LA-13207

# Final Project Report

# TA-21, Buildings 3 and 4 South

Los Alamos
NATIONAL LABORATORY

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# TA-21, BUILDINGS 3 AND 4 SOUTH

by

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## ABSTRACT

**The Environmental Restoration Project has completed the decommissioning of Buildings 3 and 4 South, which are located at Technical Area 21, Los Alamos National Laboratory. This project involved the decontaminating, dismantling, and demolishing of an enriched uranium processing facility housed in two buildings. The Laboratory met all technical objectives in a safe, timely, and cost-effective manner.**

**This final report presents all project details and also serves as a lessons-learned document. It presents a detailed work plan; planning and management issues and resolutions; environmental, safety, and health concerns and solutions; final site conditions; and lessons learned and recommendations that will help the Laboratory address future decontamination and decommissioning efforts.**

## 1.0 BACKGROUND

### 1.1 Introduction

Decommissioning Buildings 3 and 4 South at Technical Area 21 (TA-21), Los Alamos National Laboratory, was one of the largest decommissioning projects funded by the Department of Energy (DOE) during the mid-1990s. It involved decontaminating, dismantling, and demolishing an enriched uranium processing facility housed in two buildings.

### 1.2 Facility Location

Los Alamos National Laboratory resides on the eastern slopes of the Jemez Mountains in northern New Mexico at altitudes between 7000 and 8000 feet. Figure 1 shows the location of the Laboratory relative to Los Alamos County, New Mexico, and the United States. Figure 1 also shows the location of TA-21 within the Laboratory. The western portion of TA-21, called DP West, was constructed in 1945 to house transuranic element research and processing facilities. Much of the site was devoted to plutonium processing until the operations were moved to a newer facility in the mid-1970s. Deactivation of the plutonium-processing facilities began in 1978 and was completed in 1981. However, actinide research continued in other buildings until the early 1990s.

The TA-21 complex also housed the enriched uranium processing facility in Buildings 3 and 4 South. Figure 2 shows the location of Buildings 3 and 4 South within the western portion of TA-21 (DP West). TA-21 is isolated from the rest of the Laboratory; there is no direct access to the site from other technical areas, except through the town site of Los Alamos. The principal reasons for vacating the DP West site were the age of the facilities, the standards under which they were constructed, and their proximity to the town site.

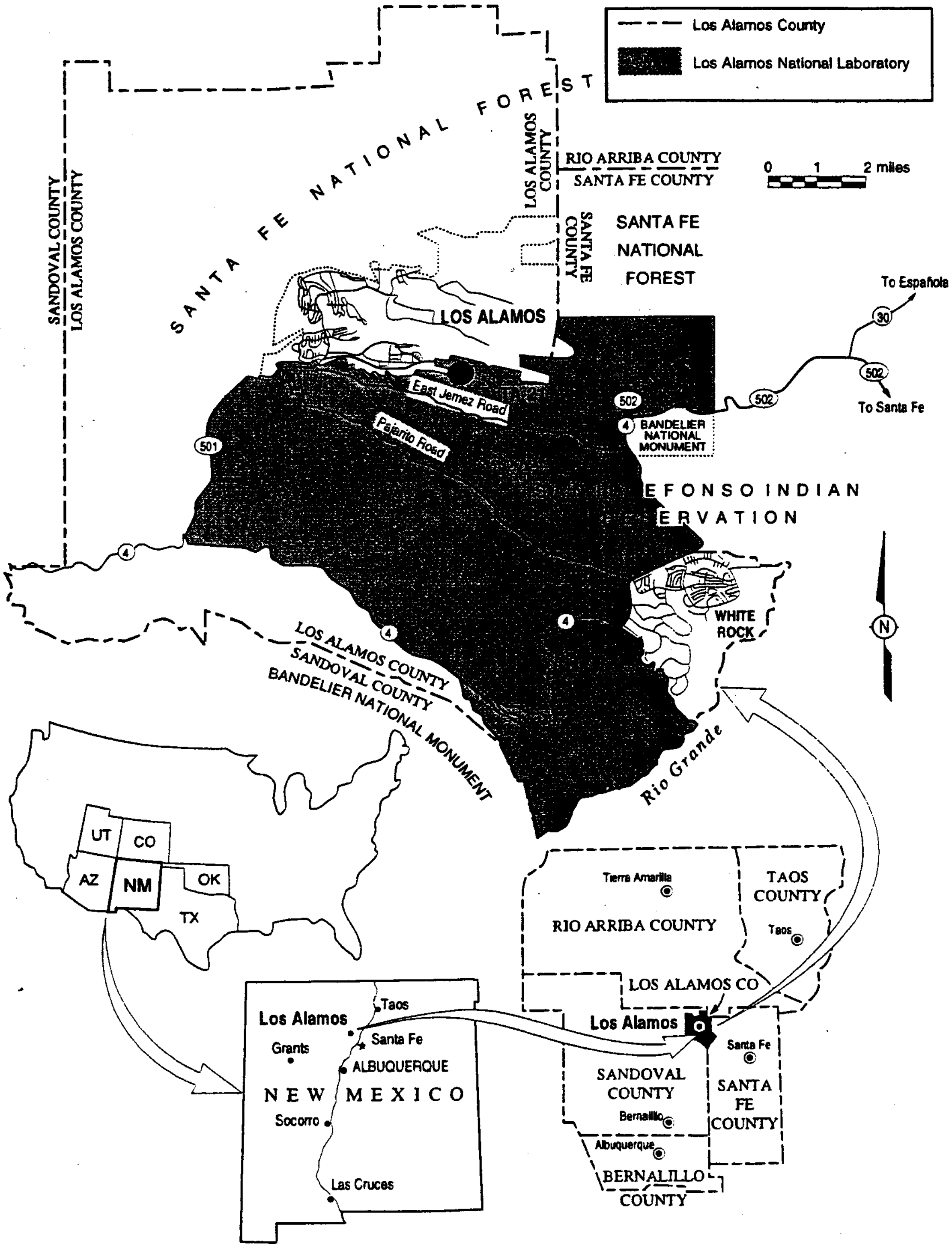



*Figure 1. Location of Technical Area 21 at Los Alamos National Laboratory.*

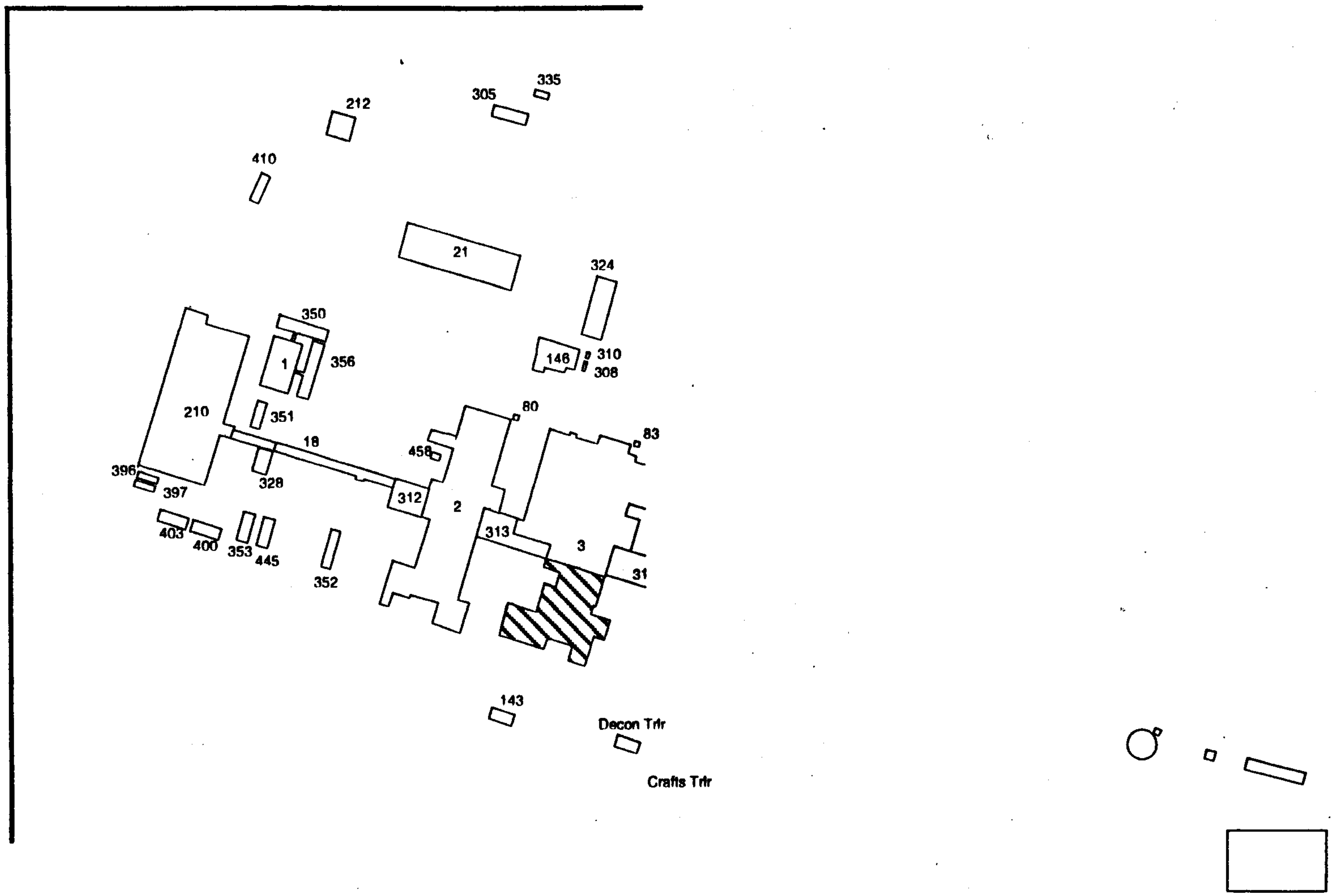



*Figure 2. TA-21 (DP West) buildings.*

## 1.3 Facility History

Buildings 3 and 4 South originally housed personnel and equipment that conducted plutonium-processing operations at TA-21. Building 3 was involved with oxalate precipitation, whereas Building 4 was involved with fluorination of oxalate.

Although detailed operational records from this time period are scarce, anecdotal evidence and interviews with former operators revealed a history of plutonium spills and contamination incidents. Processing efficiency improvements enabled the Laboratory to consolidate plutonium operations in other buildings; as a result, Building 4 South and one-half of Building 3 South were vacated in the early 1950s. However, the other half of Building 3 South continued to be used for plutonium processing, until it also underwent deactivation in the late 1970s.

Established in the early 1950s, the Enriched Uranium Processing Facility at Buildings 3 and 4 South recovered and recycled enriched uranium from scrap, which came in several forms, such as solution, rags, metal bits and pieces, and unused fuel elements. The facility used chemical processes to convert the scrap to a purified oxide or uranium metal that could be reused in nuclear research programs, nuclear weapons, and reactors.

The Enriched Uranium Processing Facility

- prepared uranium metal, alloys, and com pounds for weapons and energy programs;
- recovered uranium from fabrication scrap generated by Laboratory programs; and
- recovered uranium from scrap material generated by other DOE facilities.

The facility was closed in 1984 because it no longer met current construction or DOE safety standards. A portion of Building 3 South was deactivated in 1986. At that time, uranyl nitrate tanks were drained, and the tanks and associated piping systems removed. Asbestos-wrapped glovebox utility lines also were removed.

## 1.4 Project Purpose

The principal goal was to safely and cost-effectively decommission Buildings 3 and 4 South at TA-21. The Laboratory needed to implement this effort not only because of the advancing age of the facilities, but also because of the magnitude of radioactive air emissions. Although the dose received by on- and off-site individuals was estimated at 1/100 of the 10 mrem/yr permissible standard, the emissions from the 2 stacks were the largest curie contributor at DP West.

# 2.0 FACILITY DESCRIPTION

Facility configuration was not well documented and remodeling and refurbishment were not noted on facility drawings. Known instances of modifications are discussed below.

## 2.1 Building Description

Because Buildings 3 and 4 were similar in construction, this description applies to both structures, except when otherwise stated.

The main structure was approximately 98 ft by 39 ft, with a height of 18 ft to the eaves of the roof and a total height of 26 ft to the peak of the roof. Much of the area was open to the bottom of the trusses, although platforms and walkways existed throughout. The area above the truss bottom was an attic, which contained most utilities (electrical, ventilation, fire protection, and steam). The structural system consisted of a clear-span roof truss supported on fireproofed steel columns on approximately 20-ft centers. A fire wall with fire doors approximately 49 ft from the south wall separated the south end from the rest of the building. The walls consisted of a horizontal girt, a vertical channel frame system, a metal exterior skin, and an interior metal lath-and-plaster coating. The building had horizontal roof purlins and ceiling support beams, a metal lath-and-plaster ceiling, and a metal roof.

Perimeter utility tunnels, which measured 4 ft by 4 ft, existed below the 8-in. reinforced concrete floor. These tunnels contained utility lines (steam, electrical, and chilled water) and a radioactive waste line. Portions of the trenches contained asphalt to fix contamination. The floor also contained smaller, grate-covered trenches used for routing processing lines. In Building 3, these trenches had been filled with concrete. Part of the floor in Building 3 and all of the floor in Building 4 had been capped with 4 to 6 in. of concrete; the caps covered up plutonium contamination from the building's use as plutonium facilities in the 1940's.

