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LOS ALAMOS DP WEST PLUTONIUM FACILITY DECONTAMINATION PROJECT, 1978-1981

by

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ABSTRACT

The DP West Plutonium Facility operated by the Los Alamos National Laboratory, Los Alamos, New Mexico was decontaminated between April 1978 and April 1981. The facility was constructed in 1944-45 to produce plutonium metal and fabricate parts for nuclear weapons. It was continually used as a plutonium processing and research facility until mid-1978.

Decontamination operations included dismantling and removing gloveboxes and conveyor tunnels; removing process systems, utilities, and exhaust ducts; and decontaminating all remaining surfaces. This report describes glovebox and conveyor tunnel separations, decontamination techniques, health and safety considerations, waste management procedures, and costs of the operation.

I. INTRODUCTION

The Plutonium Facility at DP West Site designated as Technical Area 21 (TA-21) at the Los Alamos National Laboratory, Los Alamos, New Mexico (Fig. 1) was decontaminated during the period from April 1978 to April 1981. The overall objective was to decontaminate three entire buildings and portions of three others, a total of 5330 m^2 of floor space, to a level which would allow continued occupancy for nonplutonium research operations.

Major elements of the decontamination project included:

- removal of process related service systems, utilities, and exhaust systems;
- preliminary experimental decontamination of plutonium contaminated gloveboxes;
- separation and packaging of 318 linear meters of gloveboxes and 109 linear meters of connecting conveyor tunnels;
- decontamination of 3500 m^2 of concrete floors and 30,000 m^2 of walls and ceilings;
- development of techniques to measure residual plutonium levels through various surface coatings and materials; and
- radiation surveys of decontaminated surfaces and equipment items.

Before commencing the decontamination operation, a general plan was formulated which was submitted to the Albuquerque Area Operations Office of the US Department of Energy (DOE) for approval.

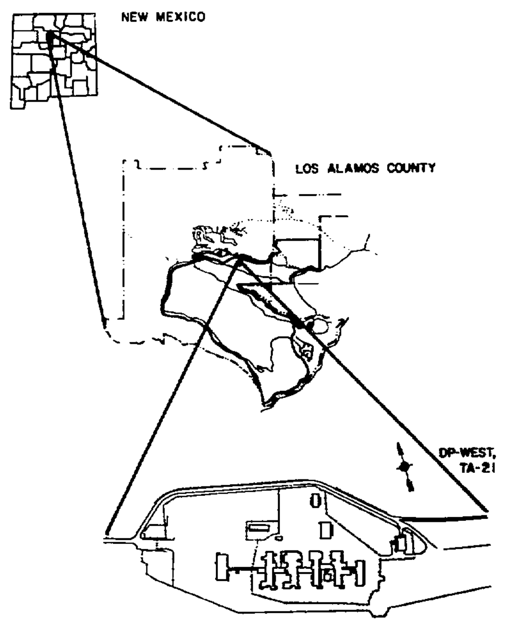

Fig. 1. Technical Area 21, Los Alamos, New Mexico.

The approved final management plan[1] established that:

- o the operation would be limited to Buildings 2, 3, 4, 5, 150, and 286 (Fig. 2);
- o high-activity liquid wastes would be reprocessed rather than discarded;
- o decontamination criteria would be (1) no swipeable surface contamination, (2) fixed contamination not to exceed 1000 dis/min/100 cm^2 alpha, or 1 mR/h beta-gamma at contact when measured with an open-shield Geiger-Muller (GM) detector;
- o decontamination operations would include (1) removal of all process equipment such as gloveboxes, pumps, storage tanks, etc; (2) removal of contaminated support process equipment such as piping, ventilation ductwork, and drain lines only to the point where they exited the area being decontaminated; (3) removal of internally contaminated lines, ducts, etc., in areas such as utility tunnels or attics; (4) removal of walls, ceilings, and floors with contamination in excess of recommended levels; (5) installation of a new floor cover and repainting of all decontaminated wall and ceiling surfaces prior to release of an area; (6) removal of the industrial waste sampling stations and wells; (7) disconnection of all services in the perimeter tunnels; and (8) documentation of final remaining surface contamination;
- o solid wastes generated by the operation would be disposed of or stored at an onsite radioactive waste management site, TA-54, after being packaged according to current Los Alamos criteria.[2] TA-54 is located 15 km from DP West.

A Los Alamos management team was formed with representatives from the plutonium Chemistry and Metallurgy group (CMB-11), the Health Physics Group (H-1), and the Engineering Construction group (ENG-1).

Group CMB-11 was assigned the overall management because the decontamination of TA-21 was considered to be the final step in the new plutonium facility (TA-55) construction project. The 4.46 million dollars allocated for the decontamination were part of the line-item construction funds for TA-55. The group also provided the project manager and part-time support from individuals knowledgeable about each room or process.

Group H-1 contributed experienced decontamination personnel who performed glovebox removal operations and directed subsequent decontamination work as well as the personnel required to provide health physics support.

Group ENG-1 provided an engineer to assist in planning the project and to coordinate the craft and equipment support required of the Zia Company, the DOE's maintenance contractor at Los Alamos. The Zia Company assigned a full-time field engineer to work with the management team and to direct work performed by Zia Company personnel.

A Health Division Task Force was created to ensure that all aspects of health and safety were considered. Disciplines represented on the task force were health physics, safety, industrial hygiene, waste management, and environmental surveillance.

Weekly management team meetings were held to discuss progress and to schedule work assignments for the following month.

II. HISTORY OF DP SITE

The DP Site Plutonium Facilities replaced the original D Building Plutonium Facility in the Los Alamos Technical Area (TA-1). Most of the facilities were constructed in 1944-1945 by moving in used warehouses and installing necessary equipment (Fig. 3).

Basically, the facility provided the capability to produce metal and alloys of plutonium and other transuranic elements from nitrate solution feed stock; to fabricate these metals into precision shapes; to provide and install protective claddings; to measure the chemical and physical properties of these metals and alloys; and to permit recycling of scrap or materials used in experiments so that these materials could be reused rather than discarded.

Additional safety and effluent treatment features were soon required as control systems and safety standards changed. Some of the major changes or additions between the evolution and retirement of the site were the following.

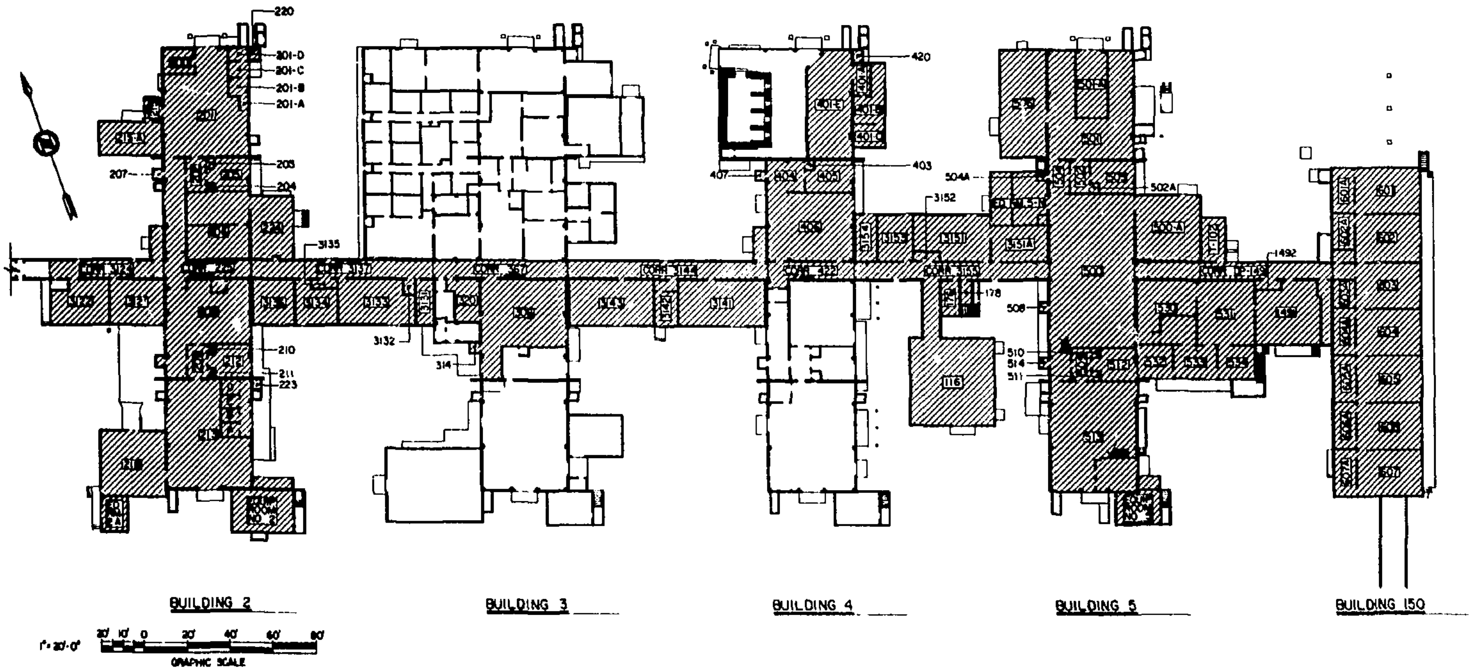

Fig. 2. DP West main plant; shaded areas in project scope.

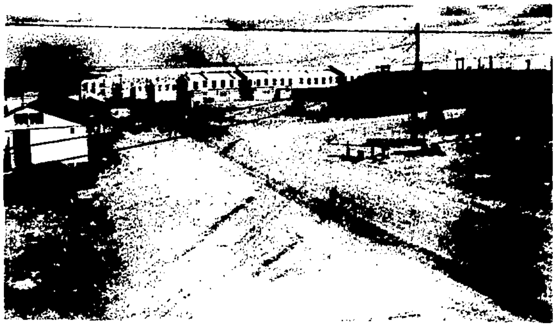

Fig. 3. TA-21, DP West, 1947.

- o In 1949, plutonium gloveboxes were connected with short pass-through tunnels.
- o In 1951, a semi-automated metal production line was put into operation. A facility was completed for recovering plutonium in dilute residues. Secondary containment rooms were constructed around potentially hazardous operations.
- o In 1952, a liquid waste treatment plant was constructed. This treatment plant, structure TA-21-35, was replaced by a new treatment plant, TA-21-257 and was decommissioned in 1968.
- o In 1956, the plutonium metallurgical and metal fabrication systems were rebuilt. Conveyor tunnel systems were placed above the gloveboxes, allowing improved plutonium transfer capabilities and personnel passage under the tunnels.
- o In 1959, a nuclear criticality alarm system based on detection of gamma radiation was installed. The process exhaust system was separated from the plant exhaust system. The new system included a high-efficiency filtration system located in Building TA-21-146.
- o In 1963, a new plutonium fuels development building (Building TA-21-150) was constructed.
- o In 1967, a new liquid waste treatment plant (TA-21-257) was constructed.
- o In 1968, personnel corridors between major buildings were converted to ventilated air locks.
- o In 1971, new room exhaust air systems were installed in plutonium areas and utility services were upgraded.
- o In 1973, the exhaust filter building (TA-21-12), abandoned in 1959, was decommissioned.[3]
- o In 1974, a wet pipe sprinkler system was installed throughout the plutonium processing buildings.
- o In 1977, the transfer of equipment to the new TA-55 Plutonium Facility began.
- o In 1981, decontamination was completed and the areas were transferred to new tenants (Fig. 4).

