or suspect that there were hazardous materials such as asbestos, lead or mercury in the area in which you are working/worked?** (If YES ask specifically about lead, asbestos and mercury-mention each substance. Also ask specifically if there were any other substances.)

6. **What were the steps that <u>you</u> took in doing this remodeling/new installation?** (Probe to obtain as many job tasks as possible.)

____

____

____

____

____

____

7. **During this assignment, how many total hours per week do/did you spend at the Oak Ridge Reservation? Does/did this include travel time?**

8. **Do/Did you use:**

Paper dust mask?

Respirator with rubber or plastic mask?

Gloves made of cloth or leather?

Gloves made of rubber-like material?

9. **Have you worked in or around this building (area) at other times? When? About how many jobs have you been on int this building/in this area?**

10. **We have sent you a list of tasks that carpenters may do. Think about** ALL OF THE TIMES **that you have worked in or around this building (location). Look at each task on the list and, as I read it, tell me if you have done this task at___________ (building or location). Remember, now I am asking you about** ALL OF THE TIMES **that you have worked at this building/in this area.**
(Use a copy of the task list to check off tasks and frequency.)

As you go through the list of tasks, the carpenter may remember additional tasks that he performed on this job. DO NOT GO BACK TO EARLIER QUESTIONS AN RECORD ADDITIONAL INFORMATION.

FIRST JOB:

The next step of the interview process will be to focus on the first job of the carpenter at Oak Ridge.

Now, could you please think back to your first assignment at _______________ (X-10, Y-12 or K-25).

1. **Where was your first job? What was the number of that building/location of that outside area?**

   Did you work inside the building or on the outside?

2. **Tell me a little about what you did at this job at Building __________.**

3. **When did you start this job?** (Try to obtain month and year. If they cannot recall the month, try to get year.)

   When were you finished with this job?

Now I'm going to ask you some very specific questions about where you were working. Answer as best you can. If you are not reasonably sure of the answer, don't guess.
As you ask these questions, keep reminding the carpenter that you are asking about his/her first job, not his/her experience through all jobs at (X-10, Y-12 or K-25).

4. (If inside a building) **In what area were you working?**

   By which piece(s) of equipment?

5. **Do you know or suspect that there were hazardous materials such as asbestos, lead or mercury in the area in which you are working/worked?** (If YES ask specifically about lead, asbestos and mercury-mention each substance. Ask specifically if there were any other substances.)

6. What were the steps that <u>you</u> took in doing this remodeling/new installation? (Probe to obtain as many job tasks as possible.)

____

____

____

____

____

____

7. **During this assignment, how many total hours per week did you spend at the Oak Ridge Reservation? Did this include travel time?**

8. **Did you use:**

Paper dust mask?

Respirator with rubber or plastic mask?

Gloves made of cloth or leather?

Gloves made of rubber-like material?

(If the location of the first job was different from the location of the current or last job, ask Questions #9 and #10. If the same building or outside area was the focus of both the last job and the first job, skip Questions #9 and # 10 and go to the next section.

9. **Have you worked in or around this building (area) at other times? When? About how many jobs have you been on in this building/in this area?**

10. **Go back to the list of tasks that carpenters may do. Think about all of the times that you have worked in or around this building (location). Look at each task on the list and, as I read it, tell me if you have done this task at**__________ (building or location). (Use a copy of the task list to check off tasks and frequency.) DO NOT GO BACK TO PREVIOUS QUESTIONS and record additional information.

OTHER JOBS:

1. **Think of your other jobs at ___________ (X-10. Y-12, K-25). Try to remember the buildings in which you worked. I'll write them down as you name them.** (After each building is mentioned, ask for building number. If they cannot remember exact building numbers, ask the carpenter to give us his/her "best guess".)

____

____

____

____

____

____

____

2. **At _________, were there any other locations that you worked at that were not buildings?**

Using the list of "Locations of Special Interest" at ___________ (X-10, Y-12, K-25), check off any that the carpenter has mentioned.

X-10	Y-12	K-25
#1-3026-C	#1-9201-01	#1-305-1
#2-3042	#2-9202	#2-402-3
#3-3503	#3-9204-04	#3-502-1
#4-3505	#4-9419-1	#4-601-5
#5-3508	#5-9998	#5-1025D
#6-3592		
#7-7503		
#8-7810		

Using the random number table, randomly select one of the buildings mentioned by the carpenter (consult protocol for exact instructions).

I would like to ask you about one other location of work at ___________ (X-10, Y-12, or K-25), Building _________ (or a non-building location). These questions will refer to all the jobs you had at Building ___________.