## 2.2 Systems Description

### *2.2.1 Material-Processing Systems*

Building 3 served as a liquid-processing "Concentration Plant." The plant converted lean and/or impure enriched uranium residues into uranyl nitrate solutions. Residues were converted to uranyl nitrate solutions, filtered, extracted with 15% tributyl phosphate in kerosene, and concentrated to a nominal 250 g U/l. Materials processed included

- rags and other combustibles,
- fabrication crucibles,
- analytical residues,
- uranium peroxide filtrate,
- recovery process solids,
- electropolishing solutions, and
- uranium chips from metal fabrication operations.

The concentration plant also incinerated graphite-casting crucible scrap in a rotary calciner; incinerated rags in a glovebox rag incinerator; dissolved processed solids, rotary calciner product, and rag ashes in HF-$HNO_3$ solution; and sampled and analyzed process solutions. Figure 3 shows the layout of Building 3 South, the Uranium Concentration Plant.

Room 313 in Building 3 South housed processing equipment. It contained hazardous materials, such as hydrogen fluoride (HF) in the HF-processing cubicle. Hoods and gloveboxes, tanks, ducts, piping, furnaces, a calciner, and an incinerator were contaminated with enriched uranium. Rooms 312, 320, and 322 were office space. Room 308 (warehouse space) contained a caustic transfer system, but the remainder of the room was deactivated during the 1978–1981 D&D project at DP West (Garde, Cox, and Valentine 1982). Remaining radioactivity (Pu) had been left in a bus-bar cable tray overhead in Room 308. Room 300A (equipment room) and 3A (mechanical room) contained support equipment for both buildings.

Building 4, the Final Recovery and Purification Plant, purified enriched uranium from the Concentration Plant and other sources; produced enriched uranium metal; and prepared special uranium compounds. To conduct the purification process, concentrated hydrogen peroxide was used to precipitate uranium from a dilute nitric acid solution as uranium peroxide. The uranium peroxide ($UO_4$) was vacuum filtered and calcined to triuranium octoxide ($U_3O_8$) as the final product.

To produce enriched uranium metal, the purified $U_3O_8$ was reduced to uranium dioxide ($UO_2$) with flowing hydrogen, and the $UO_2$ was converted to uranium fluoride ($UF_4$) with anhydrous hydrogen fluoride. The $UF_4$ was reduced to pure uranium metal with calcium. Special uranium compounds prepared in the plant included uranium dioxide conforming to several sets of characteristics, as well as uranyl fluoride and uranyl sulfate solutions. Figure 4 shows the layout of Building 4 South, the Final Recovery and Purification Plant at the start of the project. Rooms 408, 412, and 413, as well as the equipment room in Building 4 South, housed the plant. The other rooms were office space and locker rooms. Figures 5 and 6 are flow diagrams that identify the processes and equipment used for metal production.

After shutdown in 1984, both buildings were maintained as Category III security areas (less than 1 kg $^{235}U$ in process), so that no special access controls or clearance requirements were necessary. Most of the equipment was left in place.

### *2.2.2 Electrical System*

An upgrade of the TA-21 electrical system

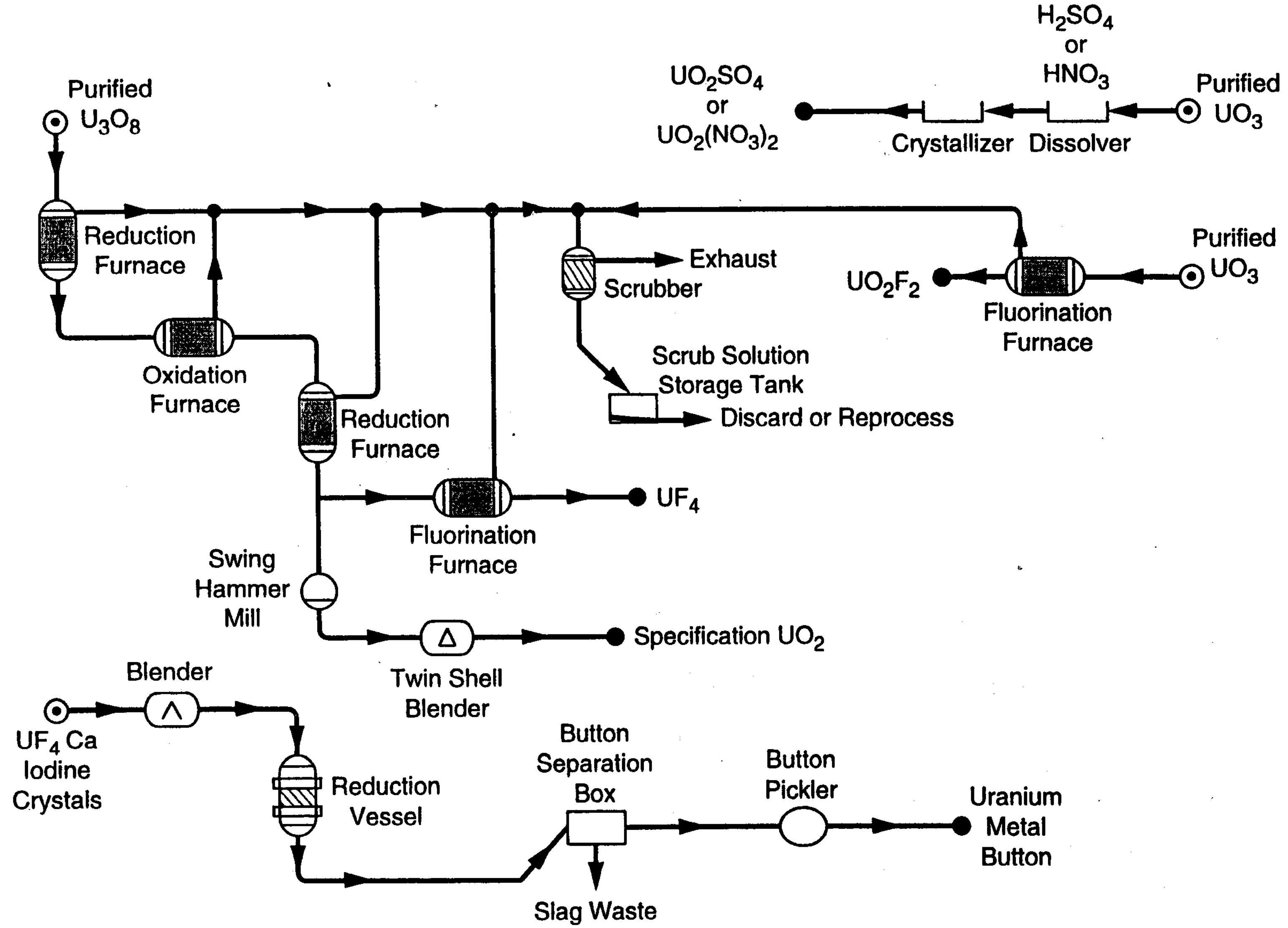



*Figure 3. Floor plan of the Concentration Plant (Building 3 South).*

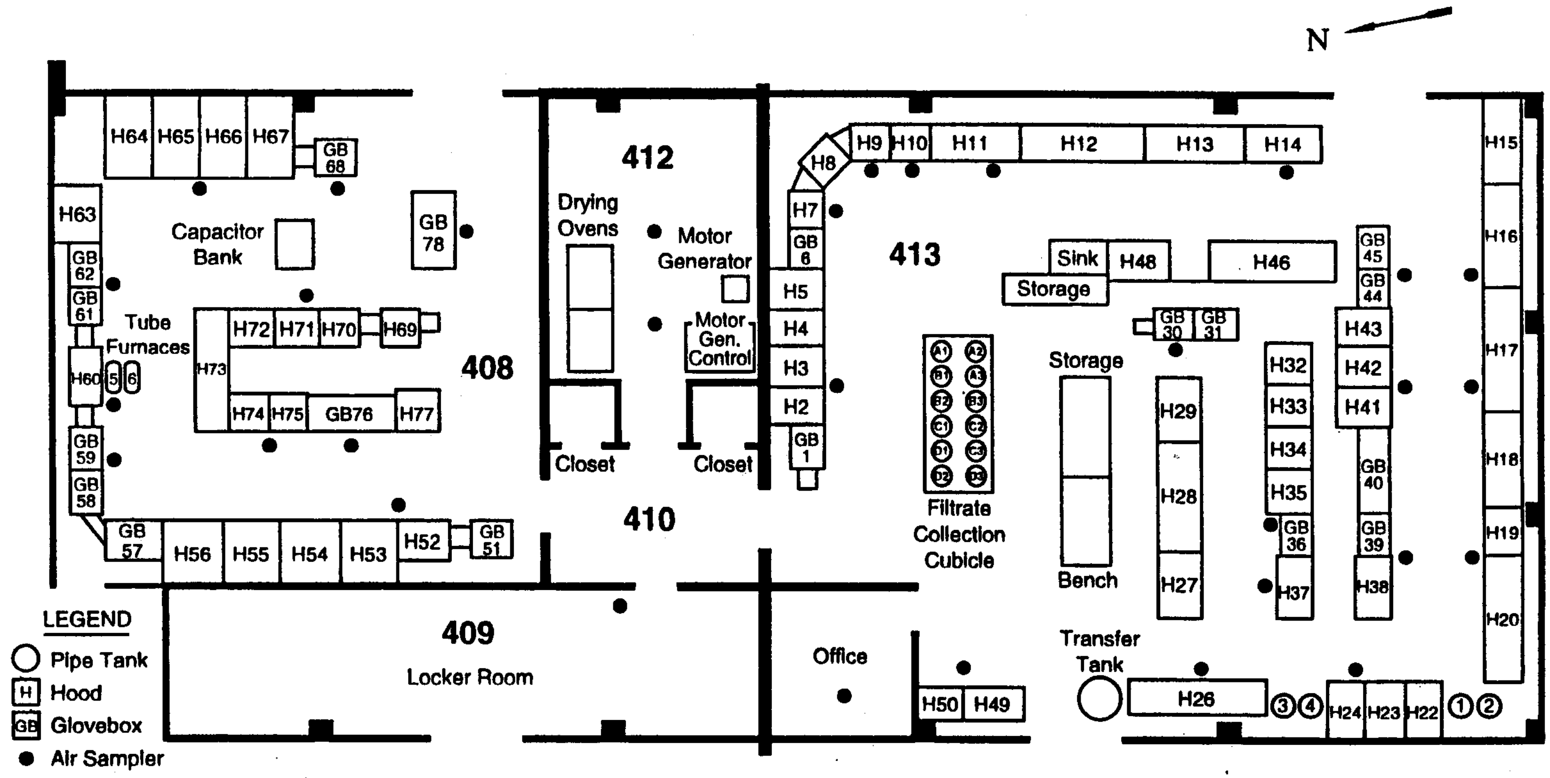



*Figure 4. Floorplan of the Final Recovery and Purification Plant (Building 4 South).*