Because the first structures, Buildings 2, 3, 4, and 5, were prefabricated warehouses, they were placed on 1.1-m high concrete stem walls to provide the necessary overhead space inside the rooms. A typical wall section for these buildings is shown in Fig. 5. In some rooms, mezzanines were constructed to provide more floor space. Metal joists, metal decking, metal lath, and plaster were used for floors and ceilings in these areas.

Building 150 construction is unique to the rest of the process facilities. The building is primarily concrete and masonry with metal joists. It has a full basement which housed most of the process support equipment and service piping. A cross section of a Building 150 wall is shown in Fig. 6.

Fig. 4. TA-21, DP West after decontamination, 1981.

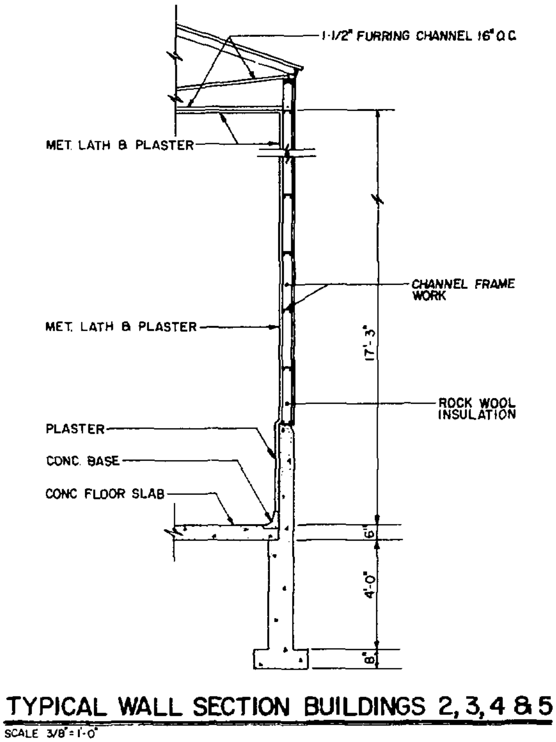

Fig. 5. Typical wall section, Buildings 2, 3, 4, and 5.

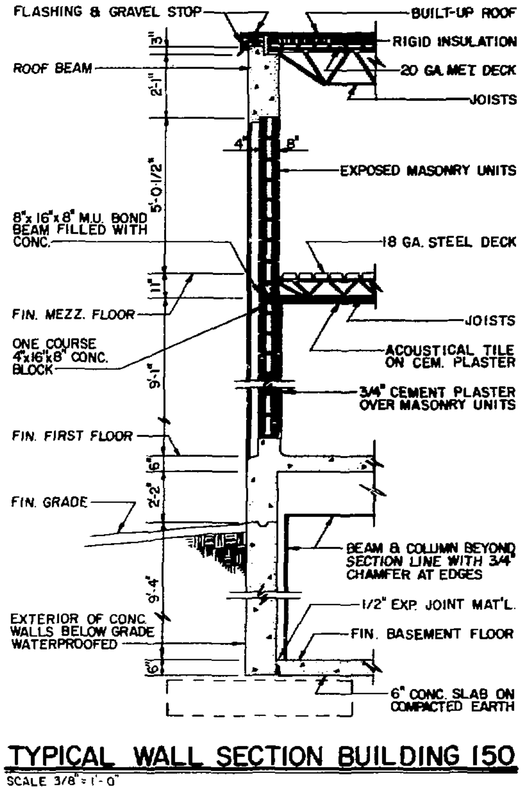

Fig. 6. Typical wall section, Building 150.

III. PRELIMINARY INVESTIGATIONS

A. Glovebox Decontamination

Early in the planning of the operation, it became apparent that perhaps the most difficult task would be the safe removal and disposal/storage of the gloveboxes and conveyor systems used for plutonium processing.

Consideration was given to decontaminating the gloveboxes to a level that would permit nonretrievable shallow trench disposal rather than the more costly 20-year storage required for transuranic (TRU) waste contaminated to levels greater than 10 nCi ^{239}Pu or 100 nCi ^{238}Pu per gram of waste. If successful, decontaminating the gloveboxes in place would provide additional benefits in that the boxes would be safer to separate and the lower plutonium levels would facilitate future size reduction. However, the acid wash solutions used for the decontamination operation would require neutralization, solidification, and disposal/storage. Washing would also be a slow and hazardous process. The equipment used for the washing is shown in Fig. 7.

The first 20 gloveboxes available for experimental decontamination were subjected to numerous wash-rinse cycles (Appendix A). Between cycles, the plutonium levels remaining in the box were measured by NaI surveys and the change in measured plutonium content was compared to the quantity of plutonium measured in the wash-rinse solution. Some of the information gained from washing operations includes:

- one acid wash-water rinse cycle removed approximately 85% of the plutonium in the gloveboxes;
- the plutonium content in a glovebox that had been wet wiped but had not been washed would likely contain nine times more plutonium than initially measured by NaI surveys due to contamination hidden in cracks,

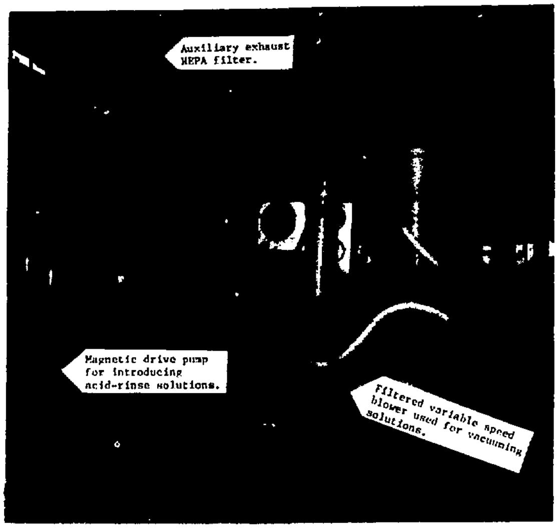

Fig. 7. Glovebox washing and vacuuming apparatus.

corners, and other shielded locations. If a glovebox was washed before being surveyed, the difference between the measured and actual plutonium amounts was a factor of five with the actual being the higher;

- the plutonium content of most gloveboxes could be measured by taking readings through gloveports using new 25-mil unleaded gloves (Appendix B); and
- surveys indicated glovebox contamination levels could be reduced to a nonretrievable level by numerous wash cycles, but due to the large solution volumes, the work should be performed in a well-equipped decontamination facility with proper waste handling and ventilation systems.

The efforts required in decontaminating the 20 gloveboxes indicated that the decontamination project funding and schedule would not permit washing gloveboxes to nonretrievable levels. The decision was made to proceed with glovebox removal and storage as retrievable TRU waste.

B. Glovebox Separations

Another early concern about glovebox removal was that separating the individual gloveboxes would be difficult because several boxes were large and in some cases working space was limited. Portable collapsible plywood and plastic tent enclosures with air locks were used on the first glovebox separation. Careful planning and thorough instruction of each member of the glovebox separation team resulted in such a successful operation that use of the air lock and tent was eliminated for the remaining 120 glovebox and 16 conveyor tunnel separations (Fig. 8).

C. Contamination History

During the early stages of the operation, past records were searched extensively to identify all potential residual contamination sources and locations. Health Physics survey and occurrence records dating back to 1945 were removed from the archives and reviewed. Lists of recorded spills or releases of contamination were compiled for each room. This information was very useful in deciding whether to remove internal walls, floors, building utilities, and soil.

IV. PROJECT DESCRIPTION

Decontamination operations performed during this project were directed by experienced individuals from the Laboratory's Decontamination and Decommissioning Section based in the Health Physics Group. These four to five supervisors and technicians had years of experience in equipment and facility decontamination involving plutonium. Because only these few experienced individuals were available for assignment to this project, some six

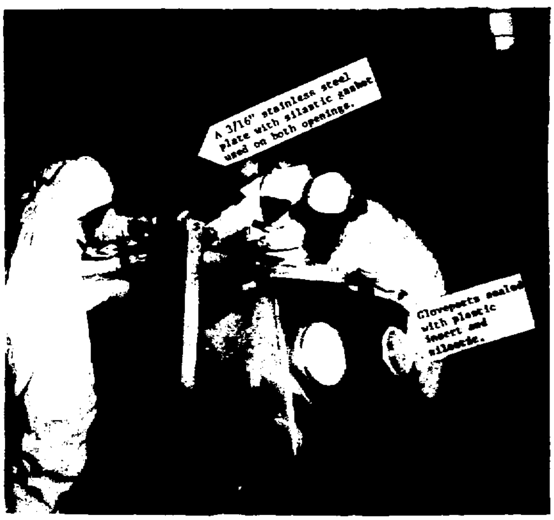

Fig. 8. Glovebox-conveyor tunnel separations.

to eight additional, inexperienced technicians were hired to assist with decontamination operations.

A full-scale startup during early phases of the operation was precluded until the process-by-process transfer of operations to the new plutonium facility was complete. Building utilities were completely operational during this period, even though much of the system was not being used. For the first several months personnel worked in gloveboxes and portions of various isolated rooms as they became available.

As soon as all areas were available, the general plan was implemented and the decontamination and release of areas in an east-to-west direction began. This plan allowed systematic access control to rooms and building areas with a well-defined contaminated-area/clean-area interface.

The steps to decontaminate and eventually release each of the buildings described in this section included:

- o removal of process equipment and utilities to permit glovebox removal;
- o removal of gloveboxes and conveyor tunnels;
- o removal of remaining process equipment, including air exhaust systems and drain line systems;
- o removal of contaminated nonload-bearing wall partitions;
- o decontamination of remaining floors, walls, ceilings, and utility service systems;
- o final radiation/contamination surveys;
- o spot decontamination and resurvey if contamination was located;
- o painting of walls and ceilings and installing of linoleum on floors; and
- o release to new occupants.

New occupants received an indoctrination and a final condition report for their assigned area. The report contained site drawings and post decontamination pictures plus special health physics control procedures for the area and site.

A. Building 150

Building 150 (Figs. 9 and 10) was built in 1963 as a plutonium fuels development building with glovebox lines perpendicular to a north-south overhead conveyor tunnel system. Some of the programs the building supported included development of

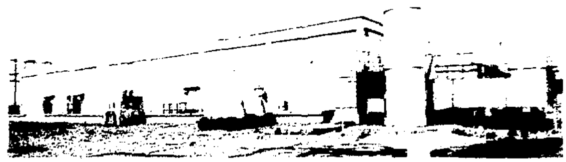

Fig. 9. Northeast side of Building 150.

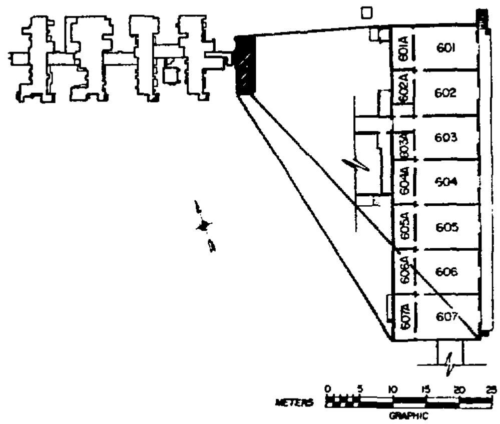

Fig. 10. Floor plan of Building 150.

^{238}Pu heat sources for space electric power applications, investigation of the suitability of various plutonium-containing ceramic materials as potential fuels for application in the Liquid Metal Fast Breeder Reactor (LMFBR) Program, and development of isotopic powered heat sources using ^{238}Pu as the fuel for powering artificial organs.

Few contamination incidents had occurred in this building; however, releases had occurred in Rooms 603 through 607. The areas had been cleaned to a low swipe count and painted to contain the contamination. Three trouble areas where plutonium contamination was know included (a) the roof over Room 605A, which had become contaminated during a release from a hood vent in 1970; (b) the outside dock east of Room 607 contaminated in 1970; and (c) some basement areas around vacuum pumps which had a history of oil leakage under the pump bases.

