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DECONTAMINATION AND DECOMMISSIONING OF THE
ARGONNE NATIONAL LABORATORY EAST AREA
RADIOACTIVELY CONTAMINATED SURPLUS FACILITIES
Final Report

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Abstract

Argonne National Laboratory (ANL) has decontaminated and decommissioned (D&D) seven radiologically contaminated surplus facilities at its Illinois site so that they could be released for conventional demolition and the land returned to unrestricted use. The group of structures consisted of a "Hot" Machine Shop (Building 17), and four support facilities; Fan House #1 (Building 37), Fan House #2 (Building 38), the Pangborn Dust Collector (Building 41), and the Industrial Waste Treatment Plant (Building 34), which made up the waste systems for treating the exhaust air from the machining of radioactive materials. Also included were a Nuclear Materials Storage Vault (Building 16F) and a Nuclear Research Laboratory (Building 22). The D&D work involved dismantling of all process equipment and associated plumbing, ductwork, drain lines, etc., so that contaminated components could be separated from those which were not. After appropriate radiation surveys were performed, floor and wall coverings, suspended ceilings, room partitions, pipe, conduit and electrical gear were taken down as necessary in each facility in order that both exposed and concealed surfaces of all walls, ceilings, and floors were accessible for radiological monitoring and decontamination. In addition, underground sewers were excavated so that they, and the surrounding soil, could be checked for contamination. The grounds around each facility were also thoroughly surveyed. Contaminated materials and soil were packaged and shipped to a Department of Energy low-level waste burial site, while non-active debris was buried in the ANL landfill. Clean, reusable items were saved, and metal scrap which was free of radioactivity was sold for salvage. After completion of the decommissioning work, each building was torn down and the site relandscaped. The project was completed in 1985, nine months ahead of schedule, required 33 months and 15 man-years to accomplish, produced just under 19,000 cubic feet of radioactive waste, and cost 1.88 million dollars, which was 700 thousand dollars under the original estimate.

Decontamination and Decommissioning
of the
Argonne National Laboratory
EAST AREA
Radioactively Contaminated Surplus Facilities

FINAL REPORT

1.0 INTRODUCTION

The "East Area" at Argonne National Laboratory (ANL) in Illinois (Figure 1.1) was built in the late 1940's and early 1950's to provide temporary quarters until permanent buildings were available for the ANL staff, which was then still located on the University of Chicago Campus and elsewhere in the general vicinity. The structures were mostly "Quonset Huts" but some were made of sheet metal and/or concrete block. All were expected to last only a few years, but due to a constant space shortage at the Laboratory, many remained in use until the 1980's, and a few are still occupied.

1.1 HISTORY OF THE FACILITIES

The seven facilities which are included in this Decontamination and Decommissioning (D&D) Project were all part of the East Area complex (Figure 1.2). They had been used in conjunction with operations involving radioactive materials, which resulted in them becoming

Figure 1-1. Aerial View of Argonne National Laboratory

Figure 1-2. East Area Facilities

contaminated with low levels of principally uranium and thorium. Because each was 30 to 35 years old and in a deteriorated condition, no beneficial reuse appeared economical, so the buildings were declared surplus and accepted into the Department of Energy's (DOE) Surplus Facilities Management Program (SFMP). Under this arrangement SFMP became responsible for funding the radiological surveillance and the physical maintenance of the buildings until D&D could be undertaken and then was to provide the money needed to actually decommission the structures.

Initially only six facilities were identified. They consisted of a machine shop, which fabricated or modified materials that were radioactive or were components of radioactive systems, three air-filtration buildings, and a small industrial waste treatment plant that treated either radioactive exhaust air or the contaminated liquids generated during the processing of the air or from the actual machining operations, and a nuclear materials storage vault used for the safekeeping of sensitive radioactive materials. Later, after the D&D was underway, a recently vacated nuclear research laboratory was added to the program without extending the original schedule or requiring any additional funding.