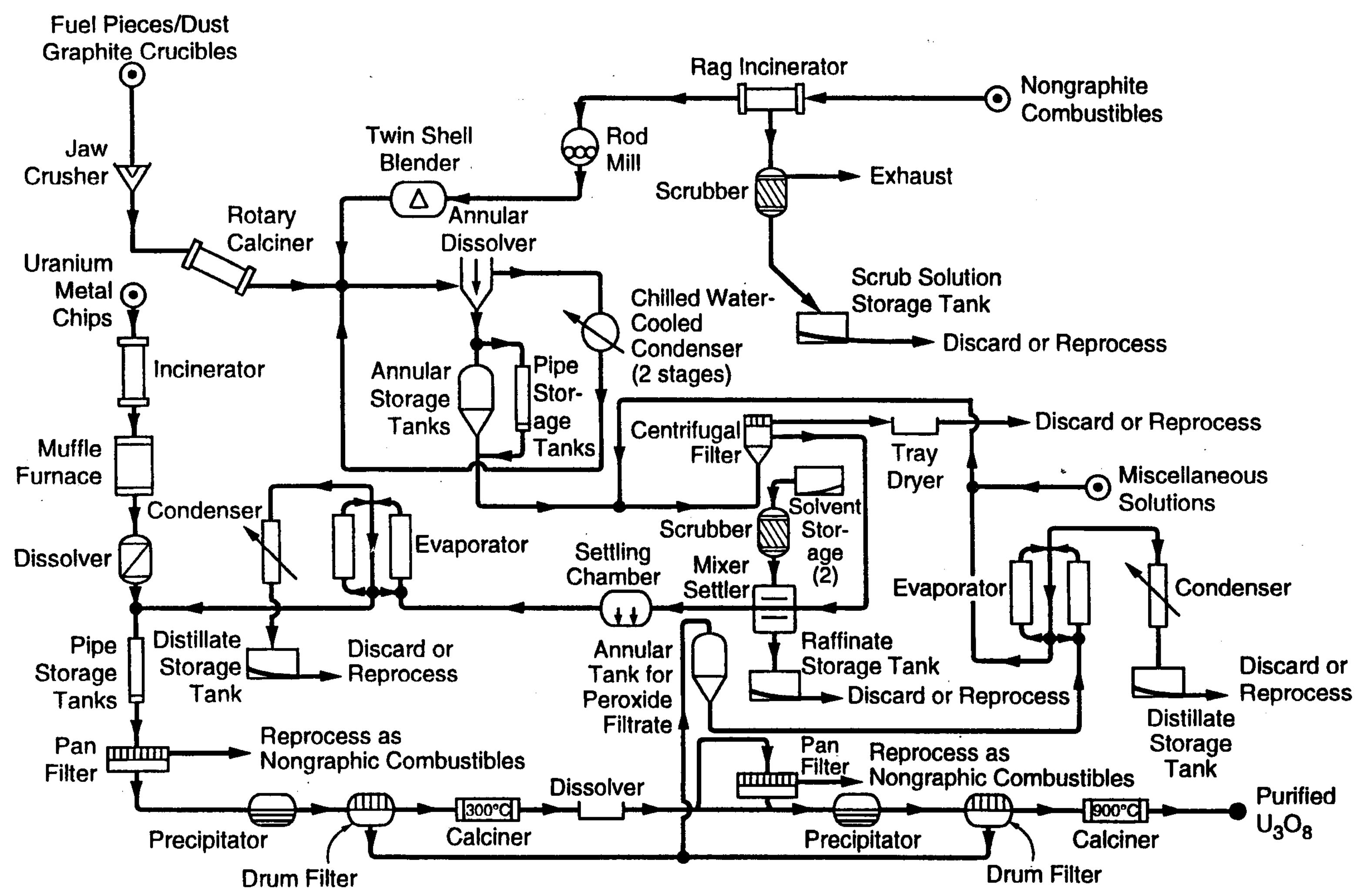



*Figure 5. Process diagram of $U_3O_8$ productio.n*

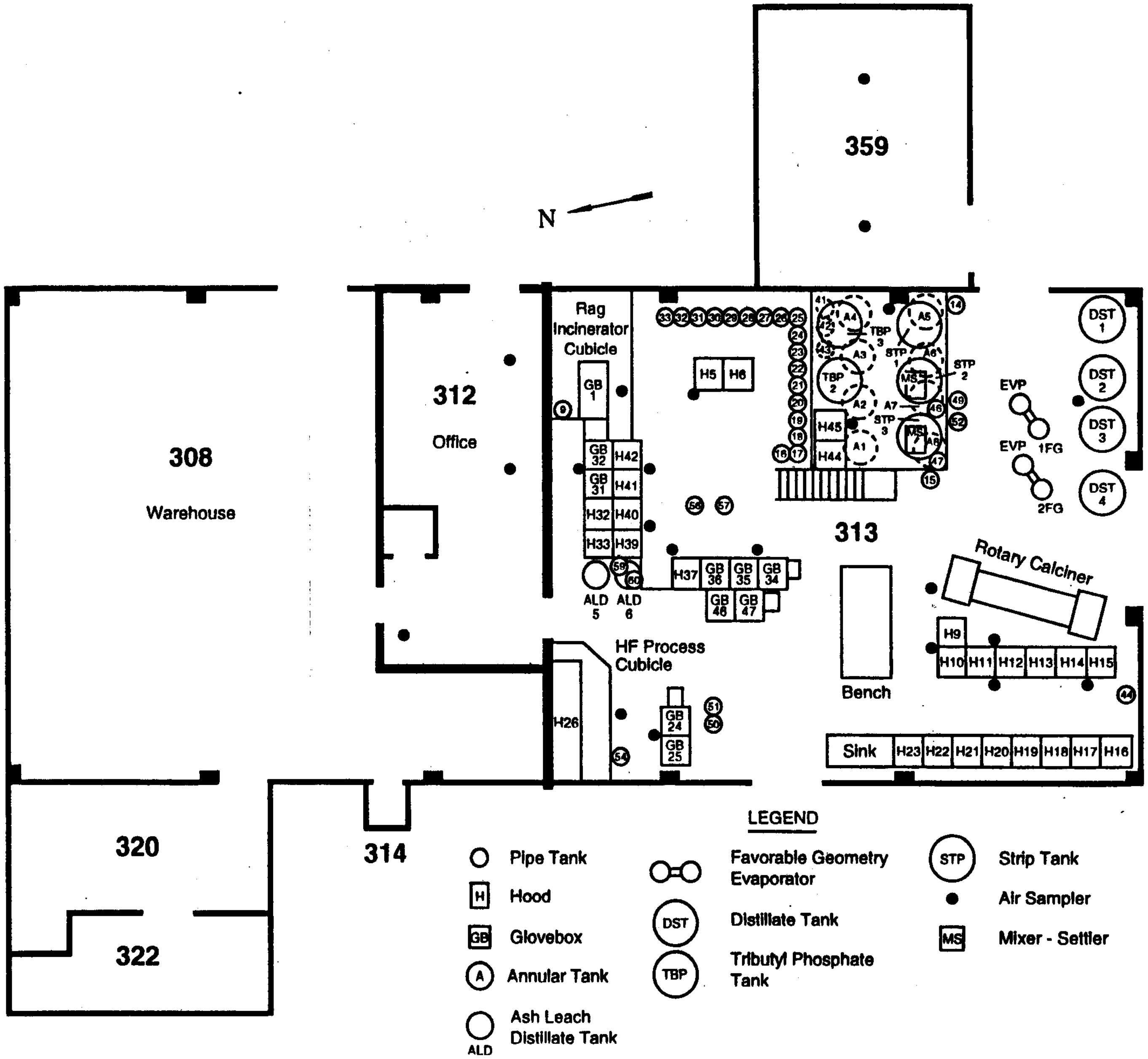



*Figure 6. Process diagram of metal production*

ferred) and the other from the Eastern Technical Area substation, which is equipped with automatic transfer capability.

A substation serves each DP West building. A 13.2-kilovolt (kV) loop with manual transfer capability feeds the primary (13.2 kV) side of each substation. The secondary side (480 kV) also can be manually transferred to provide backup power. The backup feeder for Building 3 is the Building 2 substation, and the backup feeder for Building 4 is the Building 5 substation. If a backup feeder is used, it is always on the secondary side.

Each substation serves both the northern and southern portions of the building. The bus ducts primarily serve panel boards, with a bus duct serving the northern and another serving the southern half of each building.

### 2.2.3 Vacuum System

Buildings 3 and 4 maintained separate vacuum systems used to transfer solutions, fill reagent tanks, and filter solutions. Both systems used steam jet ejectors to provide the vacuum. The vacuum receiver in each system was a nominal 100-gal. tank that acted as a reservoir. The reservoir was packed with borosilicate Raschig rings to provide nuclear criticality safety. The vacuum system in Building 4 also had two 6-in.-diameter Pyrex cylinder traps: one 4-ft primary trap, and one 3-ft backup trap. Most of the system was in place at the start of decommissioning, but the reservoir tanks had been removed in 1987 for safeguards purposes.

### 2.2.4 Steam Distribution System

The TA-21 steam distribution system provided steam to Buildings 3 and 4. The steam supply lines entered the buildings in the attic; the steam was piped to the various processing areas, where it was used in the vacuum systems, continuous evaporators, water still, steam plates, and other processes. The steam condensate passed through a heat exchanger and drained to the industrial waste system. The system was in use at the start of decommissioning.

### 2.2.5 Compressed Air Lines

Three air compressors provided compressed air at 60- to 80-lb/in$^2$ pressure to the DP West buildings. The compressed air lines entered Buildings 3 and 4 in the attic; the air was piped to the various processing areas. Compressed air was used in the rotary calciner, rag incinerator, mercury dissolvers, and drum filtration system, as well as to operate air cylinders. The system was operational at the start of decommissioning.

### 2.2.6 Chilled Water System

Housed in the equipment room (Room 300A) next to the south side of Building 3, a refrigeration system provided recirculating chilled water to all TA-21 buildings. Because the equipment room was razed as part of the decommissioning effort, a smaller unit was installed near Buildings 3 and 4 North to meet chilled-water needs. The old system, which was intact but not operational at the start of decommissioning, supplied 330 gal./min. Chilled water was used in the concentration plant for the following:

- the burning chambers of the rag incinerator,
- the condensers for the distillate from the continuous evaporators,
- the reflux condensers in the HF-dissolution system, and
- the heat exchangers for the steam jet exhaust in the vacuum system.

The Final Recovery and Purification Plant used chilled water in the high-frequency induction heater system and in the heat exchangers for the steam jet exhaust in the vacuum system. The Final Recovery and Purification Plant also had a dedicated chilled-water system for the hydrogen peroxide and ammonium hydroxide used in the continuous precipitation process. The chilled-water system was not a limited volume system; leaks in the system caused localized flooding and various times during its operation.

### 2.2.7 Water System

Water from Los Alamos County comes to TA-21 through two elevated towers protected by an air gap. Water is then supplied to all buildings at the site through an 8-in. loop. At each building, the supply is diverted into two separate systems, potable and nonpotable, which are protected from each other by backflow-prevention devices.

#### 2.2.7.1 Potable Water

The potable water system served drinking fountains, kitchen sinks, janitor's sinks, showers, lavatories, commodes, emergency showers, eye-washes, and hose-bib outlets. All water systems operated at the beginning of the project.

#### 2.2.7.2 Nonpotable Water

Nonpotable water (also called process water) served laboratory sinks, the makeup to the chilled water circulating system, and processing systems that had the potential to become contaminated by chemical or radiological constituents.

### 2.2.8 Sanitary Waste Disposal

All sanitary waste fixtures were connected to a common main routed to the sewage treatment facility at TA-21.

### 2.2.9 Radioactive Liquid Waste Treatment

Liquid waste generated during the recovery process, including discard solutions and waste released into stainless-steel sinks, was discharged through a 1.5-in. stainless-steel process waste line and routed to the waste treatment facility at Building 257, the radioactive liquid waste treatment plant. Other liquid waste, including waste from fountains, mop and lavatory sinks, steam condensate lines, and the vacuum transfer steam jets, was discharged to a 4-in. cast-iron industrial waste line and routed to the waste treatment facility at Building 257. The stainless-steel process waste lines and the cast-iron industrial waste lines were installed in 1952, and the lines were extended in 1967. The Building 4 waste lines could not be used because they had been grouted with concrete.

### 2.2.10 Ventilation Systems

Buildings 3 and 4 each maintained a separate ventilation system. Both systems were once-through. No interlocks existed between supply and exhaust; no overpressurization controls were in place. Building 3 had one supply fan (which also served Building 4) and three exhaust fans, whereas Building 4 had one exhaust fan. Ventilation systems were operational at the start of the project.

#### 2.2.10.1 Supply

The supply unit for Buildings 3 and 4 South was on the roof of the spinal corridor that connects the two buildings. This unit took air from outside then either passed it through a dust filter and over steam coils to heat it or passed it through a washed-system evaporative cooler to cool it. The air was then distributed through ceiling diffusers and through wall louvers with adjustable manual dampers.

#### 2.2.10.2 Exhaust

Air in Rooms 312 and 313 was exhausted through louvered vents on the wall near the floor. Exhaust from these rooms was unfiltered and vented to the main stack on the east side of Building 3 (stack # FE-3). Exhaust from Rooms 308, 314, 320, and 322 went into two different high-efficiency particulate air (HEPA) filtered systems that serve the spinal corridor and north side of Building 3. The exhaust from hoods in Room 313 was unfiltered, except for hoods 11 through 15. Hood 20 (in Room 313), which was used for drying solids from the HF dissolver, had a dedicated exhaust blower to maintain the hood at a negative pressure. The exhaust from this hood was unfiltered; it was vented to a small stack on the west side of Building 3.

The glovebox system in Building 3 South had a dedicated exhaust blower to maintain the gloveboxes at a negative pressure. The exhaust passed through a HEPA filter at the box and another HEPA filter before exiting through a stack on the roof of Building 3. The exhaust blower/HEPA filter was not operating at the beginning of the project, and exhaust ventilation was provided by a redundant connection to unfiltered stack FE-3.

Building 4 South did not have a room exhaust system: all exhaust in the building passed through hoods, gloveboxes, or furnaces. Before venting to a stack on the roof of the spinal corridor, it passed through one stage of prefilters and one stage of 80% efficient filters. HEPA filtration was not present.

## 2.3 Radiological and Toxicological/ Chemical Contamination

The Laboratory typically follows the "observational approach" when decommissioning. That is, rather than fully characterize the facility to identify all problems, only enough data are collected to begin work, followed by preparing contingency plans to address potential unknowns. Section 4 discusses site characterization planning in more detail.

Alpha contamination was distributed throughout the facility. The primary source of alpha contamination was $^{235}U$, with lesser amounts from $^{238}U$. Plutonium, americium, and other radionuclides also were present. Although amounts were not quantified at the beginning of the project, areas surveyed during the 1978-1981 deactivation and known to contain plutonium contamination in excess of 1 million dpm/100 $cm^2$ included the perimeter utility tunnels and the electric bus bar in Building 3.

Buildings 3 and 4 South also contained a variety of processes, many of which used toxic and/or corrosive materials. Table 2-1 identifies the significant contaminants of concern at the start of decommissioning; the table also presents U-235 estimates obtained by non-destructive assay during the project. Figure 7 presents photographs of the building interiors at the beginning of the project.