Removal of process equipment such as chilled circulating water system piping, industrial liquid waste lines, vacuum lines, and air exhaust systems presented few difficulties because most of the process piping was exposed in the building basement (*Fig. 11*).

Because of the ample work space and the ability to remove wall sections under the material conveyor tunnel (Fig. 12), gloveboxes and conveyor tunnels were easily separated for removal. Approximately 84 m of gloveboxes and 44 m of conveyor tunnels were removed. The conveyor was separated into seven sections for packaging and storing as retrievable waste.

The remaining process utility lines and the process air exhaust were also removed (Fig. 13). Water lines, compressed air lines, etc., were removed to the basement and capped. The room air exhaust system was cleaned to the filter plenum located outside and northeast of the building. The fresh air supply system had low-level contamination on some internal surfaces so the complete system was removed and later replaced. The entire roof surface was removed and replaced with a new tar and gravel roof. The circulating chilled-water system was drained and flushed until no activity could be detected in the water. It was left in place at the request of the incoming occupants. The asphalt and soil near the outside dock east of Room 607 were removed (Fig. 14).

After removal of all detectable contamination by a decontamination crew and damp wiping or mopping of all interior surfaces by a janitorial crew, all surfaces were monitored by health physics personnel. The walls were painted, new sheet linoleum

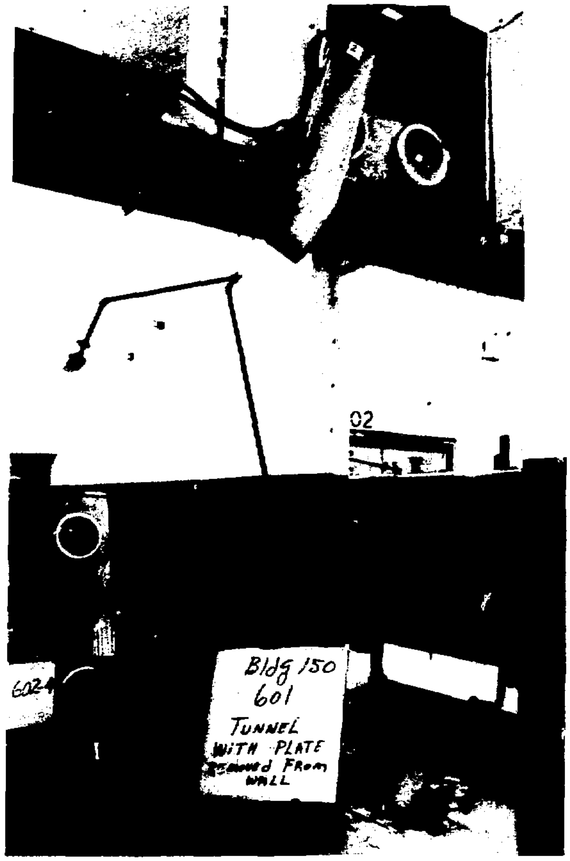

Fig. 12. Building 150, removable wall under conveyor tunnel.

Fig. 11. Building 150 basement, overhead utilities.

Fig. 13. Removal of process air exhaust, Building 150.

Fig. 14. Removal of asphalt and decontamination of loading dock, Building 150.

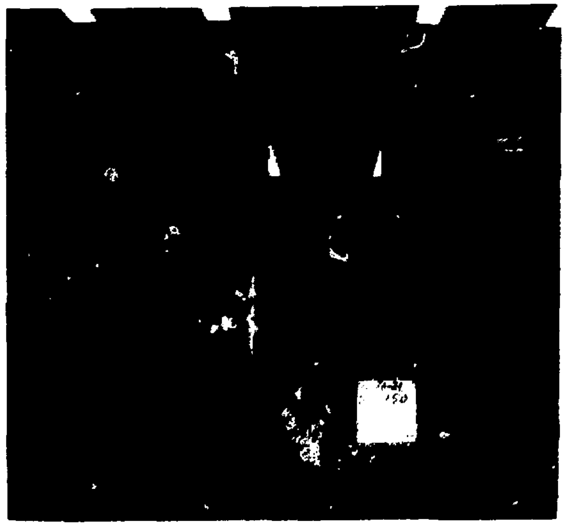

Fig. 15. Typical room after decontamination.

floor covering was installed, and photographs were taken for final documentation (Fig. 15). The building was released to the Inorganic and Structural Chemistry Group (CNC-4) of the Laboratory's Chemistry-Nuclear Chemistry Division.

B. Building 5

Building 5 (Figs. 16 and 17) was the plutonium metal fabrication facility. In 1963, Room 506 was constructed to house electrorefining equipment needed to produce high-purity plutonium metal. Also in 1963, room 500A was added to house an air drying system for air supply to the conveyor tunnels and gloveboxes.

Work conducted in Building 5 centered around the production of plutonium metal and metal alloys and the fabrication of precision plutonium parts for nuclear devices in support of the Laboratory's National Security programs. In 1964, Rooms 530-534 were added to provide additional fabrication and testing facilities. This addition had a basement for electrical panels, waste lines, and other service systems.

Until 1974 all work was with ^{239}Pu for the weapons program. In 1975, ^{238}Pu was introduced into one glovebox chain in Room 500 for limited research work on testing of high-efficiency particulate air (HEPA) filters.

Fig. 16. Northwest side of Building 5.

In Building 5 decontamination operations became more complicated. Instead of process piping being accessible in a basement, piping dropped from the gloveboxes into 0.5-m deep, 0.6-m wide trenches (Fig. 18) then traversed each room to 1.2-m x 1.2-m utility tunnels which extended around the entire perimeter of the building (Fig. 19). Piping in the congested tunnels included water, steam supply and return, industrial waste sewer, caustic supply and return, helium, argon, air, two chilled water supplies, and return systems and hot water. The entire electrorefining glovebox lines in Room 506 had been relocated to the new plutonium facility before starting the decontamination of the rest of Building 5.

The first step was to free the gloveboxes for removal. Tinners, fitters, and electricians re-

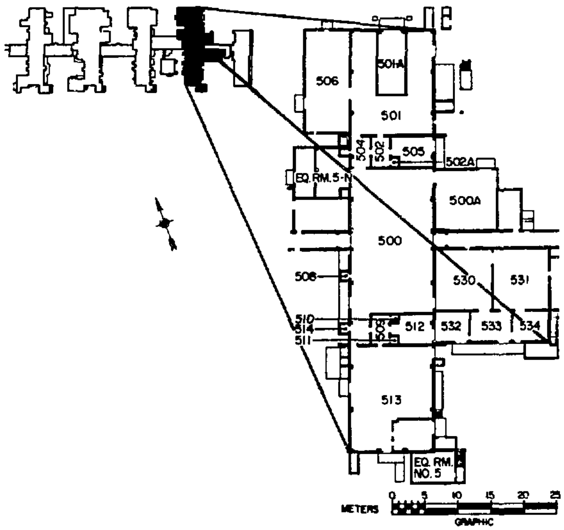

Fig. 17. Floor plan of Building 5.

Fig. 18. Typical floor trench in Building 5 before removal of utilities.

moved all utilities down to the point of entry to the trenches except for one connection to the process air exhaust system. Part of the exhaust ductwork was replaced with an extra-long flexible wiremold hose to permit movement of the box while maintaining a vacuum during separation (Fig. 20). In some cases utility lines were embedded in the concrete floor (Fig. 21).

The gloveboxes were also more difficult to remove than those in Building 150. They were larger, had more external equipment connected to them, had larger openings at the separation points, and (particularily in Room 500) had less space between boxes (Fig. 22).

The material conveyor tunnels presented new problems in that there were interconnecting tunnel systems (Fig. 23) and there were fewer gloveports for cleaning and inspecting. In one case, a section 18 m in length was disconnected and lowered for further separation into shorter lengths at floor level.

Removal of equipment, gloveboxes, and conveyor tunnels was followed by removal of surface contamination. The task was complicated by many coats of paint applied to contaminated walls and floors during the 33 years of use. Alpha survey instrumentation would not detect plutonium through the paint, yet the background was too high for gamma radiation surveys to be meaningful. It was only after removal of the concrete floor surface and removal of plaster from the more highly contaminated walls (Fig. 24) that the gamma survey instruments could be employed. After pipes in the room trenches were removed, the trenches were decontaminated to a no-swipe level and filled with concrete.

The perimeter utility tunnels were decontaminated by removing highly contaminated lines, i.e., vacuum, liquid waste, and circulating water lines. All other lines were isolated, sealed, and abandoned in place because the tunnels could not have been totally decontaminated without destroying the integrity of the building. Cramped working quarters with limited egress were thought too hazardous to warrant additional decontamination effort. All entrances to the tunnels were eliminated by filling the openings with concrete except at the north and south ends of the building. These entrances for Buildings 2 and 5 tunnels were covered with locked metal covers (Fig. 25).

The attics were in much better condition than would be normally expected at a 33-year-old facility because they were cleaned during the 1974 ventilation and fire protection upgrading project. All accessible services were damp-wiped, monitored, and spray painted with an asphalt emulsion.

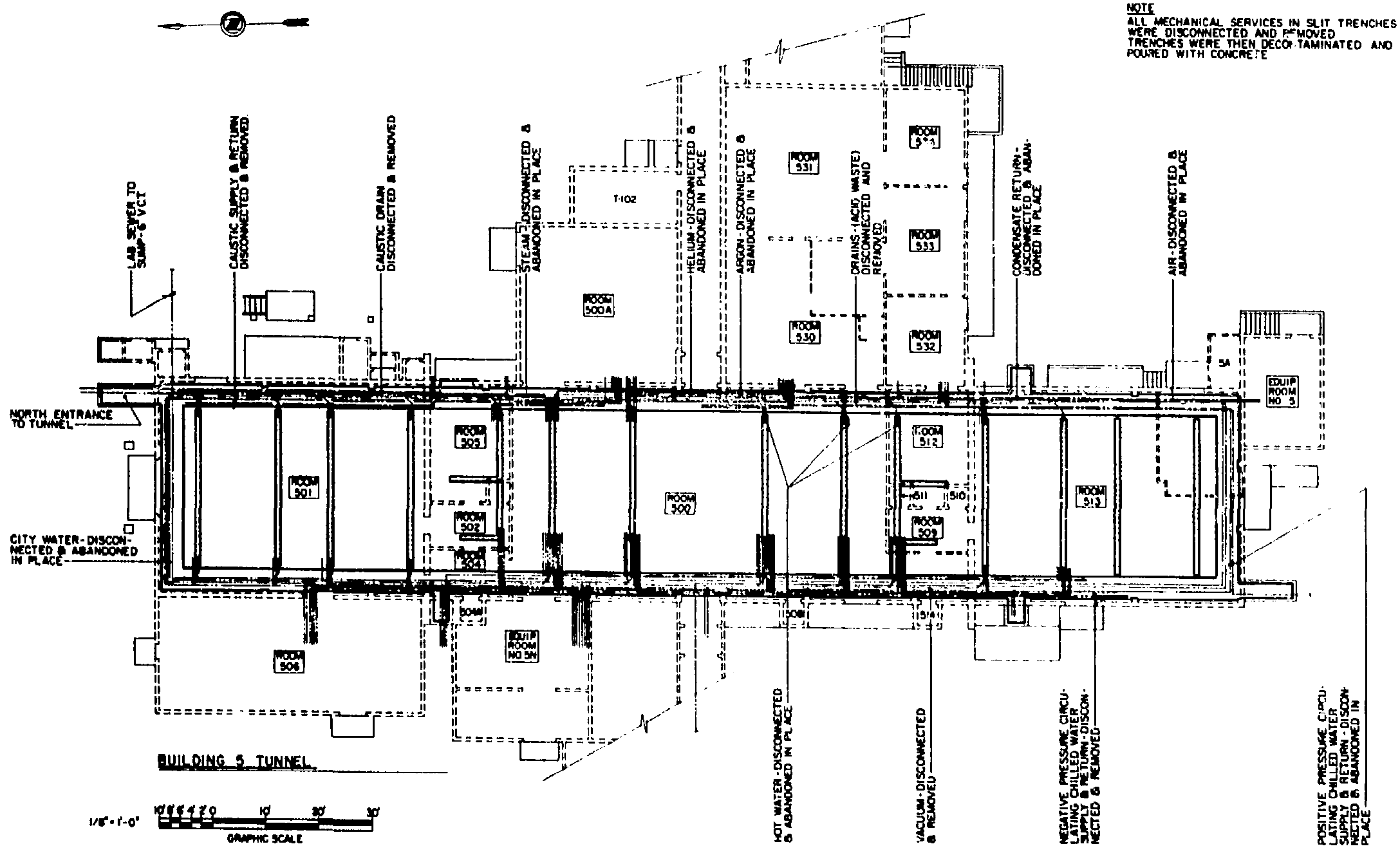

Fig. 19. Utility tunnel around Building 5.