1.2 PROJECT PURPOSE

The overall purpose of this project was to eliminate seven unneeded radioactively contaminated surplus facilities from the Argonne site in

a manner which allowed the buildings to be released for conventional demolition and the land returned to unrestricted use.

2.0 FACILITY DESCRIPTIONS PRIOR TO DECOMMISSIONING

The seven facilities included in this project are listed below and in the order in which the D&D work was planned to be carried out. They will be described individually in the paragraphs that follow.

- Building 37 - Fan House #1
- Building 16F - Nuclear Materials Storage Vault
- Building 41 - Pangborn Dust Collector
- Building 38 - Fan House #2
- Building 17 - "Hot" Machine Shop
- Building 34 - Industrial Waste Treatment Plant
- Building 22 - Nuclear Research Laboratory

2.1 BUILDING 37 - FAN HOUSE #1

2.1.1 Physical Description and Condition

Building 37 (Figure 2-1) was a two-story structure approximately 50 feet x 50 feet x 40 feet high. Its first story was of concrete-block construction while its second story was of sheet metal attached to a light structural-steel frame. The second story of the building contained an air-filtration facility which was formerly used to clean exhaust air from adjacent "hot" machine shops. The air-filtration

Figure 2-1. Building 37

equipment (Figure 2-2) consisted of eleven American Air Filter Company Type 4N Rotoclone hydrostatic precipitators and nine American Air Filter Company Electro-Cell electrostatic precipitators. Each Rotoclone unit was 4'-9" x 5'-5" x 10'-10" high and weighed about 2,000 pounds. The Electro-Cell units were each 4'-8" x 12'-7" x 6' high and weighed about 3,000 pounds.

The first story of Building 37 contained two vault rooms which were formerly used to store special nuclear materials, an adjacent nuclear-materials workroom, and several other work areas generally used for non-nuclear related activities. Process drain lines from the air-cleaning equipment above passed through the first-floor areas including the corridor, and were connected to sewer lines beneath the building's foundation slab.

At the start of decommissioning work (March 1983), the building had been abandoned for about ten years except for the first floor which was occupied briefly by a research group doing nonradioactive experiments. On the upper floor, where the air-filtration equipment was located, all power, lighting, heat, water, etc., had been cut off, but the building was still reasonably weathertight. Both floors contained an accumulation of leftover unusable equipment and unwanted materials, as well as a great deal of dust and other debris. The first floor still had heat, light, and water, so it became the base of operations during most of the project.

Figure 2-2. Building 37 Second-Level Floor Plan

2.1.2 Radiological Conditions

The only significant gamma exposure-rate measurement that had been obtained in the second floor air-filtration facility was one of 130 micro R/h above a plugged floor drain. The general background radiation level in the facility was found to be 4-6 micro R/h. The highest gamma exposure-rate measurements other than the floor drain ranged from 20 to 30 micro R/h inside two of the filtration units. Smear samples taken from various items of equipment in the facility and from floor, wall, and overhead surfaces yielded loose activity ranging from 600 to 3,600 dpm/100 cm² beta-gamma and from 300 to 1,300 dpm/100 cm² alpha. This contamination was mainly due to natural uranium and natural thorium.

On the first floor, the vault rooms and the associated work room were contaminated with natural uranium and natural thorium up to 1,000 dpm/100 cm² alpha, beta, gamma. The ceiling of the corridor (covered walkway) adjoining the vault work room and small portions of the lower-level floors in Building 37 were also contaminated due to process water leaking from the air cleaning equipment located above. Smear samples indicated up to 4,000 dpm/100 cm² beta-gamma of removable contamination on those surfaces. In addition, drain lines from the second story which passed throughout the lower level contained internal radioactivity.

2.2 BUILDING 16F - NUCLEAR MATERIALS STORAGE VAULT

2.2.1 Physical Description and Condition

Building 16F (Figure 2-3) vault was a concrete-block structure consisting of four vault rooms. Overall dimensions were approximately 40 feet x 30 feet x 14 feet high. It was formerly used for the secure storage of special nuclear materials, mainly uranium and some thorium. It was abandoned in 1980 and contained only the shelving upon which the nuclear materials were stored, a HEPA-filtered air-exhaust system, and a laboratory hood.