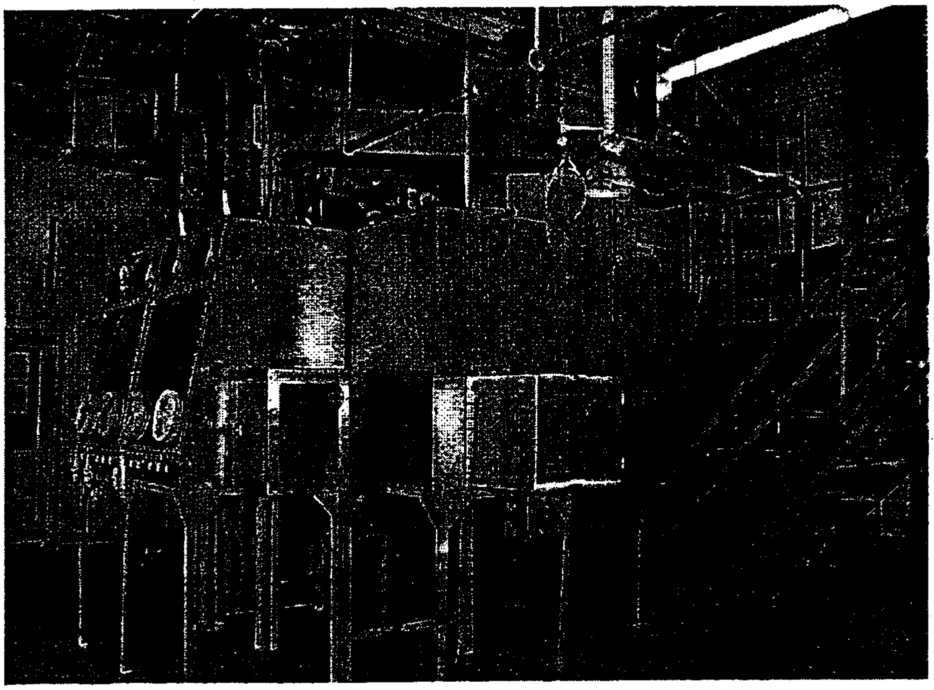
# 3.0 DECOMMISSIONING OBJECTIVES AND WORK SCOPE

## 3.1 Goals

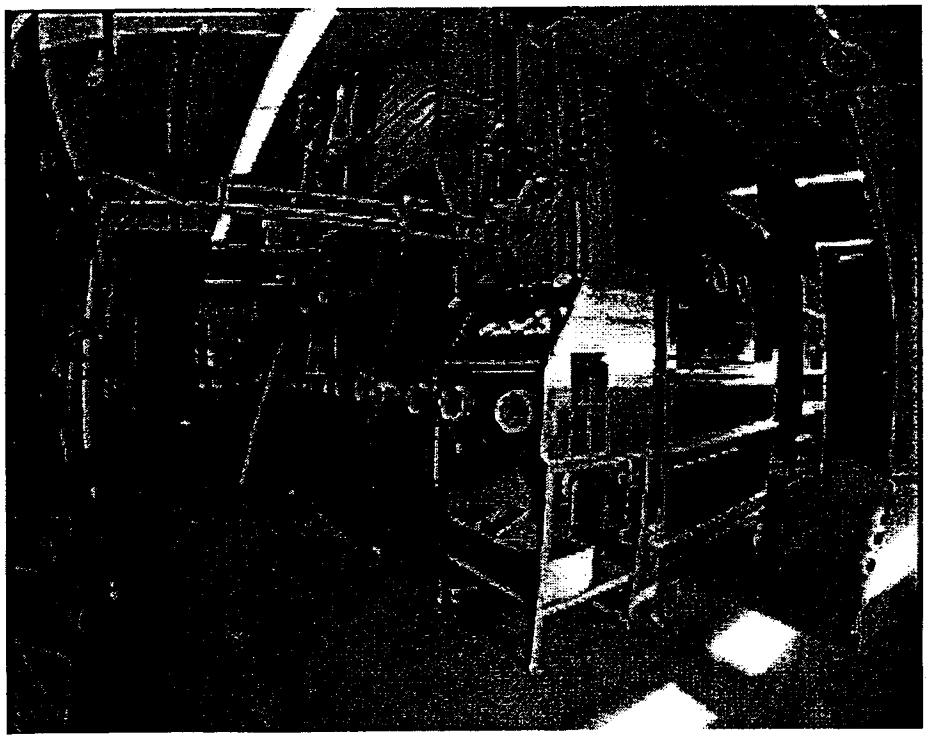
The overall goal of the Decommissioning Project for TA-21, Buildings 3 and 4 South, was to decommission the Enriched Uranium Processing

**TABLE 2-1. SUMMARY OF POTENTIAL CONTAMINANTS AT BUILDINGS 3 aand 4**

| Radioactive | | Chemical |
|---|---|---|
| Location | Total Grams of U-235 | Asbestos: piping, furnaces, floor tile |
| Bldg. 3 hoods & gloveboxes | 570 | Resource Conservation and Recovery Act metals: piping, paints, limit switches |
| Bldg. 3 other equipment | 370 | PCBs: lighting ballasts, transformers |
| Bldg. 3 exhaust ventilation | 360 | Nitric, hydrofluoric, acetic, and sulfuric acid : piping systems |
| Bldg. 4 hoods & gloveboxes | 5000 | Hydrogen peroxide: piping systems |
| Bldg. 4 other equipment | 195 | Potassium hydroxide: piping systems |
| Bldg. 4 exhaust ventilation | 1615 | Ammonium hydroxide: piping systems |
| **Total U-235** | **8110** | Ammonium nitrate: piping systems |
| | | |
| Pu-328, Pu-239, and Am-241 in tunnels and the floor | | |



*Interior of Building 3, at start of project.*



*Process equipment inside Building 4, Room 413, at start of project.*

*Figure 7. Photos of building interiors.*

## 3.2 Scope

Decommissioning of Buildings 3 and 4 South involved clearing the buildings to the walls and ceiling by removing all contaminated and uncontaminated equipment, hoods, gloveboxes, tanks, and piping. The buildings were then razed to the supporting truss closest to the corridor, which separates the north and south sides of the buildings. Also removed were the utility tunnels under the buildings, exhaust ventilation ductwork, and stacks. Figure 8 details the remaining structures and indicates the portions removed.

The original project plan called for excavating up to two feet of soil beneath the entire building footprints. Much of the soil underneath the floor slab was not contaminated, although the soil in the perimeter utility tunnels was. The footprints were remediated to below the release criteria presented in Section 3.4.

The project scope also included the management of all wastes generated during decommissioning. Waste management activities included characterization, minimization, packaging, transportation, and disposal.

## 3.3 Technical Approach

Because of the age and condition of the buildings, the Laboratory decided early in the project-planning phase to demolish the structures rather than renovate them. Consequently, the fundamental technical approach relied on proven technology, combined with engineering controls to protect workers and the environment. Within each building, large source terms were removed as soon as practicable. Portable HEPA-filtered negative air units provided each building or work area with HEPA ventilation. Building demolition began only after loose residual contamination was below acceptable levels, and the buildings were demolished using a hydraulic shear to minimize waste, dust emissions and hazards to workers.

An important part of the technical approach consisted of project organization and work methods. To reduce characterization costs, the Laboratory follows the observational approach. As discussed later in Section 4.5. A small project team capable of on-the-spot decisions conducted detailed planning as decommissioning progressed.

## 3.4 Final Release Criteria

Cleanup and release criteria were identified to release waste for subsequent transportation from the site, to release equipment and materials from the site, and to remediate contaminated soil.

Equipment and material were released for other uses outside of radiological and controlled areas; such releases followed the procedures and surface contamination limits specified in DOE Order 5400.5. For transuranics, release limits are 20 dpm/100 $cm^2$ removable, 100 dpm/100 $cm^2$ average; for uranium release limits are 1000 dpm/100 $cm^2$ removable, 5000 dpm/100 $cm^2$ average.

Volumetric cleanup levels for radiological contaminants were established using procedures specified in DOE Order 5400.5. The RESRAD computer code was used to determine radiation doses associated with concentrations in soil for residential and industrial use scenarios. The guidelines were reviewed and approved by DOE (DOE 1996), and are based on the more restrictive value obtained from either the residential scenario, at a calculated annual exposure of 100 mrem, or the industrial use scenario at a calculated annual exposure of 15 mrem. The following table shows single radionuclide limits for residual radionuclides above background.

| Nuclide | Authorized Limit (pCi/g) |
|---|---|
| Am-241 | 90 |
| Cs-137 | 45 |
| Sr-90 | 9 |
| Pu-238 | 105 |
| Pu-239 | 95 |
| Pu-240 | 95 |
| Pu-241 | 3330 |
| Pu-242 | 100 |
| U-234 | 380 |
| U-235 | 140 |
| U-238 | 340 |

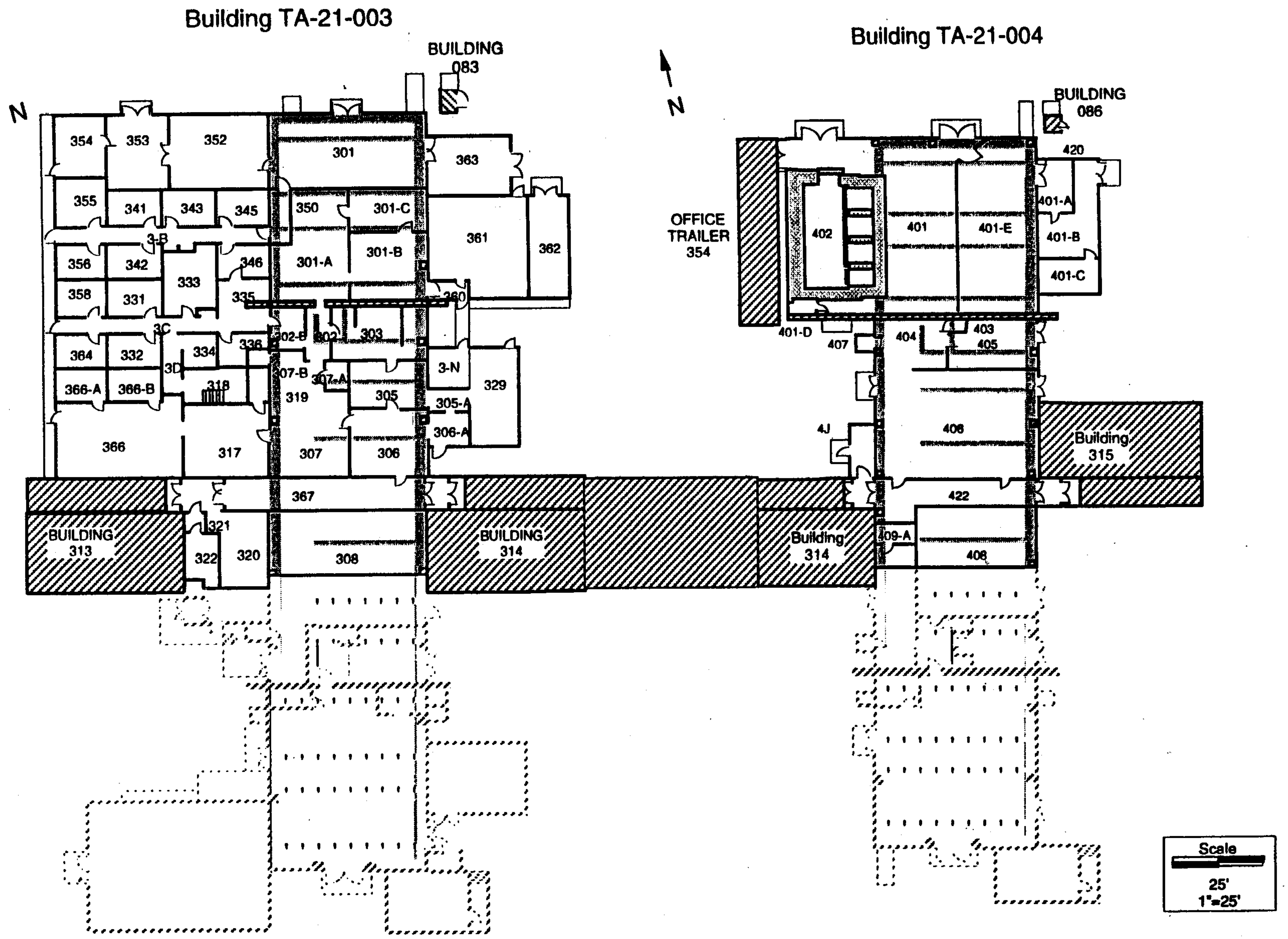



*Figure 8. Diagram of Buildings 3 and 4 at Technical Area 21.*

Soil was excavated to levels below the authorized limits. Additionally, decontaminated concrete was crushed and surveyed to confirm it was below release limits and then used as backfill. See the Appendix for final survey results.

### 3.5 Restoration

Minimal site restoration has been performed. Crushed concrete was used to fill the building footprints, followed by compacting and grading to prevailing conditions. Additional site restortion will be performed when all structures have been removed from DP West

## 4.0 PLANNING AND PROJECT MANAGEMENT

### 4.1 Project Management

The Laboratory's Environmental Restoration project managed this project. The Laboratory supplied health physics support, safety oversight, engineering coordination, and waste management. Johnson Controls World Services Inc. (JCI), performed decontamination and dismantlement.