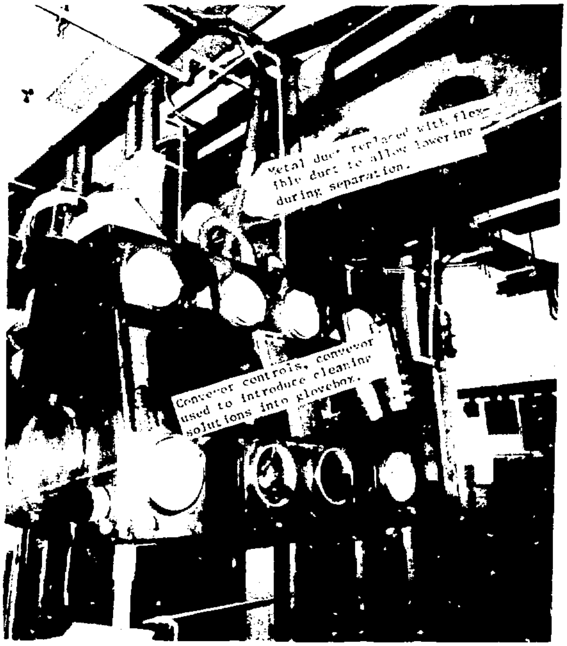

Fig. 20. Glovebox ready for separation.

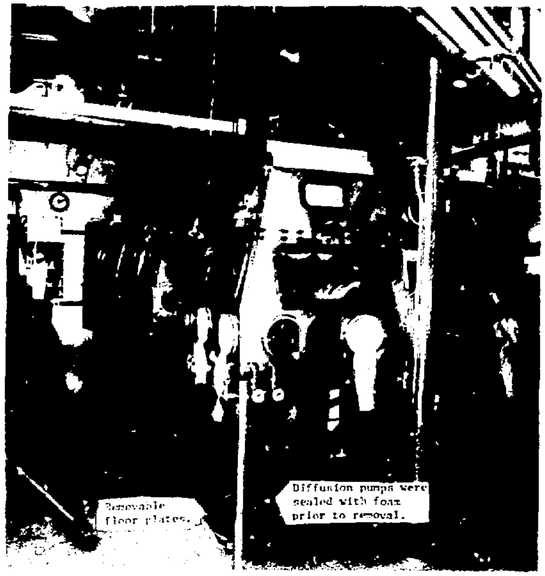

Fig. 22. Typical glovebox line in Building 5.

Fig. 21. Utility lines embedded in concrete, Building 5.

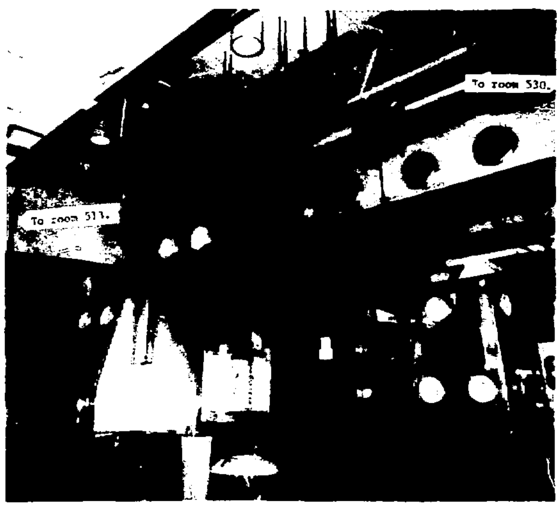

Fig. 23. Glovebox tunnel connection in Building 5.

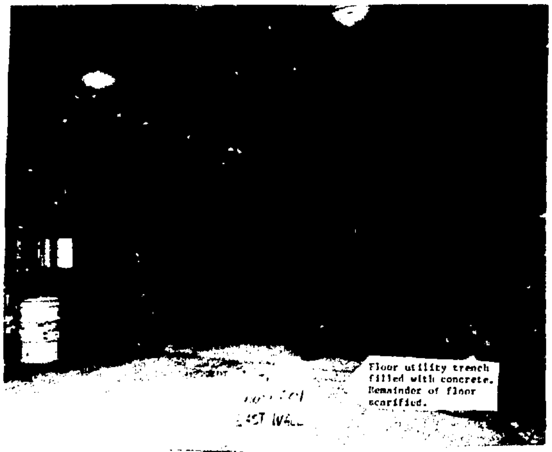

Fig. 24. Building 5 wall after decontamination.

Fig. 25. Metal covering over utility tunnel entrance.

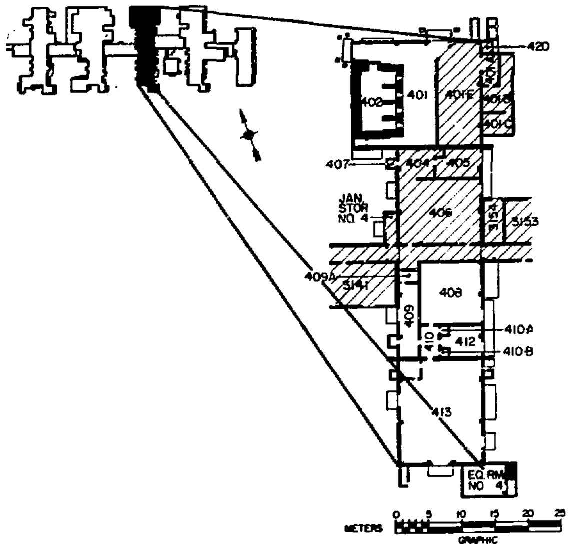

Fig. 26. Building 4, location of decontaminated areas.

After decontamination, which included the removal of some 85 m^2 of plaster from walls and ceilings and 240 m^2 of concrete floor surface, the walls and ceilings were replastered and painted. The floors were leveled and covered with sheet linoleum. In Room 501 a new 8- to 10-cm concrete floor was poured before laying the linoleum.

The building was assigned to two Laboratory groups. The north half, including all of Room 500, is used by the Electronics Division for fuel cell studies. The south half is assigned to the Laboratory's Plutonium Chemistry and Metallurgy Group as a photographic processing facility.

C. Building 4

Only part of Building 4 (Fig. 26) was decontaminated since ongoing operations continued in Rooms 401 and 402 occupied by the Irradiated Materials, Examination and Handling Group (CMB-14) and in the south half of the building by the Physical Chemistry and Metallurgy Group (CMB-8). Both groups were able to continue normal operations during the decontamination of the 401E and 406 room areas with minimal downtime.

1. Room 401-E and Support Rooms 401-A, 401-B, and 401-C

From 1945 until 1948, Room 401, which was later divided into 401-E and 401, was a development laboratory for plutonium research. It was decontaminated in 1948 and was converted to an enriched uranium hydride production area. In 1960 all hydride equipment was removed, the area was again decontaminated, and a hot cell for the examination of irradiated plutonium and enriched uranium fuel elements was constructed on the west side of the room.

In 1965 a partition in Room 401 created room 401-E in which two glovebox lines were installed to support ^{238}Pu metal production work. This area was decontaminated early in the decontamination project along with the three support areas (Fig. 27).

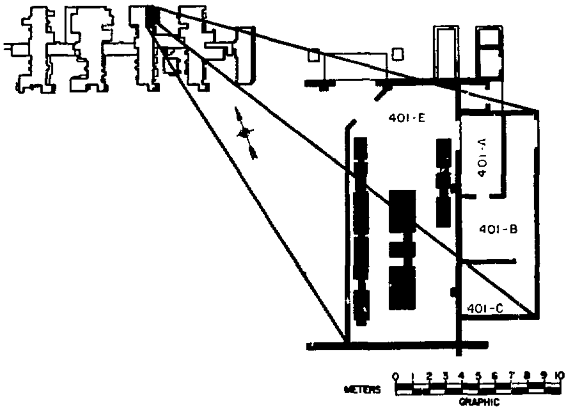

Fig. 27. Floor plan of room 401-E and adjoining support rooms.

Fig. 28. Glovebox in rooms 401-E.

The gloveboxes in 401E were similar to those in Building 150 in that they were linked by circular connecting ports which facilitated separation. The 16 m of gloveboxes (Fig. 28) were removed in approximately two weeks.

Because the process piping was less complicated than in other major areas such as Buildings 5 and 150, this area was the first to undergo all the steps in the decontamination operation and was the first to be released.

Two previous decontaminations (1948, 1960) and the absence of serious plutonium-238 contamination resulted in the rooms being easily decontaminated. Room trenches were filled with concrete after decontamination to a no-swipe level using procedures described for Building 5. The walls were repainted and new linoleum was installed.

The utility tunnels for this building were not in the scope of this project since all utilities had to be preserved for operations in the other parts of the building. The tunnels, however, are not as contaminated as the Building 5 tunnels.

The process air exhaust system in Room 401-E was removed to the north wall and capped off to allow easy reuse by future occupants. Rooms 401W, 401-A, 401-B, and 401-C were transferred to the Laboratory's Inorganic and Structural Chemistry Group (CNC-4) for low-level chemistry work with transuranic elements.

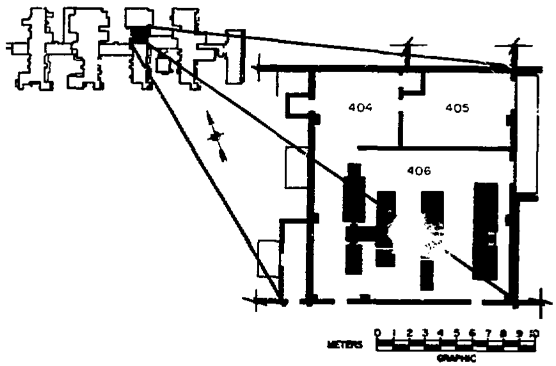

Fig. 29. Floor plan of room 406 and adjoining support rooms.

2. Room 406 and Support Rooms 403, 404, 405, and 407

Contamination levels in this area (Fig. 29) were similar to those in Building 5, since it had been used as ^{239}Pu and ^{238}Pu metal preparation area during the early years. Extensive decontamination was required since Room 406 also had a history of spills dating back as early as 1948. The floor had been painted to contain contamination at least 25 times between 1948 and 1970.