3. **What kind of jobs did you have at this building (location)? Tell me about the jobs that took the longest.**
Record information about these jobs.

Job #1 ____________________

In what area were you working?

By what piece(s) of equipment?

Job #2 ____________________

In what area were you working?

By what piece(s) of equipment?

Job #3 ____________________

In what area were you working?

By what piece(s) of equipment?

Job #4 ____________________

In what area were you working?

By what piece(s) of equipment?

Job #5 ____________________

In what area were you working?

By what piece(s) of equipment?

Job #6 ____________________

In what area were you working?

By what piece(s) of equipment?

4. Go back to the list of tasks that carpenters may do. Think about ALL OF THE TIMES you have worked in or around this building (location). Look at each task on the list and, as I read it, tell me if you have done this task at ______________ (building or location). Remember, I am asking you about ALL OF THE TIMES that you worked at Building ____________. (Use a list of carpenter tasks and check frequency. Do not go back and add information to the answers to previous questions.)

5. Did you know or suspect that there were hazardous materials such as asbestos, lead or mercury in the area of Building ______ ? (If YES, ask specifically about lead, asbestos and mercury, or any other materials mentioned.)

6. While you worked around Building ______, did you use:

   Paper dust mask?

   Respirator with rubber or plastic mask?

   Gloves made of cloth or leather?

   Gloves made of rubber-like material?

GENERAL QUESTIONS:

I have just four more questions. These questions refer to the ENTIRE TIME YOU WORKED at the Oak Ridge reservation, at ANY ONE OF THE THREE PLANTS.

1. Do/did you wear a radiation badge?

   (If YES,) When (month and year) did you first wear a radiation badge?

   Did you wear a radiation badge on all of your assignments after that date?

2. Were you ever involved in a major fire? By "involved" we mean being in a smoke filled area during a fire or helping to fight a fire. (If YES,) Where (what building or area)? When?

   Any other fires?

3. Did you ever have to be decontaminated? (If YES,) What was this for? Where had you worked? When?

Were there other carpenters working with you who also had to be decontaminated at that time? (If YES,) Who?

Did you know of other carpenters who had to be decontaminated at other times? What was this for? When did this occur? Who?

4. Did you ever work with equipment that then had to be decontaminated? (If YES) What equipment? When?

COMPLETION OF INTERVIEW:

After administering the set of questions for each job at Oak Ridge, ask the carpenter if he/she would like to add any additional information about any work assignment.

Do you have any other information about any of your jobs that you think I should know about?

Thank you for participating in this interview. As I mentioned earlier, the information you have given me will be used create a more complete history of the work done by carpenters Oak Ridge. Thank you for your time. (Have a nice evening.)

Finish time: ____________________

OAK RIDGE WORK HISTORY PROJECT

Name:______________________________

Study ID: _ _ _ _

CARPENTER TASKS

LAST	FIRST	OTHER	Construction
☐	☐	☐	building with wood (other than scaffold)
☐	☐	☐	building scaffolds
☐	☐	☐	carpenter shop
☐	☐	☐	erecting towers
☐	☐	☐	fabricating covers/enclosures
☐	☐	☐	fabricating wooden parts
☐	☐	☐	hanging doors/cutting door openings
☐	☐	☐	hanging suspended ceilings
☐	☐	☐	installing equipment
☐	☐	☐	installing drywall
☐	☐	☐	laying floor tile/repairing floors
☐	☐	☐	roof surfacing/repairs
☐	☐	☐	setting forms
☐	☐	☐	shoring activities
☐	☐	☐	soil drilling
☐	☐	☐	supporting other crafts
☐	☐	☐	work with wet cement
☐	☐	☐	work with dry cement

Demolition/Removal

☐	☐	☐	dismantling equipment
☐	☐	☐	removing asbestos insulation/transite
☐	☐	☐	removing ceiling tile or panels
☐	☐	☐	removing fiberglass
☐	☐	☐	removing pipe
☐	☐	☐	removing siding
☐	☐	☐	removing and wrecking forms
☐	☐	☐	ripping masonite/wall board
☐	☐	☐	stripping walls/ceilings/floors

☐ ☐ ☐ Welding

☐ ☐ ☐ Pile Driving

Support Activities

☐	☐	☐	expediting materials
☐	☐	☐	issuing construction supplies
☐	☐	☐	issuing protective clothing; cleanup of change house
☐	☐	☐	ladder safety inspections
☐	☐	☐	attending meetings
☐	☐	☐	sign-up and orientation
☐	☐	☐	security delay