Project management made every effort to obtain competitive products and services. Using the on-site support services subcontractor, JCI, rather than external subcontracting on a bid basis, was justified based on local conditions, remote location of the site, lack of other experienced decommissioning contractors within a practical distance, and JCI's successful record of providing decommissioning support to the Laboratory.

The project was organized in two phases: planning and operations. The planning phase addressed relevant environment, safety, and health concerns through analyses and radiological sampling. Additionally, cost estimates and work plans were developed. Before beginning operations, the Laboratory and DOE conducted a readiness review to confirm preparatory work was complete and to ensure all involved aprties were ready to begin decommissioning.. Decommissioning operations are discussed in Chapter 5.

Figure 9 shows the organization chart for the TA-21 Project. The decommissioning project leader was responsible for overall project execution. The Engineering Project Coordinator served as the

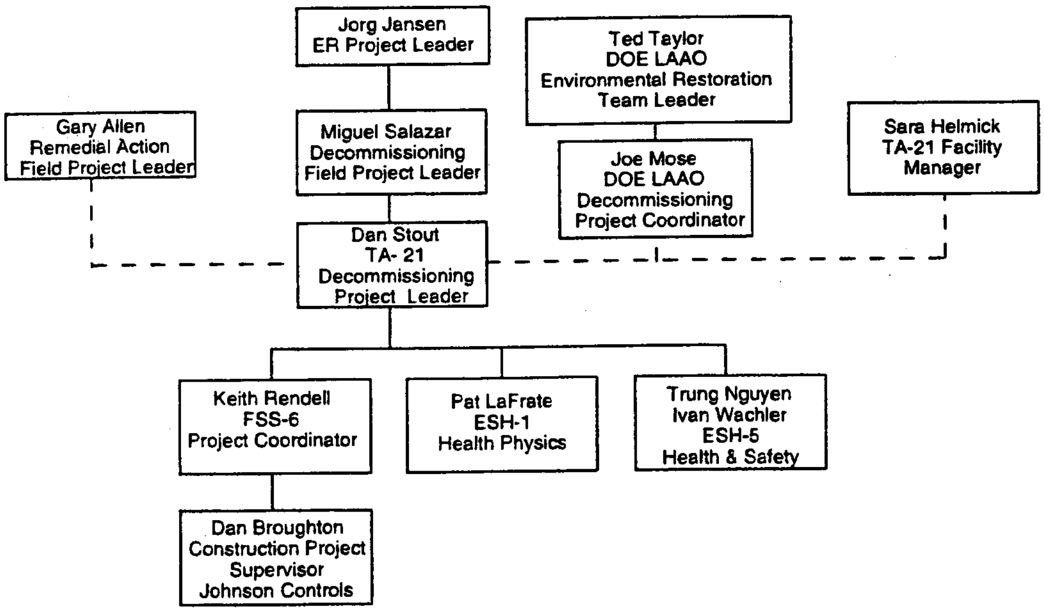



*Figure 9. Organization chart for the TA-21 Project.*

liaison between the Laboratory and JCI. Other project team members included representatives of Health Physics Operations (ESH-1), the Facility and Risk Management Group (ESH-3), the Industrial Hygiene and Safety Group (ESH-5), the Criticality Safety Group (ESH-6), the Waste Management Group (EM-7), the Environmental Protection Group (EM-8), the Safeguards Assay Group (NIS-5), the DOE Los Alamos Area Office (DOE-LAAO), and the Chemical Science and Technology Division.

Throughout the project, weekly meetings were held in which the decommissioning team would discuss matters that facilitated the project.

Decommissioning project management also provided for generating, reporting, analyzing, and controlling cost and schedule performance in the following ways:

- Project participants used and maintained information on performance measurement of costs and schedules; the information provided timely, objective performance data.

- Actual project progress was tracked each month against baseline budget reviews and scheduled milestones. Cost and schedule status were monitored using earned-value techniques to determine work in progress in relation to budgeted cost of work performed.

Appropriate corrective action was initiated to rectify cost and schedule variances as they were identified.

## 4.2 Project Engineering

Alternatives evaluated in the project planning phase consisted of facility decontamination followed by re-use, and facility decommissioning. Because no new users for the facility could be found, and because the buildings did not meet modern codes and standards, demolition was selected as the best alternative.

As part of the planning phase of the project, a Project Management Plan, which also contained Health and Safety Plan, Waste Management Plan, and Quality Assurance plans were prepared (LANL 1993). These plans were approved by the Laboratory and DOE. As is consistent with the Los Alamos decommissioning philosophy, many of the specific methods for removing systems or demolishing the buildings were deferred until the operational phase in which detailed work packages were developed and approved.

Existing data were used whenever possible. Construction drawings and as-built drawings prepared during the construction and operational phase of the TA-21, Buildings 3 and 4 South, were used to support decommissioning activities, although some additional drawings were prepared as the project proceeded. Similarly, the Safety Analysis Report for the Enriched Uranium Processing Facility proved beneficial in determining process history (Johnson 1984).

Compliance with Occupational Safety and Health Administration and other worker-related regulations was ensured by normal adherence to the appropriate sections of the Laboratory Environment, Safety, and Health Manual (ES&H Manual), the Laboratory's Radiation Protection Program Documents, and the project Health and Safety Plan. In addition, specific task hazard analyses were prepared for field activities to address worker safety. A concern identified during the planning phase was the proximity of the site to co-located Laboratory employees: several operating laboratories were within 50 feet of the project. An evaluation of the estimated radiation dose to employees at TA-21 in the vicinity of Buildings 3 and 4 South during decommissioning was prepared before beginning work. The maximum dose received by a nearby occupational site resident was estimated at $2.4 \times 10^{-2}$ mrem/yr.

## 4.3 Site Characterization and Environmental Planning

Although the project was not exhaustively characterized, there was enough exisiting information to begin decommissioning operations. Summarized in the project plan was extensive radiological survey data and preliminary hold-up estimates of ventilation system and process equipment.

Immediately at the start of operations, the Laboratory's Safeguards Assay Group conducted more detailed measurements of nuclear material hold-up. The information enabled the Laboratory to receive authorization from DOE Albuquerque to discard the materia as low level radioactive waste; it also helped in conducting dismantlement and waste disposal activities.

A DOE Environmental Checklist (DEC) was prepared in 1992 to address the project (DEC-92-187). DOE determined (DOE, 1993) that the project would be eligible for a categorical exclusion under NEPA, as long as activities were in compliance with National Emission Standards for Hazardous Air Pollutants (NESHAP).

The decommissioning project followed the requirements of NESHAP, Subparts A and H (40 CFR 61). Because this project was conservatively considered to be a modification to an existing structure, NESHAP required an estimate of radioactive air emissions. The estimate showed a minor increase in emissions for a short duration, but overall emissions decreased in the long term (one year or more). Ordinarily, the estimate can be reviewed and approved internally; however, the Laboratory as a whole was not in compliance with NESHAP requirements, so approval of the analysis was necessary from the Environmental Protection Agency (EPA). To comply with NESHAP requirements, DOE submitted an application for approval of modification of a stationary source of radionuclide emissions to EPA on April 13, 1993. This application was approved by EPA on June 25, 1993. The planning phase of the project took an additional 18 months because of the time required to prepare the detailed analysis.

## 4.4 Site Preparation

Little site preparation was required to begin operations. Although downgraded and unmanned, site security was extensive because the facilities had been Category 1 special nuclear material areas. Existing fencing and entrances were used to control site access. JCI controlled site entry. A portable change trailer was located on site for worker dressing and showering. Some special items were procured in advance, included a two-person lift, scaffolding, a concrete cutting saw, and several HEPA-filtered negative-air machines. Existing tools and equipment from previous projects also were used.

## 4.5 Work Package Development

Because hazards can vary greatly even on similar work tasks (such as ductwork removal), all significant activities were incrementally controlled and authorized through the work package process. The work package consisted of the following components, as required:

- a task procedure or instruction,
- a task hazard analysis (THA),
- a Radiological Work Permit (RWP), and
- special work permits (confined space, spark- or flame-producing, lockout/tagout, criticality).

The project team prepared a work package for each task, such as removal of a particular section of duct, several weeks or days before the scheduled start. In many cases, the THA was updated to reflect any new hazards, although the procedure remained unchanged. The complete package described hazards, including contamination levels; identified required personal protective equipment (PPE); and specified the required work sequence. Workers signed off on the package prior to beginning the task, and the package was posted near the actual location of the activity. Daily safety meetings also reinforced work package requirements. During the weekly project meetings, requirements for permits and procedures for upcoming work were identified and responsibility for preparation was assigned.

## 4.6 Quality Assurance

The criteria established for the project in the QA Plan followed the requirements of DOE Order 5700.6C in all aspects of the operation.

These areas included

- program,

- personnel training and qualification,
- quality improvement,
- documents and records,
- work processes,
- design,
- procurement,
- inspection and acceptance testing,
- management assessment, and
- independent assessment.

The following processes were implemented to improve project quality:

- Individual work package performance was inspected weekly. The inspection checked deviations from the package and process improvements.
- A site safety officer inspected biweekly a different subset of applicable regulations or guidelines, such as the OSHA (Occupational Safety and Health Administration) crane and lifting device standard.

# 5.0 DECOMMISSIONING OPERATIONS

The project followed presently accepted industry practices. Because alpha contamination was the radioactive hazard in question, remote systems were unnecessary.

## 5.1 Decommissioning Sequence

The general decommissioning sequence consisted of system electrical disconnects, acid-line and piping removal, hood and glovebox removal, exhaust system removal, asbestos removal, concrete floor sawing, utility piping removal, final system disconnects (i.e., electrical and fire protection), and building demolition. Table 5.1 summarizes the activities and quantities dealt with.

## 5.2 Asbestos Removal

Procedures for asbestos removal adhered to OSHA and EPA requirements. Removal procedures in general followed these guidelines:

- Removal operations were confined to small areas.
- Glove-bagging techniques were used.
- Workers in the area wore protective clothing and respiratory protection.
- Wetting or encapsulation procedures were used to reduce airborne asbestos.
- Asbestos-covered piping and tanks were removed without stripping all asbestos. Only enough asbestos was removed to free the pipe or tank. The exposed asbestos was double-bagged for removal and disposal at TA-54.
- Air sampling during removal operations was conducted in accordance with OSHA requirements.
- Required reporting of removed asbestos were made to EPA and the New Mexico Environment Department.

## 5.3 Equipment/System Removal

Before removing equipment, appropriate systems were removed following standard practices (e.g., lockout/tagout procedures for electrical and piping systems). Acid and caustic systems relied on straightforward work practices and similar controls; in some cases, however, nitric acid systems were removed by using supplied-air respiratory protection because of the potential for large quantities of residual acid and the lack of an approved air-purifying cartridge for nitric acid.

Initially, an oxyacetylene torch was used to dismantle industrial piping and support structures (e.g., mezzanines). After a small fire near a support building, caused by sparks traveling through a horizontal pipe outside to dry brush, use of the cutting torch was greatly restricted. Portable bandsaws, circular pipe cutters, and a hydraulically actuated crimping shear were suitable replacements.

Hoods and gloveboxes were removed intact as much as possible. The primary constraint was size, which made handling and waste packaging difficult. Initially, individual sections were wrapped in plastic and transported to an on-site disposal area. However, this method had a number of inefficiencies:

- it was difficult to wrap the sections;
- it required many flatbed shipments; and
- it required increased fill material at the disposal site (low disposal efficiency).

Large sea-land shipping containers, measuring 20 ft by 8 ft by 8 ft were used for all items from Building 4, and this greatly simplified all phases of the operation.

All hoods and gloveboxes inside Building 3 were unbolted, although protective enclosures surrounding the rag incinerator and hydrofluoric acid cubicle had to be removed with a plasma arc torch. Some separations inside Building 4 had to be performed with the plasma arc torch. The plasma arc torch required supplied-air respiratory protection because of potential lead emissions or radiological concerns. Additionally, twelve large gloveboxes/enclosures containing furnaces required extensive decontamination because of visible (100 grams or more) amounts of uranium oxide spilled on the enclosure floors. After decontamination, the enclosures were dismantled and the furnaces removed.

Dismantlement typically followed the negative pressure supplied by the ventilation system. Because it lacked a filtration system, the exhaust system for Building 3 was cut off at the beginning of the project. The stack was then capped and portable HEPA systems were attached near the stack to control ventilation. Additional portable HEPA machines provided general and task-specific exhaust. The Building 4 ventilation system also had to be isolated midway through decommissioning because the filtration system was only 80% efficient.

Initially, a portable reciprocating saw was used to remove stainless-steel exhaust ductwork. However, a small fire was started inside the Building 3 ductwork. A sample of material scale inside the ductwork revealed that 3-5% perchlorates were present. Perchlorate salts, which form from the use of perchloric acid, can be explosive, shock sensitive, and are a strong oxidizer. Perchloric acid use had not been identified during record searches and interviews with the original building users. Modern perchloric-acid-handling hoods rely on water washdown systems within the exhaust ductwork to rinse out perchlorate salts.