The 12.7 m of gloveboxes were removed, the process exhaust was removed, and the room trenches were filled with concrete. The walls were free of contamination; however, 12 m^2 of floor surface area required removal. Services in the utility tunnels had to remain to support ongoing operations in the rest of the building. The walls were painted, new linoleum was installed, and the rooms were transferred to the Inorganic and Structural Chemistry Group (CNC-4).

D. Building 3

The decontamination operation in Building 3 was confined to Room 308 and adjoining support rooms (Fig. 30). The rest of the building was excluded because the north half of the building, occupied by the Inorganic and Structural Chemistry Group, had earlier been isolated from the main plant complex and because the enriched uranium scrap recovery operations continued in the remaining southside rooms.

During decontamination operations, exterior doors from the work area were sealed and a fence erected to eliminate possible tracking of contamination and to control traffic.

The records search indicated that Room 308 was possibly the most highly contaminated room to be decontaminated. Plutonium-238 and ^{239}Pu had been processed in the room in old gloveboxes (Fig. 31) and numerous contamination incidents had occurred. The decontamination approach was similar to that used in all the other buildings, except in Room 308 almost all work required respirators. The west wall and a portion of the ceiling plaster were highly contaminated and had to be removed. These walls and ceilings were replastered and painted. The main overhead electrical service bus conduit to other south side rooms was decontaminated, sealed, painted, and left in place. The rooms were released to the Laboratory's Physical Chemistry and Metallurgy Group (CMB-8) as additional storage space and solution makeup area for their adjoining enriched uranium recovery operations.

E. Building 2

Building 2 (Fig. 32), had a history of spills and releases. In addition to numerous gloveboxes used for dissolution and recovery of plutonium and storage of ^{241}Am wastes, the building housed a scrap incinerator, solvent extraction columns, and a liquid-waste-loading area. Unlike the other buildings, Building 2 had 165 cylindrical stainless steel liquid storage tanks and several 3.8-m columns to contend with (Fig. 33). The difficulties of handling and transferring plutonium solutions not only from glovebox to glovebox but also from room to room had resulted in many solution spills and extensive floor contamination.

A team of two pipefitters and one health physics technician (HPT) separated the storage tanks, columns, and lines. This operation was begun as early as possible in 1978 to avoid the maintenance that would be required if the tanks were unattended until the regular decontamination crews arrived in Building 2.

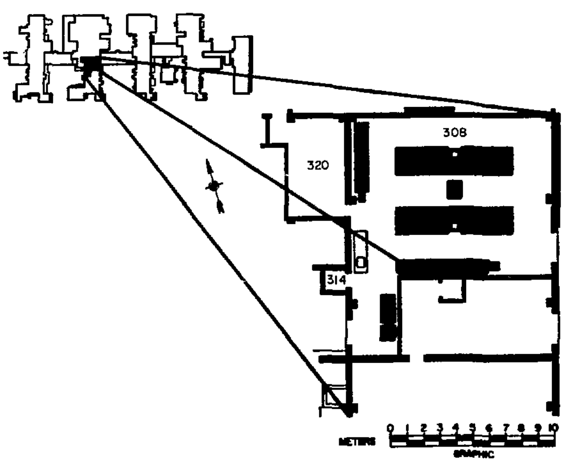

Fig. 30. Floor plan of Room 308 and adjoining support rooms.

Fig. 31. Gloveboxes in room 308.

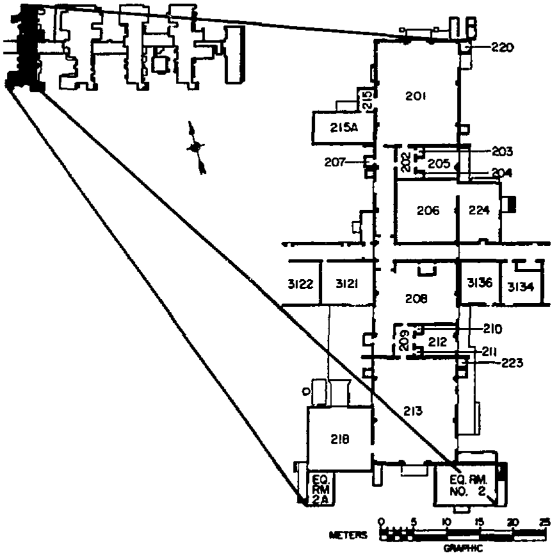

Fig. 32. Floor plan of Building 2.

Fig. 33. Storage tanks and column in Building 2.

Decontaminating this building presented problems not previously encountered. The floors were generally more contaminated than in other buildings. A plastic enclosure similar to the one used for a glovebox separation was constructed over the floor utility trenches in Room 201. It was used to control air flow during the removal of process piping and during initial decontamination operations. A section of external wall on the northeast side of the building required surface removal. In Room 213, a large glovebox that had a wall in common with a room wall and two satellite gloveboxes required a simultaneous separation in two directions (Fig. 34). The section of utility tunnel between Rooms 213 and 218 was known to be highly contaminated. The tunnel was entered from above and approximately 0.5 m^3 of soil containing approximately 13 grams of ^{239}Pu and ^{241}Am were removed.

All other aspects of the decontamination and release operation were similar to those described for the other areas.

The building was assigned to the Environmental Studies Group (LS-6) of the Laboratory's Life Sciences Division. It will be modified to provide the group offices and chemistry labs.

F. Building 286

Building 286, a 350-m^2 metal warehouse building with metal framing/drywall partitions (Fig. 35)

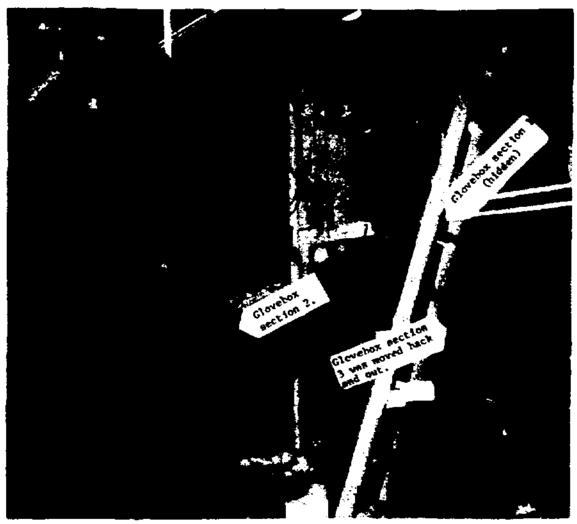

Fig. 34. Gloveboxes ready for separation in two directions.

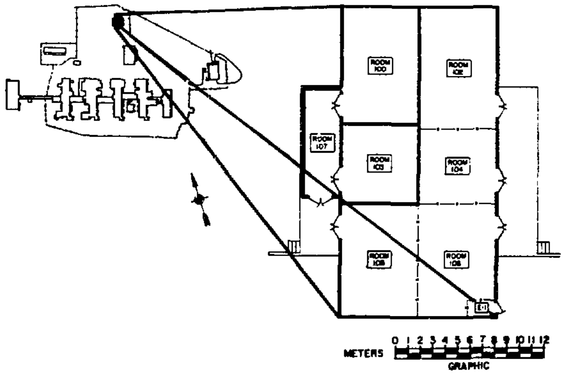

Fig. 35. Floor plan of Building 286.

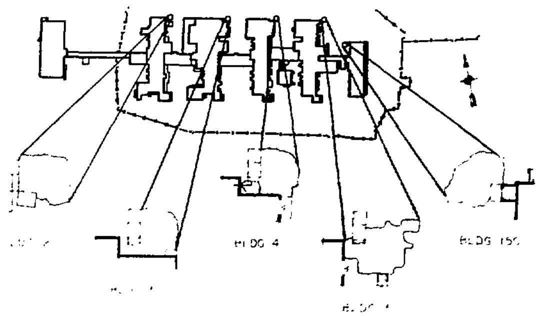

Fig. 36. Location of acid waste sampling wells.

was built in 1972. Rooms 100 and 103 were used as storage vaults for plutonium solutions. The rest of the building was used for equipment and material storage.

The northeast corner of room 100 was known to be highly contaminated under the paint and between the drywall separating rooms 100 and 102 due to a plutonium nitrate solution leak. The rest of the vault area was suspect, but the other rooms were essentially contamination free.

The building was decontaminated and transferred to H-1 as a warehouse for decontamination equipment.

G. Outside Areas

The project also removed five industrial liquid-waste collection and sampling wells. The wells were at the northeast corners of the four original buildings and the northwest corner of Building 150 (Fig. 36). The original well structures for Buildings 2, 3, 4, and 5 were 4.65 m deep and 1.5 m in diameter and constructed of brick. Stainless steel liners were added later. The reinforced concrete structure for Building 150 was 1.8 m x 1.8 m x 4.65 m deep. Prior to removal, the remaining liquids were pumped from the wells and dry cement placed in each well to absorb any free water. When the cement had set, approximately 1.5 m of urethane foam was sprayed on top of it.

Four of the five wells were removed in one piece by exposing them as much as possible with a backhoe then pulling them out with a crane. All surfaces were then sprayed with asphalt and the structures were wrapped in plastic and tarpaulins and transported to TA-54.

The well from Building 2 collapsed during removal. The rubble was loaded into plastic-lined, tarpaulin-covered dump trucks and transported to TA-54. After removal of the acid wells, contaminated soil was removed to the point where further excavation would jeopardize the adjoining buildings or could best be removed at a later date when the waste lines are decommissioned. The remaining contamination was documented as to amounts and locations and the pits were backfilled with clean soil. The contaminated pit walls were sprayed with asphalt to alert personnel excavating in the area in the future.

Although the acid well removal was the only planned external work, the records search indicated considerable contamination existed southeast of Building 2 under the asphalt covering and in an abandoned acid line between Buildings 2 and 3. Eighty cubic meters of soil and 13.2 m of pipe were removed and the area was resurfaced with asphalt to match remaining paved areas.

The asphalt driveways around the buildings were surveyed. Soil from several small areas ranging from 0.1 to 0.3 m^2 in size was found to be above acceptable limits and was removed.

V. HEALTH PHYSICS

Group H-1 was responsible for worker protection and for providing trained technicians for radiation monitoring of jobs and decontaminated areas. A health physics section was maintained at the facility throughout the operation. The section was supervised by a staff health physicist. Reporting to the health physicist was a supervisor who functioned as the first-line supervisor of the technician crew which ranged in size from two to six when the operation peaked in 1979 and 1980.

The decontamination section technicians performed extensive surveys while performing their jobs to determine the effectiveness of their efforts. Their knowledge of radiation protection and monitoring allowed them to proceed with minimal health physics support. However, the health physics section was responsible for providing health physics support for decontamination personnel and their operations as well as for the construction contractor's activities. Health physics personnel also performed the final release surveys, documented the results of these surveys, and provided new occupants with information concerning restrictions and conditions pertaining to their assigned area.

This section describes the health physics program elements and reports results of these program elements where appropriate.

A. Personnel Protection

Before being assigned to the project, workers were required to submit a plutonium bioassay (urine) sample, have an in-vivo measurement for plutonium, and be quantitatively fitted for full-face respirators. Workers thereafter submitted quarterly bioassay samples and participated in an annual in-vivo measurement. Special in-vivo measurements were performed following a few suspected exposures (see below).

On assignment to the project, workers attended a health physics indoctrination lecture. Among the topics addressed were (a) clothing requirements, (b) dosimetry badges, (c) respiratory protection, (d) eating and smoking regulations, (e) contamination control and use of self-monitoring instruments at exits from radiation areas, (f) nasal smears, (g) wound counting, and (h) site and work area alarms.

Each work crew was assigned an HPT whose primary responsibility was to keep personnel radiation exposures as low as practicable. To implement this responsibility, the Radiation Work Permit (RWP) was initiated by operations personnel, submitted to the health physics supervisor for identification of radiation protection requirements, and a copy given to the HPT. No job was performed without the RWP and no change in operation or in protective requirements was allowed without approval by the operations and health physics supervisor.

The permit was initiated following a near-miss exposure incident in October 1979. Since this incident resulted from a field decision to use a power saw instead of a hand saw to remove a section of contaminated sheet rock dry wall, the investigating committee recommended tighter controls on operations and field changes.

The RWP caused some delays while personnel became accustomed to ensuring that the permit was available when needed. It soon proved very valuable in assuring that personnel were protected and that changes were reviewed. Decontamination activities were monitored by HPTs either continuously or intermittently, commensurate with the requirements identified in the RWP. All workers were required to wear thermoluminescent dosimetry (TLD) badges. Figure 37 shows monitoring activities during decontamination operations.

Special personnel monitoring procedures included wound counting[4] and urine and fecal sampling.[5] The criteria for these procedures follow along with results concerning frequency and findings.

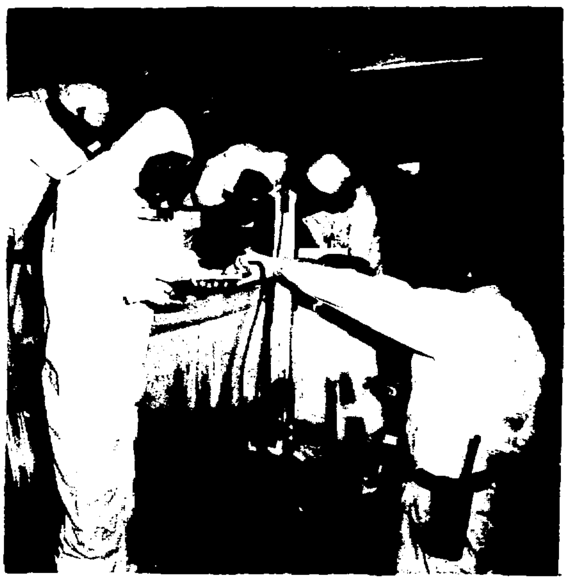

Fig. 37. Health physics monitoring during glovebox separation.

A part of the training for the HPT assigned to a work crew was documenting and responding to wounds because the nature of the work resulted in numerous minor skin scratches, abrasions, or punctures. Although the Laboratory's plutonium wound count procedures address many wound and injury situations, the basic rules for the minor wound were that a wound count would be required if the wound occurred in a plutonium work area and (a) if alpha contamination was found in the vicinity of the wound; (b) if alpha contamination was found on the object causing the wound; or (c) if the object causing the wound could not be monitored but was suspected for any reason of being contaminated; or (d) if the worker or his supervisor specifically requested a plutonium wound count.

Seventy-five such wounds were reported and counted during the operation. None contained a measurable amount of plutonium.

A program for collecting fecal samples following potential exposures was initiated at Los Alamos in 1973. The program requires collection of fecal samples if any of these situations occur: (a) introduction of plutonium into tissue, to the extent that levels exceed 2 nCi by the plutonium wound monitor; (b) chemical burns (acidic or alkaline) from plutonium-bearing solutions which result, after attempts to decontaminate, in skin contamination in excess of 10,000 dis/min with a 60-cm^2 alpha air proportional probe, or in a plutonium wound count of the burn area in excess of 2 nCi; (c) facial contamination before decontamination in excess of 40,000 dis/min on an alpha probe near the nose or mouth or on the face as the result of a leaky respirator; or (d) nose swipes (either side) in excess of 500 dis/min before blowing nose or showering.

On six occasions, personnel were requested to submit fecal samples because of a nose swipe in excess of 500 dis/min. Levels in these samples were less than the minimum detection level for plutonium and americium.

B. Transfer Procedures and Final Release Surveys

In January 1979, a Standard Operating Procedure (SOP) was developed for final survey of the areas and eventual transfer of the areas to new occupants. The SOP was required to ensure proper surveys were performed and documented and to ensure proper indoctrination of new occupants. This procedure began with the termination of operations by the plutonium chemistry and metallurgy group and ended when the area was transferred to the new occupant. This sequence was later incorporated in the project management plan.

The procedure called for personnel from the operations group to remain and ensure that the gloveboxes were given an initial cleaning to remove all accountable levels of plutonium and to guide the crafts through the removal of special equipment and utilities from the gloveboxes, which became known as the predecontamination phase.

The room or area was then transferred to the Supervisor of the Decommissioning Section. Decontaminators from this section separated gloveboxes and conveyor tunnels and removed high levels of contamination. Skilled craftsmen removed contaminated services and miscellaneous equipment, and janitors and laborers removed lesser contaminated structures and surfaces.

The health physics section of H-1, which to this point had been providing health physics personnel to the craft and decontaminator crews, then took over the area to ensure that the decontamination effort met release criteria and that any remaining contamination was documented. Final survey reports were prepared for each room and building.

When contamination levels in an area met predetermined release criteria, new flooring was installed, the walls were painted orange to alert future occupants of possible contamination, and a final condition report was prepared for each room and building. A meeting was then held with the new occupants to discuss future use restrictions and health physics control program requirements.

C. Radiation Detection Instruments Used For Final Surveys

1. Alpha Survey Instruments

Since weapons-grade plutonium, ^{238}Pu, and ^{241}Am were the primary contaminants, and since the main project objective was to ensure surface alpha contamination levels were below 1000 dis/min direct reading and 400 dis/min swipeable, alpha detection instruments played a major role in radiation surveys, particularly in the final release surveys. The two portable instruments used were the Eberline Portable Alpha Counter Model 7 (PAC-7) and the

Ludlum Model 139. The type used depended primarily on availability; however, each had desirable features for certain situations. The approximate minimum detection level that could be detected using either instrument in the field was 400 dis/min.

The PAC-7 is a small, lightweight, battery-operated count-rate meter with an integrally connected air proportional detector (Fig. 38). The clip-on meter module contained the meter and speaker and was connected to the main case of the instrument by a coil cord.

The detector was an Eberline Model AC-24C attached directly to the electronics package with a Type C connector. Efficiency for alpha was approximately 50%; active detector area was 60 cm^2. The instrument's major drawback was the 12.7-cm height and fixed detector which prevented using the instrument in congested areas such as piping chases and under gloveboxes.

The Ludlum Model 139 is a portable, battery-operated alpha survey instrument with a cable connected detector. The detector was an air proportional detector with an 0.8 mg/cm^2 aluminized mylar window. The active area was 50 cm^2 and the instrument had approximately 50% efficiency.

2. Beta and Gamma Survey Instruments

Beta-gamma surveys were made to verify that surface radiation levels were less than 1.0 mR/h. Levels were found to be below the detection capabilities of this counter. Since the laboratory areas were to be released for occupancy by non-radiation workers, long-term thermoluminescent dosimetry badge exposures were made to demonstrate that beta-gamma levels were below 0.25 mrem/h or 500 mrem/year based on a 40-hour-per-week, 50-weeks per-year occupancy factor. Thermoluminescent dosimetry badge results showed beta-gamma radiation levels were not significantly different than natural background levels for the area.

The instrument used most frequently for beta-gamma surveys of building surfaces was the Eberline E-112B meter (Fig. 39) and a 3-cm diam. by 16-cm long halogen-filled GM tube with 30 mg/cm^3 stainless steel wall. It detects photon radiation from 20 keV to several MeV and beta radiation >200 keV. The detection range was 0-20 mR/h with a typical background reading of 0.1 mR/h.

A Ludlum Model 14 was occasionally used instead of the E-112B. It used the same probe and had basically the same detection capabilities as the Eberline E-112B. All beta-gamma radiation final surveys of areas were performed with the detector shield open.

3. Neutron Survey Instrument

Neutron surveys were performed to measure neutron radiation levels throughout the facility. These surveys were performed using an Eberline Portable Neutron REM Counter, Model PNR-4. In addition to making surveys with this counter, the detector, which is a 22.9-cm (9-in)- diameter, cadmium-loaded polyethylene sphere with a BF_3 detector in the center, was used with a scaler system to make fixed location measurements

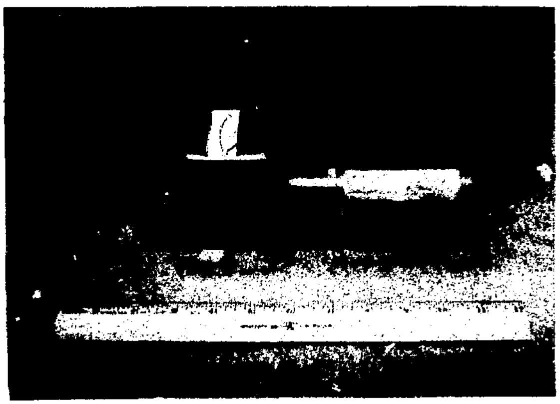

Fig. 38. Eberline Portable Alpha Detector Model 7.

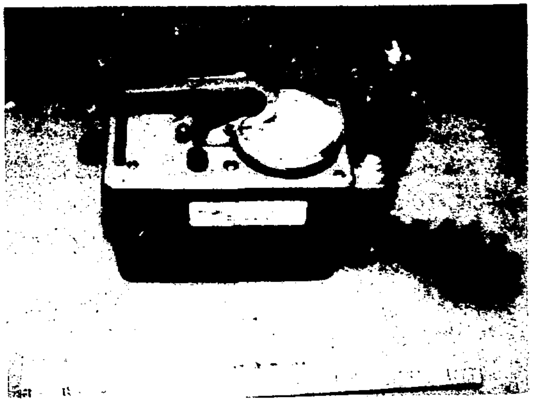

Fig. 39. Portable beta-gamma Eberline Meter Model E-112B.

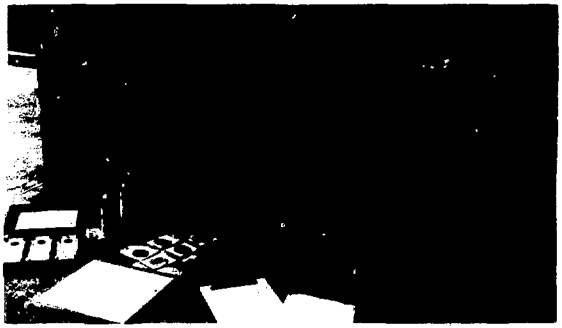

Fig. 40. Battery-operated portable phoswich detector.

throughout the facility. This system was capable of measuring much lower neutron radiation levels than was the PNR-4 and results of these measurements verified that neutron levels were not significantly above background levels in the area.

4. "Phoswich" Detector

A Los Alamos-developed phoswich (phosphor sandwich) detector,[6] which consists of a NaI crystal backed by a CsI crystal, and measures low-energy photon radiation, such as plutonium x rays, was used extensively throughout the operation to detect subsurface plutonium. The detector, electronics, and scaler were housed individually (Fig. 40). The electronics included an aural popper used when background noise levels permitted.

Because the phoswich is very sensitive to scattered radiation, it could not be used in an area housing plutonium gloveboxes and process equipment or in a highly contaminated area. Once contamination levels were reduced, it became extremely useful in locating hot spots such as those in cracks or under paint on concrete floors. Phoswich readings also helped establish worker protection requirements, because below-surface contamination levels could be estimated with some confidence. Phoswich sensitivity for painted-over plutonium is about 10,000 dis/min. Its use also assured that no painted-over high-level spot was left behind. Surfaces with contamination detectable with the phoswich were cleaned or removed. Figures 41 and 42 show the phoswich being used for wall and ground surface surveys.

Fig. 41. Phoswich detector on rack for wall monitoring.