The problem posed by the Building 3 exhaust system was formidable. The two perchlorate-contaminated sections measured 3 ft by 3 ft; ran for 30 ft inside the building; formed a larger 4 ft by 4 ft upsweep through the attic which continued onto the building roof; and each section contained several hundred grams of enriched uranium. To solve this problem, Los Alamos contracted experts in perchlorate system dismantlement from Oak Ridge National Laboratory (ORNL). They visited the project and advised the Laboratory on sampling and dismantlement procedures. ORNL has established a 750-ppm action threshold, above which a system must be treated as perchlorate contaminated.

To test for perchlorates in the field, a sample is collected on a wet swab. The tester typically must wear ballistic protection gear. The swab is analyzed by a precipitate test (methylene blue) and with a perchloric-ion-specific electrode. Tests inside Building 3 confirmed the perchlorate problem, but Building 4 was free from perchlorates (testing was conducted at the fan-flexible housing, just before the filter plenum, and in individual hoods).

As long as they are wet, perchlorates can be safely handled. To dismantle the system in Building 3, a criticality analysis was performed to ensure that the addition of water did not lead to criticality. Because the minimum amount of uranium needed in a perfectly reflecting, spherical solution is approximately 800 grams, criticality was not a problem. The exhaust system was connected to the steam lines in the attic, steamed for 24 hours, and dismantled with high-strength nibblers. Components were washed in a large tank and sampled to ensure residual perchlorate levels were below 750 ppm. Steaming proved very effective in reducing initial levels, and one stack in Building 3 was cleaned to

## TABLE 5-1. ECOMMISSIONING SEQUENCE AND RESULTANT WASTE QUANTITIES

| Activity | Bldg. 3 Quantity | Bldg. 4 Quantity |
|---|---|---|
| Site Mobilization | N/A | N/A |
| | | |
| Decontamination | Little initial decon | Extensive decon of process equipment (furnaces) , catwalks, and walls (10 furnaces and 2000 $ft.^2$ of walls) |
| | | |
| Asbestos Removal | 500 linear ft. in attic and main equipment room; 2 5000 gal. chiller tanks | 300 linear ft. in attic |
| | | |
| Piping Removal | 80 ft. $HNO_3$ lines, 20 ft. HF lines | 250 ft. $HNO_3$ lines, 80 ft. HF lines, NAOH tanks and 50 ft of piping, 15 critically safe Pyrex pipe columns, 12-12 ft. Pyrex pipe tanks (filtrate collection cubicle). |
| | | |
| Hood and Glovebox Removal | 45 (105 linear ft.) | 77 (295 linear ft.) |
| | | |
| Miscellaneous Equipment Removal | Rotary calciner, rag incinerator , HF cubicle, and cooling tower | |
| | | |
| Utilities Removal | Electrical , fire protection, heat, supply air | Electrical , fire protection, heat, supply air |
| | | |
| Exhaust Removal | 250 ft. interior, 75 ft. exterior (discovered perchlorate contamination) | 1000 ft. interior, 200 ft. exterior |
| | | |
| Outside Stack Removal | 1- 55 ft. stack, 3-15 ft stacks | 1-25 ft. stack |
| | | |
| Structures Removal | 6400 $ft.^2$ | 3850 $ft.^2$ |
| | | |
| Trench Piping Removal | 1000 linear ft., 100 ft. asbestos contaminated | 320 linear ft. |
| | | |
| Concrete Structures Removal | 700 $yd.^3$ | 500 $yd.^3$ |
| | | |
| Soil Removal | 50 $yd.^3$ | 150 $yd.^3$ |

below the action level only by steaming. The rinse solution was sent to the radioactive liquid waste treatment plant; the perchlorate ion posed no hazards to the treatment system. Although the fire was caused by perchlorates, the portable reciprocating saw was no longer used on ductwork because of its potential for sparking.

Before structural demolition took place, all utilities and fire protection systems were disconnected. In the case of Building 3, the concrete slab above the perimeter utility trenches was sawed and lifted off, and the tunnel piping was removed. The entire concrete slab also was sawed into 8-ft by 8-ft sections. Neither practice was followed for Building 4, which was removed with a trackhoe. The trench-piping removal inside Building 3 did not result in radioactive emissions, so building containment was unncessary, and it proved difficult and costly to work in the building with open trenches. With respect to sawing the entire floors. Dust suppression controls for the building razing would have been adequate for removing the concrete floor with a wrecking ball, and the intent of minimizing concrete waste volume by sawing the Building 3 floor was not realized. Sections proved too difficult to wrap individually for disposal, and transport in covered dumptrucks resulted in debris comparable to those resulting from removal with heavy equipment.

## 5.4 Building Razing

To demolish the buildings, the Laboratory rented a hydraulic shear and trackhoe. Although renting equipment is common in the commercial sector, the practice had not been used before by the Laboratory because of the potential for contamination. However, the risk for contamination on this particular effort was low, and the advantages of increased productivity, improved worker safety, and effective waste segregation and minimization clearly outweighed the contamination risk. Building 3 was demolished using the shear in August 1994, and Building 4 was demolished in April 1995. In both cases, the equipment was decontaminated below surface contamination limits and returned without incident.

Radiologically controlled areas were established around the buildings. Air-monitoring stations were placed around the perimeter of the controlled area to monitor emissions. Workers also wore lapel air samplers to check for radioactive emissions. A fine water mist was sprayed over areas being demolished to control dust.

Building interiors were surveyed for residual contamination before demolition. Although Building 3 was below surface release limits, Building 4 had hot spots reading in excess of one million dpm. These spots were decontaminated using a rotary scabbler tool to acceptable levels and then sprayed with a fixative to trap loose contamination. No airborne radioactivity was detected during demolition of either building. Figure 10 shows the demolition of the buildings.

The floor slab of Building 4, which consited of a 4" to 6" cap over the original 8" slab, was decontaminated, after the structure was removed, using a vacuum shot-blast system. Approximately 1/4 in. of concrete was removed. The area was surveyed for residual contamination, and portions above surface release limits were marked. The top slab was removed and segregated into contaminated and "clean" piles. The process was repeated on the bottom slab. By crushing and using the "clean" concrete on-site as fill, approximately 500 cubic yds. of waste was averted.

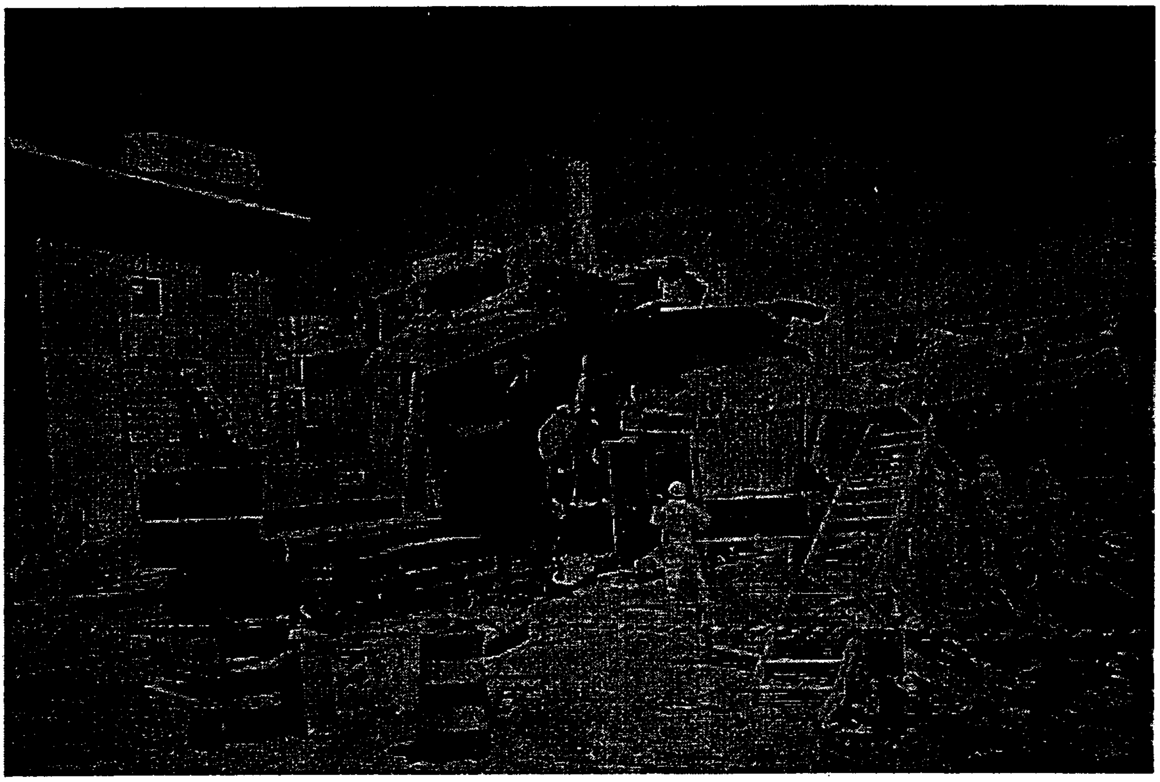
## 5.5 Post-Decommissioning Radiological Survey And Results

The project's scope originally included the removal of a finite volume of soil beneath both slabs. Because contamination was exclusively radioactive and was largely present only beneath the utility tunnels, the footprint was remediated to levels below the previously listed authorized limits. Table 5.2 summarizes initial footprint contamination levels following building demolition. Sampling locations are presented in Figures 11 and 12. The "Work Plan for the Soil Remediation of Buildings 3 and 4 South Footprints" (LANL 1995) describes the procedures used to remediate and survey the soil. The project, and the Work Plan, followed the DOE

**TABLE 5.2. INITIAL FOOTPRINT CONTAMINATION LEVELS IN PCi/G PRIOR TO REMOVAL**

| Contaminants | Building 3 | | Building 4 | |
|---|---|---|---|---|
| | Average | Maximum | Average | Maximum |
| U-234 and U-235 | 50 | 19000 | 30 | 4100 |
| Pu-239 | 70 | 890 | 60 | 960 |
| Am-241 | 10 | 260 | 8 | 120 |
| Cs-137 | 5 | 150 | NDA | NDA |

*NDA - No detectable activity above backgound



*Demolition of Building 3 South (August 1994).*

*Demolition of Building 4 South (June 1995).*

*Building 3 Concrete Pad after razing.*

*Figure 10. Demolition photographs.*

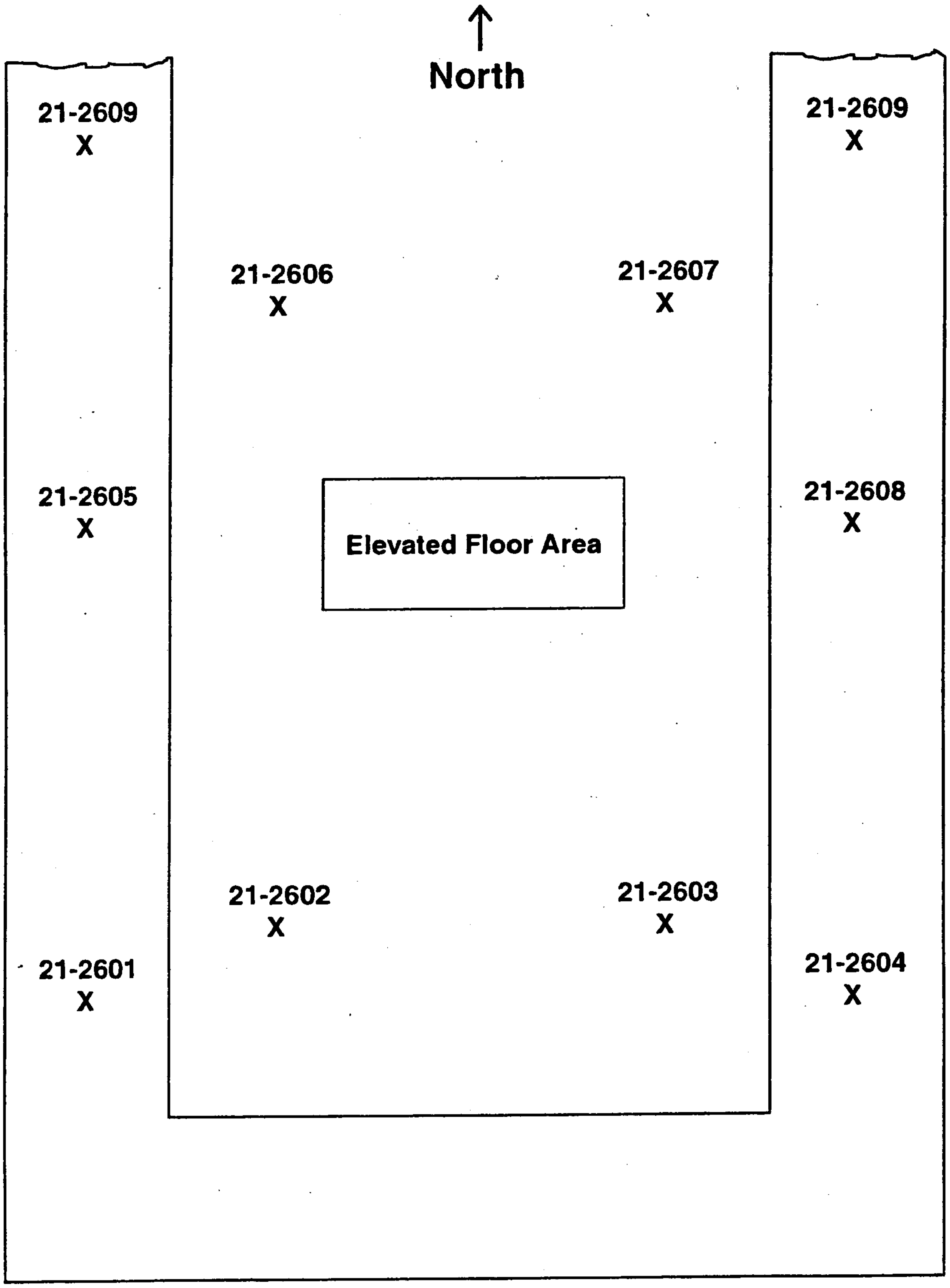



*Figure 11. TA-21 Building Number 3 South Sampling Locations.*

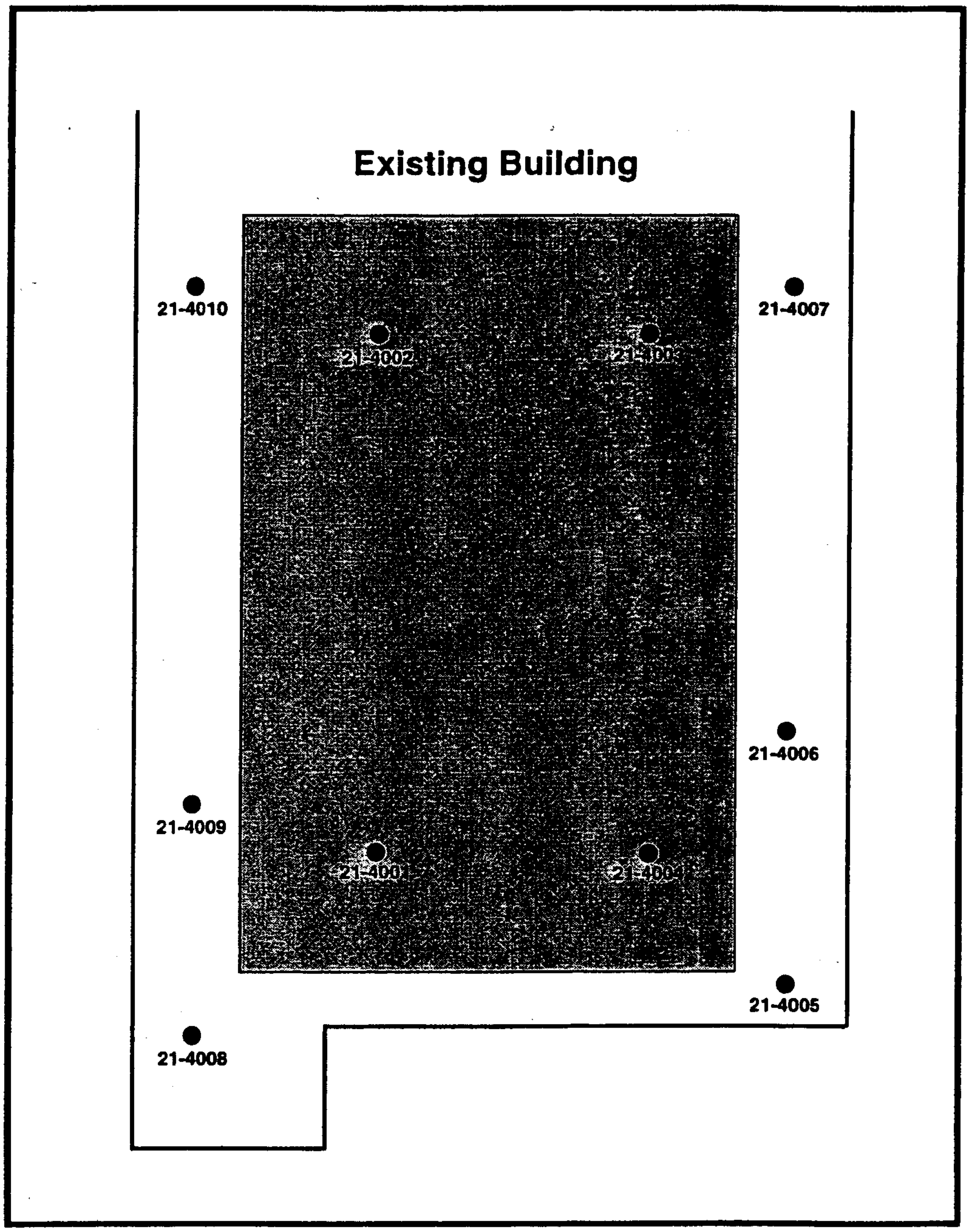



*Figure 12. TA-21 Building 4 South Sampling Locations.*

Order 5400.5,the process necessary for obtaining unrestricted release of the site. Actions were consistent with the requirements of the DOE Decontamination and Decommissioning Guidance Document (DOE 1994), NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination," (NRC 1992), and the Laboratory's Radiation Protection Program Documents. The Appendix provides final verification data. Approximately 50 $yd^3$ of soil was removed from Building 3 South, and 150 $yds^3$ removed from the Building 4 footprint. Soil was largely removed from the utility tunnels.

## 5.6 Post-Decommissioning Hazardous Chemical Condition

Prior to excavation, the soil beneath the buildings was sampled and analyzed for volatile organics, semi-volatile organics, and RCRA metals. (locations are shown on Figures 11 and 12). No hazardous constituents (above applicable standards) were identified. Of the volatile and semi-volatile analyses, trace amounts (1 ppm) of poly-chlorinated bipheyls were detected in the Building 3 South footprint. Only background levels of RCRA metals were detected. Following final soil excavation and disposal as low-level radioactive waste, additional chemical sampling was not warranted or performed.

# 6.0 COSTS AND SCHEDULE

The cost and schedule baseline for the TA-21 project established and monitored progress against agreed upon milestones and activities consistent with funding levels. The baseline was reviewed during the readiness review before the start of remediation. A project management and control system, including earned value analysis, was used to monitor project performance, consistent with DOE guidance and Laboratory requirements.

## 6.1 Baseline Cost And Schedule

At the beginning of remediation process, the estimated funding required to accomplish the scope of work is summarized on Table 6-1.

## 6.2 Final Costs

By way of direct comparison, final costs also are summarized on Table 6-2.

The project was completed approximately one year early and $754K under budget. Activities were not completed in the same sequence as originally planned. Building 3 was demolished prior to Building 4, instead of the opposite planned sequence. This enabled activities in both buildings to be accomplished in parallel, reducing the project schedule. Moreover, it proved advantageous to move between the two buildings in the event that an obstacle (such as perchlorates) was encountered.

Several significant scope changes were added, although formal change proposals were not processed (because costs/schedules remained the same). The first of these changes consisted of increasing waste minimization efforts. A contaminated metal-recycling contract was put in place with the Scientific Ecology Group, Oak Ridge, TN, to ship

**TABLE 6-1. PROJECT COSTS**

| Fiscal Year | Activity | Final $K | Final $K |
|---|---|---|---|
| | | Actual | Planned |
| 92 | Assessment | 328 | 300 |
| 93 | Begin Remediation of Building 3 | 396 | 477 |
| 94 | Start Remediation of Building 4 | 2876 | 3398 |
| 95 | Finish Remediation of Building 4 | 2778 | 2413 |
| 96 | Finish Remediation of Building 3 and Project Close Out | 731 | 731 |
| | | | |
| | Total: | 6565 | 7319 |

TABLE 6-2. TOTAL COSTS BY WBS ELEMENT

| WBS Element | FY92 | FY93 | FY94 | FY95 | FY96 | Total |
|---|---|---|---|---|---|---|
| Site Characterization | 45 | 30 | 0 | 0 | 0 | 75 |
| Project Planning | 213 | 268 | 0 | 0 | 0 | 481 |
| Environmental Compliance | 0 | 25 | 15 | 0 | 0 | 40 |
| Project Support | 0 | 18 | 557 | 584 | 0 | 1159 |
| Decommissioning Subcontractor | 70 | 47 | 1930 | 1505 | 0 | 3552 |
| Health Physics | 0 | 8 | 242 | 520 | 0 | 770 |
| Waste Management | 0 | 0 | 132 | 169 | 30 | 331 |
| Final remediation and close-out | 0 | 0 | 0 | 0 | 157 | 157 |
| | | | | | | |
| Total costs by fiscal year | 328 | 396 | 2876 | 2778 | 187 | 6565 |

contaminated scrap metal into their beneficial reuse program. Additionally, several compactors were purchased to volume reduce items within drums and metal waste boxes. Remediating soil to the authorized limits also increased the project scope, as did the removal of 500 linear feet of asbestos-clad pipe racks that ran the length of the DP West site.

## 7.0 WASTE MANAGEMENT

The Laboratory maintains at TA-54 a disposal and storage facility for radioactive, chemical, and mixed wastes. Low-level radioactive waste is disposed of on-site at Area G. Hazardous and chemical wastes are stored at Area L, pending disposal at commercial facilities, whereas mixed waste is stored on-site. Wastes were transported in accordance with Department of Transportation (DOT) requirements. Typically, radioactive waste was shipped either as low specific activity waste or non-regulated material. Shipment of some recovered oxides did require closing public roads through town because of the lack of an approved shipping container.

### 7.1 Waste Minimization

The Project devoted considerable attention to minimizing low-level radioactive waste because it constituted 99% of the total waste. Because of the history of spills and contamination incidents at the buildings, most items had to be regarded as potentially contaminated. Items with potential internal contamination (e.g., pipes and motors) could not always be surveyed and released. Nontheless, the preferred waste minimization method was to decontaminate, survey, and free release as much material as possible.

This approach also was applied to the concrete foundations of Building 3 and all the flooring and foundation in Building 4. The concrete was scabbled where needed with a shot-blast scabbler system, surveyed, and segregated into contaminated or below surface contamination limit streams. Material below the surface limits was surveyed to confirm that it also was below the authorized volumetric limits, then crushed and used for backfill.

Volume reduction through on-site compaction and off-site metal-melting also proved effective. As itemized below, 70% of the total waste volume of 3380 $m^3$ was disposed of as low-level radioactive waste. The remaining 30% (995 $m^3$) was salvaged, recycled, or decontaminated and released. Additionally, on-site compaction reduced approximately 140 $m^3$ of PPE and ductwork to 22 $m^3$. The compactors were added late in the project, otherwise substantially greater volume reduction could have been realized.

## 7.2 Waste Generated

Radioactive waste was characterized by non-destructive assay or surface readings, as appropriate, based on knowledge of materials used. Hazardous wastes were characterized by sampling and analysis. Potentially contaminated items received 100% surveys before release from controlled areas

Table 7-1 provides a summary of TA-21 Decommissioning Project wastes and disposal methods. Volumes provided are approximated divisions of waste generated. Exact figures are not available because streams overlapped; for example, most PPE was used to fill void space in hoods, gloveboxes, and ductwork, and as a result it was not directly measured.

Decontamination of the furnaces in Building 4 resulted in the recovery of 1.5 kg of 93% enriched uranium, which was sent to an on-site laboratory for re-use. The activity of all low-level waste removed was approximately 0.6 Ci. This activity largely results from the disposal of the remaining 7.1 kg of 93% enriched uranium, although plutonium contamination in the floors and soils was a secondary contributor.

**TABLE 7-1. DESCRIPTION OF PROJECT WASTES AND DISPOSAL METHODS**

| Waste Stream | | Volume ($m^3$) | Weight (kg) | Destination |
|---|---|---|---|---|
| Hoods | LLW | 225 | 64,400 | to TA-54, Area G |
| Gloveboxes | LLW | 110 | 34,500 | to contaminated metal recycler |
| Steel, piping, tanks, pumps | LLW | 175 | 38,400 | to TA-54, Area G |
| | clean | 140 | 45,400 | to salvage/recycle |
| | LLW | 75 | 18,000 | to contaminated metal recycler |
| Asbestos | LLW | 120 | 35,600 | to TA-54, Area G |
| Building Debris | LLW | 1070 | 415,000 | to TA-54, Area G |
| | | 80 | 22,700 | to landfill |
| Concrete | LLW | 640 | 595,500 | to TA-54, Area G |
| | clean | 60 | 57,300 | to municipal landfill |
| | clean | 530 | 504,500 | as backfill |
| PPE, Miscellaneous low-level waste | | 20 | 1760 | to TA-54, Area G |
| Soil | LLW | 135 | 135,900 | to TA-54, Area G |
| Hazardous Waste RCRA Metals | | 1 | 275 | to TA-54, Area L |
| Acids, bases | | 80 l | n/a | neutralized, to radioactive liquid waste treatment plant |
| Rinse and decon solutions | | 10,000 l | n/a | to radioactive liquid waste treatment plant |

ensure operations did not exceed allowable exposure thresholds and to minimize airborne contamination. The CAMs were set at 10% of the derived air concentration and proved very effective in controlling airborne contamination. If they alarmed, the activity was reviewed to determine if engineering controls or procedures were adequate. In cases where activities had a high potential for airborne contamination (such as plasma arc cutting of gloveboxes), containments were constructed around the work area and high-volume air samplers were used to ensure adequate respiratory protection. Typically, a sample was collected for a 15-minute interval and counted immediately. As noted above, no internal uptakes occurred on the project.