VI. DECONTAMINATION TECHNIQUES

Decontamination personnel performed the high-level, high-risk glovebox and conveyor tunnel separations, and the structural decontamination requiring specialized techniques or equipment. These special decontamination techniques are described in the rest of this section. Decontamination activities involving low-level contamination and use of conventional cleaning techniques such as washing with soap and water were performed by ZIA Company personnel.

A. Glovebox and Conveyor Tunnel Separation

Although glovebox washing was not continued, experiences gained from working in and around these gloveboxes were extremely valuable and aided in accomplishing the glovebox work.

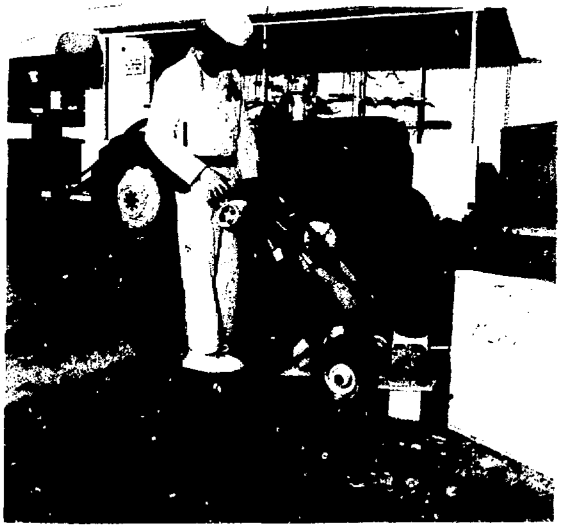

Fig. 42. Ground surface surveys with phoswich detector.

The rationale for preparing gloveboxes and tunnels for separation was to complicate future size reduction operations as little as possible by minimizing painting, foaming, etc. After a few successful separations, cleaning and painting the separation area and the adjacent 30 cm in both directions became standard procedure. The lack of gloveport openings in some long sections of conveyor tunnels necessitated lowering the tunnel in one large section, fabricating an end plate that would accommodate an exhaust duct, and then separating the tunnel into smaller sections at floor level. At the selected separation point, a 15-cm diam hole was made and decontamination and painting were accomplished with long-handled brushes and tools. The hole was later used as an exhaust port for the next separation. Support rails for the conveyor bucket did not always butt together at the separation point; hence, several tunnel sections had to be partially unbolted and separated enough to allow sawing the rails with a hacksaw blade (Fig. 43).

Glovebox separation areas were cleaned with a commercial spray detergent introduced into the glovebox system in a $1-\ell$, plastic spray bottle. After cleaning, the surface was spray-painted with enamel, also introduced in a spray container. Usually four coats of enamel were applied. The last coat was applied just before the separation.

Fig. 43. Sawing of conveyor track through tunnel opening.

Large bag-out ports were sealed by introducing a steel plate into the box, then using a bolt to tighten the external plate onto the glovebox. Silicon rubber was used as a sealant between the box surface and the plate.

The need to keep gloveboxes and conveyor tunnels under vacuum resulted in designing a gloveport vacuum device (Fig. 44) that served as an exhaust port for sections which had no connection to the process exhaust. A variac-controlled vacuum cleaner motor and a HEPA filter were used to adjust the vacuum on the box. When the box was isolated, the device then became a filtered vent for the glovebox, allowing the box to go through temperature changes during temporary storage without becoming pressurized and releasing plutonium contamination.

Almost every glovebox had a bottom protuberance of one kind or another. Since working safely under a glovebox was very difficult some protuberances were allowed to remain with the glovebox and were protected by a metal framework (Fig. 45) which can easily be removed when the glovebox is processed at a size reduction facility.

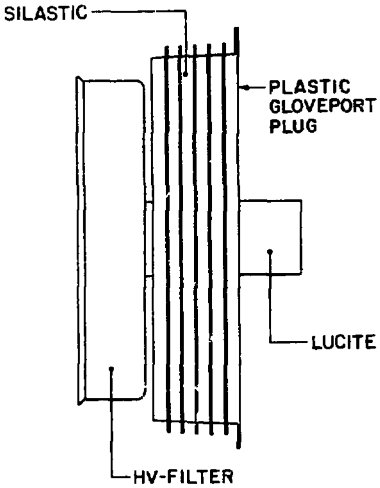

Fig. 44. Gloveport vacuum device.


Fig. 45. Protective metal framework attached to glovebox bottom.

B. Concrete Surfaces

The project required decontamination of 5300 m^2 of concrete slab floors. Since Los Alamos experience was primarily limited to using acids, paint removers, and pneumatic chippers on small areas, new techniques had to be developed for large areas.

Early in the project single-head, hand-held and seven-head, floor-type pneumatic scarifying tools were purchased and experimentation began in isolated areas. To eliminate the possible spread of contamination, an enclosed HEPA-filtered con-

Fig. 46. Confinement chamber for scarifying.

finement chamber was constructed using a glovebox section (Fig 46).

Numerous tests were conducted with a floor-type scarifier. By covering the floor with a thin layer of water or water-detergent mixture and vacuuming immediately after scarifying, very high levels of plutonium contamination could be scarified without spreading contamination or creating an airborne problem (Fig. 47). This method was used to decontaminate over 3500 m^2 of concrete surfaces.

The effectiveness of scarifying was compared to using abrasives, acid solutions, and paint removers. Scarifying proved to be the safest and most cost effective.[7] Identifying highly contaminated areas with the phoswich detector, scarifying them, then scarifying the entire floor using the floor model soon became standard practice. Each pass removed approximately 0.5 cm. Usually, except for cracks or bolt holes, two or three passes removed all contamination. Removal of bolt plugs or anchors used for supporting gloveboxes and other equipment required removal with a hand-held air chisel. Room 213 in Building 2, for example, had 600 bolt plugs and anchors. Some 125 m of metal

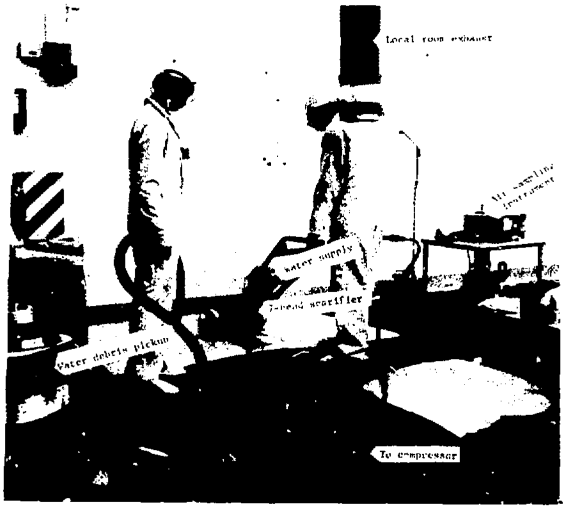

Fig. 47. Removal of concrete surface.

stripping used to cover expansion joints in the concrete floors were also removed. The ends were loosened with a pneumatic chisel and pried loose with a crowbar. The remaining cracks were usually highly contaminated; hence, they were spray painted and cleaned with a hand-held scarifier after strip removal.

The single-head scarifier was used on some of the concrete stub walls. Although using a single-head model was time consuming, it was effective and met all the needs of this project. By keeping the surface wet, scarifying could be done without air-borne contamination problems.

C. <u>Metal Surfaces</u>

Decontaminating metal structural supports, wall sheeting, etc., depended on contamination, finish (painted vs unpainted), and the value of the item.

Structural supports in relatively clean areas such as attics were damp mopped or wiped using water and detergent solution. Metal wall partitions with fixed contamination were decontaminated when possible by using paint removers or dilute HCl solutions with abrasive cleaners. Generally, for fixed contamination, detergents were ineffective, paint remover somewhat effective, and HCl solutions and abrasives very effective, removing approximately 80% of the contamination. Highly contaminated walls were removed to save time and costs, to be more complete, and to minimize injuries such as acid burns, cut fingers, etc.

D. <u>Plaster Walls and Ceilings</u>

Most wall surfaces were plaster on metal lath Early in the project, paint remover was used to try to save the plaster, but the many steps required to apply the remover, scrape it off, check the surfaces, and then repeat this process several times made it easier and more economical to remove and replace the plaster. Paint was removed from a total of 270 m^2 of wall surface and 427 m^2 of plaster were removed.

A very useful contamination control aid used while scarifying or chipping contaminated plaster and paint was a filtered vacuum cleaning system which could be positioned to collect chips and dust from the operation. The 200- (55-gal) drum which served as a trap was later sealed and used as the primary waste disposal container (Fig. 48). The vacuum cleaner was a commercially available, air operated, HEPA-filtered system.

VII. WASTE MANAGEMENT

Waste management aspects of the operation were directed by an onsite representative from the Laboratory's Waste Management Group, H-7.

Fig. 48. Device used to collect plaster and paint chips.

When practical, room trash was packaged in 0.05-m^3 cardboard boxes and surveyed for retrievability in a Multiple Energy Gamma Assay System Counter[8] (Fig. 49). Nonretrievable waste totaling 7426 m^3 was sent to TA-54 in plastic-lined, tarpaulin-covered trucks or Dempster Dumpster waste containers.

Waste with over 10 nCi ^{239}Pu or 100 nCi ^{238}Pu per gram of waste was packaged and placed in approved TRU storage containers and trucked to TA-54. Retrievable waste generated by this operation consisted of 1488 m^3 of gloveboxes and conveyor tunnels (Fig. 50); 166 m^3 of pipe, duct, etc. (Fig. 51); and 104 m^3 of soil.

One hundred and two cubic meters of gloveboxes packaged in bolted metal containers were sent to TA-50-37 for future size reduction studies.

Each load of waste sent to TA-54 for disposal or storage was accompanied by a Laboratory Radioactive Solid Waste Disposal Record Form.[2]

Liquid wastes were treated at an on-site industrial waste treatment plant.[9] Before removing of the acid wells, liquids were poured down the drains located in the janitor closets in each building. With the removal of the acid wells and associated piping, liquids were vacuumed into 200-ℓ (55-gal) drums and later pumped into a 2000-ℓ (500-gal) trailer, for delivery to the treatment plant. Solutions from the glovebox washing operations were vacuumed into a 20-ℓ cylinder and analyzed for plutonium before pumping to the trailer.

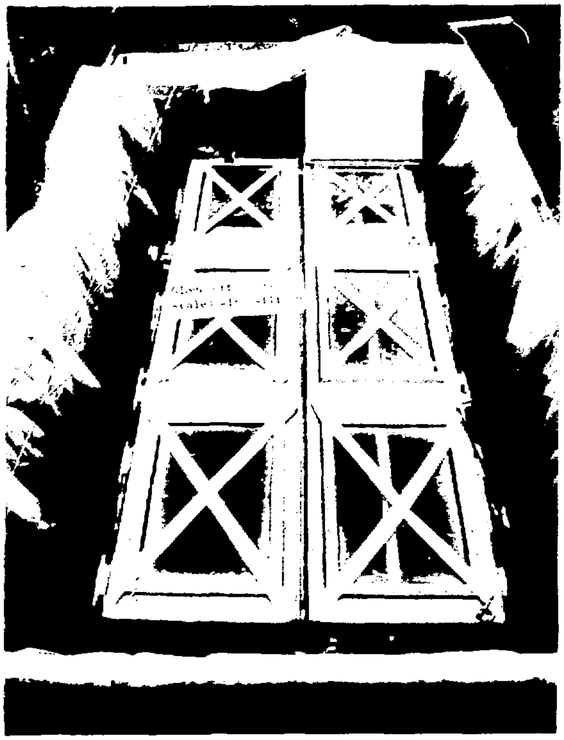

Fig. 50. Glovebox section in 20-year storage container.

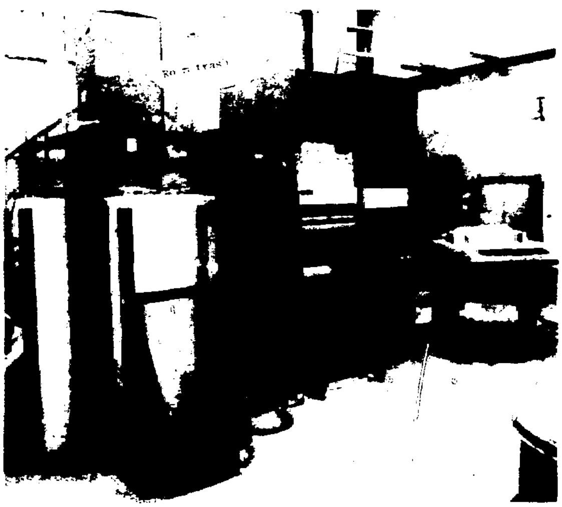

Fig. 49. Multi Energy Gamma Assay System.

Fig. 51. Twenty-year storage container with miscellaneous pipe.

VIII. COSTS

The project required three years and a total cost of $4,418,400. Table I illustrates the craft application and time required to accomplish this task. Health physics personnel time as shown in the table covers final surveys only. Table II lists the costs for each of the participating organizations and supplies.

ACKNOWLEDGEMENTS

Many Los Alamos National Laboratory and Zia Company personnel contributed to the success of this decontamination effort. However, the authors are particularly grateful to John Anderson, CMB-11, for controlling the budget and providing advice and key CMB-11 support personnel as necessary; Charles Blackwell, H-1, for handling the project's records and waste management problems; Pascual Chavez, H-1, for ensuring that work crews didn't lack health physics monitoring support, and that areas were surveyed for timely release to new occupants; Alfredo B. Fernandez, H-1, for converting unskilled new hires into effective radiation workers in a manner that the glovebox separations remained on schedule; Robert Gilmore, CMB-11, for helping establish initial glovebox and tunnel separation techniques; Darrell P. Hohner, ENG-1, for his effective advance planning and foresight; and Mike Tomlison, Zia Company, for his effective supervision of Zia crafts personnel. The assistance received from Joyce Martinez, H-1, in preparing the document and from Frank Lavigne, Zia, in providing the drawings are also appreciated.

TABLE II

SUMMARY OF COSTS FOR THE DP WEST PLUTONIUM DECONTAMINATION PROJECT

	Costs in Thousands of $s					
	1977	1978	1979	1980	1981	TOTAL
LOS ALAMOS NATIONAL LABORATORY						
H-Division	1.3	148.5	473.6	416.1	93.0	1132.5
CMB-Division	0.0	43.5	164.4	180.3	5.9	394.1
ENG, WX, E	0.0	1.7	68.2	62.3	1.4	133.6
ZIA COMPANY	0.0	144.8	767.9	1190.4	110.7	2213.8
MATERIAL						
General Supplies	19.7	55.7	66.7	50.6	63.2	255.9
Fiberglass Boxes	0.0	0.0	98.8	169.1	20.6	288.5
Totals	21.0	394.2	1639.6	2068.8	294.8	4418.4

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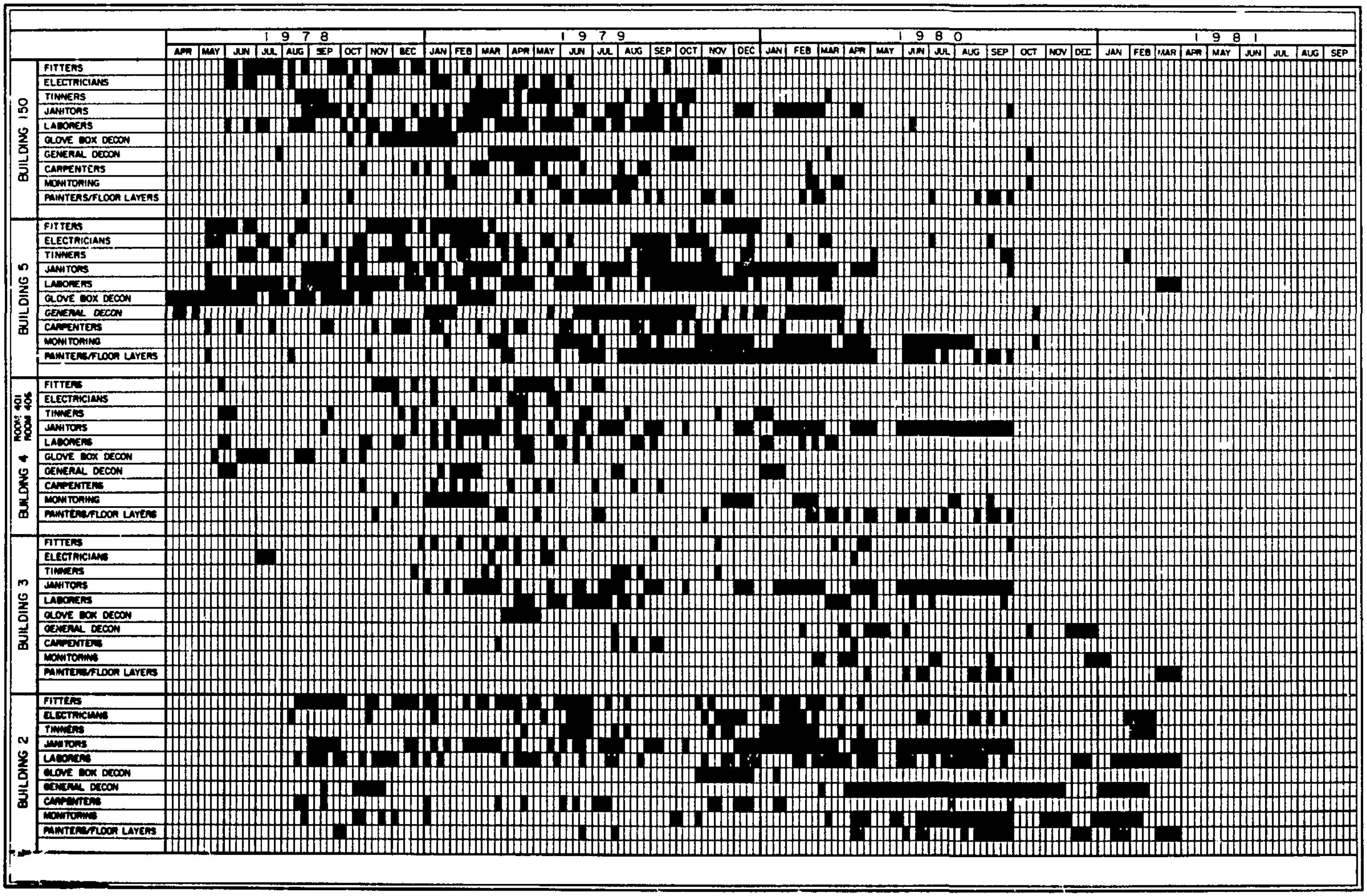
TABLE I

SUMMARY OF DECONTAMINATION EFFORT

BY AREA AND DISCIPLINE



APPENDIX A

GLOVEBOX ACID WASH PROCEDURE

Washing a glovebox requires a minimum crew of two decontamination technicians and a health physics technician.

Preparation

1. Make sure the crafts have completed disconnecting the utilities and the tinner craftsmen have installed flex duct and an in-line filter in the exhaust system.
2. Check the glovebox vacuum; it should be at least 1/2 in of H_2O, when measured by a magnehelic gauge.
3. Prepare area: remove loose items from around the glovebox, clean area, lay plastic sheeting on the floor and surrounding surfaces.
4. Isolate area with barriers and signs.
5. Establish monitoring station at entrance. Equip with hand-foot counter, clean booties, spare coveralls, rubber gloves, etc.
6. Position equipment, check operation of pump and vacuum system.
7. Drill two 1/2-inch holes into face of glovebox, insert approximately 1.5 m of plastic tubing into box and epoxy in place.
8. Bag epoxy and/or silastic sealants into glovebox.
9. Seal all openings, i.e., bag-out port covers, furnace covers, etc.
10. Allow epoxy or silastic time to set; overnight should be adequate.

Acid Wash

1. Mix acid solution, 20% HNO_3 - 3% HF, in a ventilated hood. Transport to work area in a capped plastic carboy.
2. Transfer 3 or 4 liters of acid solution into pump reservoir.
3. Activate pump and spray interior of box starting at the top. Pay particular attention to window gaskets. When wash cycle is completed, let solution drain down the sides and collect on the bottom. Allow 20-30 minutes. Record amount of acid solution used.
4. Vacuum out as much acid solution as practical.
5. Add tap water to pump reservoir and spray interior of box. Record amount of water used.
6. Vacuum out water.
7. Repeat steps 2 thru 6, two times.
8. When vacuum holding tanks are full, draw a 2-mℓ sample and submit to H-7 for analysis. On analysis request form indicate total amount of solution represented by sample.
9. Change glovebox gloves for NaI survey (number and location of gloves to be changed will be determined by survey analyst). During change, bag out old gloves and epoxy containers. Cut off exposed ends of wash and vacuum tubes and seal ends.
10. After NaI survey, install plastic gloveport plugs.

APPENDIX B

DETERMINING RESIDUAL PLUTONIUM IN GLOVEBOXES USING NaI DETECTION SYSTEM

I. INTRODUCTION

This technique uses an NaI scintillation detector for detecting the low-energy photons emitted during the decay of the transuranic radionuclides. For plutonium assay, the decay of x rays (energies approximately 17 keV) are monitored. For ^{241}Am the decay 60-keV gamma ray is detected. The entire system remains external of the glovebox and measurements are made by placing the probe into a clean unleaded glove and aiming it at the surface of interest. Photon transmission through the glove is better than 70% for photon energies above 15 keV.

The electronics package consists of a photomultiplier tube base and preamplifier, a high-voltage power supply, and a Davidson Model 1056 multichannel analyzer.

II. PROCEDURE

- o Prepare a map of the glovebox showing dimensions with actual measurements, determine where clean gloves are needed to allow monitoring without significant overlapping, $\pm$10% of actual surface area.
- o The Model 1056 analyzer has easily set "Regions of Interest" (ROI) for integrating peaks or other groups of channels. Up to eight spectra of 128 channels each may be held in separate memory subgroups, allowing comparison between measurements and the holding of data for later transcription. Spectra are shown on the small display scope. Set six ROI, one for each set of channels 4-8, 10-25, 27-31, 39-43, 45-60, 71-75, in all eight of the 128-channel memories.
- o An 8.54 Ci ^{241}Am source is used for calibration. The display scope will show two peaks, one centered near channel 17 and covered by the chanel 10-25 ROI, the other centered near channel 60 and covered by the channel 45-69 ROI. Further, the counts in the 45-69 ROI should be roughly equal ($\pm$10%) with the 10-25 ROI slightly higher. The gain on the Model 1056 will occasionally need to be changed to center the 17- and 60-keV peaks.
- o From map, determine location and probe to surface distance. Perform a 10-second count, at each location, repeat until all eight memory channels have been used. Record counts for each channel, erase, and continue until all locations have been surveyed.
- o Survey location and counts obtained are transferred to an 80-column entry form and submitted to the Laboratory Computer Center. The final results will be in nCi/cm^2. This number is then multiplied by 5 or 9 depending on the extent of decontamination the box received prior to the survey.
- o Final nCi/g values are obtained by applying the nCi/cm^2 value to the glovebox surface area and weight.