Stack monitors remained operational until the main ventilation systems were bypassed and capped in 1994 and 1995. Results were as follows:

| Year | Total Uranium and Plutonium (uCi) |
|---|---|
| 1991 | 92.4 |
| 1992 | 50.7 |
| 1993 | 52.5 |
| 1994 | 27 |
| 1995 | 1.1 |

*Note: 1994 adjusted for 158 uCi rlease caused by filter changeout.*

During building demolition, low-volume monitors and CAMs were placed on the perimeter of the controlled area. No airborne activity above background was detected. Likewise, air monitoring stations located throughout TA-21 did not detect any activity attributable to decommissioning above background.

## 8.4 Industrial Hygiene Monitoring

Industrial hygiene sampling was performed throughout the project. Air samples were collected and analyzed during all phases of decommissioning. Table 8.1 summarizes sampling and engineering controls. Because airborne levels could not be determined in advance, engineering controls and protective equipment were used to minimize the potential hazard, with sampling used to corroborate engineering control effectiveness. Analysis confirmed that all results were below permissible exposure levels even in the absence of protective equipment.

## 8.5 Environmental Compliance

The project complied with the Laboratory's Administrative Requirement 9-1, Air Pollution, and applicable state and federal regulations. Operations

**TABLE 8-1. INDUSTRIAL HYGIENE AIR MONITORING**

| Sample and Quantity | Activity | Engineering Control |
|---|---|---|
| Lead - 8 | Lead anchor removal, metal cutting, and shear operations | Water spray or local exhaust ventilation |
| Chromium III & VI - 2 | Cooling tower removal | Water spray |
| Asbestos - 29 | Floor tile removal, insulation removal, roofing removal, and electrical line tracing. | Local HEPA exhaust ventilation and surface fixative |
| Uranium - 1 | Wall plaster removal | Surface fixative |
| Respirable dust - 11 | Concrete pad removal, concrete decontamination (shot blasting), foundation removal, and concrete crushing | Water spray or built-in HEPA system |
| Silica - 10 | Concrete pad removal, concrete decontamination (shot blasting), foundation removal, and concrete crushing | Water spray or built-in HEPA system |
| Vinylidene Chloride - 1 | Plaster wall fixative application | Local exhaust ventilation |

at TA-21 were conducted in compliance with the NESHAP modification, approved by EPA on June 25, 1993. This modification generally described the operational sequence and the mitigation techniques to be followed.

To minimize or eliminate airborne emissions, portable HEPA-filtered ventilation systems were used to collect particulates that could have been dispersed by removal operations.

Emissions were minimized during structural dismantlement with the use of fixatives and during excavation by misting with water.

Hazardous waste was generated during the project. These wastes were stored in a RCRA satellite storage area and managed in accordance with RCRA requirements.

# 9.0 FINAL SITE CONDITIONS

## 9.1 Facility Systems

All facility systems were disconnected and removed. The structures were demolished from the far south end to the first structural column south of the corridor. The remaining portion of the structures (approximately a 10-ft section of the building) was left in place, with the attic capped to protect corridor utilities from cold weather. Figures 11 and 12 show the final site condition.

## 9.2 Data Package

Project data (including correspondence, meeting minutes), assay, and waste disposal records are archived with the Laboratory's Records Management Office. Health physics records (including RWPs, incident reports, survey data, and monitoring data) are archived by the Laboratory's Health Physics Operations group.

## 9.3 Record Of Completion

This report constitutes the record of completion.

# 10.0 LESSONS LEARNED, CONCLUSIONS, AND RECOMMENDATIONS

## 10.1 Technical Problems

A project of this complexity is bound to encounter many technical problems and unknowns. Most problems encountered during this project involved specific details regarding accomplishing a particular activity, such as glovebox separations or acid-piping removal. These problems were solved quickly, with fallback work substituted until the particular problem was resolved. More difficult problems that had the potential for seriously hampering operations were encountered in the areas of nuclear material assay and building demolition. Unknown items included perchlorate contamination and contaminated supply system ductwork.

Assay of nuclear material holdup inside the buildings was originally planned to be performed concurrent with equipment dismantlement. However, special nuclear material accountability and waste management considerations necessitated advance knowledge of the amount of uranium present. Additionally, economic discard limits do not exist for enriched uranium. Therefore, approval from DOE was required to discard contaminated items, based on the residual uranium estimate. For these reasons, all hoods and gloveboxes were assayed *in situ* by the Laboratory's Safeguards Assay Group at the start of remediation.

Data already existed for the ventilation system holdup. As-left, one-line diagrams were prepared for the ventilation systems and holdup data recorded on the drawing. The drawings were used in subsequent dismantlement to identify hazardous sections and to determine the uranium content of waste packages. Approval to discard the material was obtained from DOE Albuquerque, based on the *in situ* and existing measurements, as was approval to maintain the facility as a Category III SNM facility. *In situ* assay proved to be superior to the proposed concurrent method. Results identified hazards in advance, and significantly reduced costs by eliminating the delay

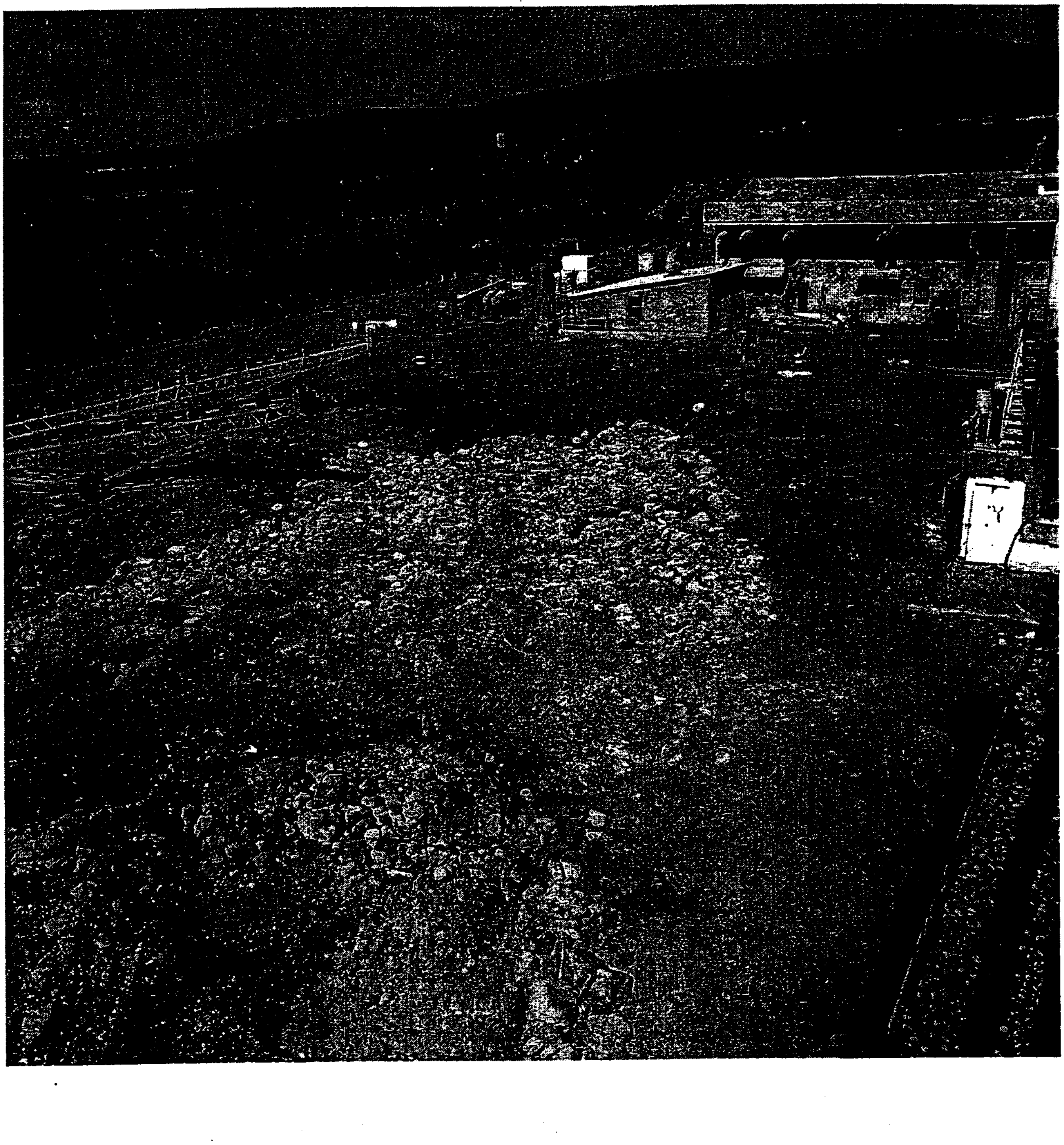


*Figure 13. Final site condition of Building 3.*

*Figure 14. Fianl site condition of Building 4.*

time, additional item handling, and personnel costs associated with concurrent assay.

Building demolition was originally to be performed with existing in-house items (e.g., trackhoe and bulldozers), with the material transported in dumptrucks to the low-level waste disposal area. Available equipment was not well-suited for demolishing the structures. Torch cutting at high elevation of the steel structures would have been necessary. Mangling of the material and bulk disposal would have increased waste volumes substantially and prevented waste segregation.

The Laboratory departed from its standard practice of not renting items that have the potential to become contaminated. By renting a hydraulic shear and trackhoe, worker safety and waste minimization were improved. Loading waste into sea-land transportainers improved disposal site efficiency from 30% to 90%, while reducing transportation costs. Large waste containers are not accepted at commercial and most other DOE disposal sites, greatly increasing dismantlement and handling costs (packaging into small containers).

Perchlorate contamination was not expected and it had a significant impact on the project; in fact, intrusive activities with the potential to disturb ductwork were suspended in both buildings, pending testing for perchlorates. Lessons learned from this incident are twofold:

- test for perchlorates and other reactive materials if process knowledge is incomplete and material use possible, and
- bring in outside expertise for difficult problems. ORNL's procedures and lessons learned averted months of delay.

Another unexpected situation was encountered when the Building 3 supply air system turned out to be contaminated with plutonium (in excess of 2000 dpm/100 $cm^2$). The supply duct was thought to be free from contamination, and plans were to send the material to a scrap metal dealer. Good health physics practices of checking everything before intrusive work prevented the contamination of workers.

## 10.2 Safety Problems

Section 8.2 addressed all significant safety problems. The most significant of these, two small fires (one in a radiologically controlled area and one on the exterior siding of a support building), necessitated restricting the use of flame- and spark-producing devices. Special cutting equipment was procured following the fires to more safely accomplish activities.

## 10.3 Recommendations

The observational approach proved very effective in addressing issues as they arose while minimizing up-front characterization expenses. Successful application of this practice also is contingent upon the type of contract used.

In the case of TA-21, use of the on-site support contractor provided an immediately skilled workforce and direct Laboratory control over a very hazardous site. This risk assumption is appropriate, given the nature of the facility; however, more straightforward projects can combine the observational approach with fixed price contracting by clearly stating risk assumptions in the bid package.

Formality of operations is difficult to implement in a dynamic environment such as decommissioning. Unlike facility and process operations, where success largely depends on consistent repetition, decommissioning operations are rarely repetitive. To ensure a safe project, the Laboratory combined team development of work packages with strong supervision and inspections, as well as worker training in conduct of operations.

Although reliance on a dedicated project team proved essential to project success, the approach should be coupled with active involvement of outside experts. Several commercial vendors were consulted regarding difficult technical problems, as was ORNL for perchlorates. The team actively searched for outside expertise rather than resolving all problems internally. In a similar vein, all activities must be evaluated for improvement. The project realized considerable success in waste minimization, concrete decontamination and handling, tunnel

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## ACRONYMS AND ABBREVIATIONS

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|---|---|
| DOE | Department of Energy |
| DOE-LAAO | DOE Los Alamos Area Office |
| DOT | Department of Transportation |
| DP West | Western portion of TA-21 |
| EPA | Environmental Protection Agency |
| ER | Environmental Restoration |
| ES&H | Environment, safety, and health |
| ESH | Environment, Safety and Health Division |
| ESH-1 | Health Physics Operations Group |
| ESH-3 | Facility Risk Management Group |
| ESH-5 | Industrial Hygiene and Safety Group |
| ESH-6 | Criticality Safety Group |
| FSS-6 | Field Operations Group |
| JCI | Johnson Controls World Services, Inc. |
| NEPA | National Environmental Policy Act |
| NESHAP | National Emission Standards for Hazardous Air Pollutants |
| OSHA | Occupational Safety and Health Administration/Act |
| PCB | Polychlorinated biphenyl |
| PPE | Personal protective equipment |
| QA | Quality assurance |
| RCRA | Resource Conservatin and Recovery Act |
| RWP | Radiological work permit |
| TA | Technical area |
| THA | Task hazard analysis |
| WBS | Work breakdown structure |

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