The area had been unheated for several years so the paint was peeling from both the interior and exterior walls, but the roof did not leak. Heat and power were restored during the D&D activities.

2.2.2 Radiological Conditions

Overall, the facility showed a small amount of contamination due to natural uranium. Smear samples yielded general removable contamination up to 100 dpm/100 cm² alpha. Vault Room #1 was contaminated mainly with enriched uranium. Smear samples taken from one "hot spot" on the floor of this vault room read approximately 200,000 dpm/100 cm² alpha. Small amounts of residual cesium-137, and natural and enriched uranium had been detected in Vault Room #3; while in Vault Room #4, traces of natural uranium had been found. The ductwork, HEPA filters, and stack were also expected to be contaminated.

Figure 2-3. Building 16F Nuclear Materials Storage Vault

2.3 BUILDING 41 - PANGBORN DUST COLLECTOR

2.3.1 Physical Description and Condition

Building 41 (Figure 2-4) was the designation given to the Pangborn Baghouse dust collector which was used to trap the dust generated by the machining of graphite in the "hot" machine shop. The dust collector was made of sheet metal and was approximately 16-feet long, by 6-feet wide, by 12-feet high. It was supported at a height of nine feet above ground level by structural-steel pillars. When the collector was in service, the trapped graphite dust was periodically discharged from the unit into 55-gallon drums that were located under the unit.

The unit had been unused and unmaintained mechanically for about ten years. All power to it has been cut some time ago and the exterior showed many areas of rust.

2.3.2 Radiological Condition

Residual material taken from inside the Pangborn dust collector was found to contain the following concentration of contaminants:

Figure 2-4. Building 41 Pangborn Dust Collector

Cesium-137	2.0 pCi/g
Cobalt-60	0.1 pCi/g
Natural Thorium	10.0 pCi/g
Uranium-235	3.0 pCi/g

The ground below the Pangborn also showed contamination which may have occurred during dumping operations. The interior, however, was not radiologically surveyed prior to the D&D work as it was believed unwise to actually open the unit to gain access.

2.4 BUILDING 38 - FAN HOUSE #2

2.4.1 Facility Description and Condition

Building 38 (Figure 2-5) was a two-story structure of sheet metal on a light, structural-steel frame, 27 feet x 29 feet x 41 feet high. The exterior of its lower story was covered with transite. The building's second story contained air-filtration equipment, similar to that in Building 37, consisting of two Rotoclone Type N hydrostatic precipitators and three Electro-Cell electrostatic precipitators that also processed exhaust air from the machining operations in the Building 17 "Hot" Shop. Its first floor contained two 500-gallon retention tanks which collected process fluids from the equipment located above.

This facility was shut down in the mid 1970's. Water, power, light, and heat were all disconnected by cutting the utilities at their

Figure 2-5. Building 38 Fan House #2

source, and the building remained abandoned until decommissioning was initiated in the Spring of 1984. Some accumulation of debris remained and a great deal of dust and dirt had collected on all the flat surfaces. In addition, pigeons had infested the second floor and left their usual mess behind. Structurally the building was only fair to poor and several roof leaks were present.

2.4.2 Radiological Condition

The air-cleaning equipment on the second floor of Building 38 was contaminated with natural thorium, natural uranium, cesium-137, and cobalt-60. Spotty contamination ranging up to 2,000 dpm/100 cm² for both alpha and beta had been detected by direct measurements on the floor of the first story. In addition, the liquid retention tanks and their associated drain pipes were known to contain low levels of radioactivity. Also, the floors on both levels showed some degree of activity in various locations.

2.5 BUILDING 17 - "HOT" MACHINE SHOP

2.5.1 Facility Description and Condition

Building 17 (Figure 2-6) was a Quonset-type metal structure, approximately 80-feet wide x 160-feet long x 24-feet high. The building's long dimension was oriented along an east-west axis and from its south side, a connecting hall, approximately 80 feet long x 40 feet wide, joined it to the north side of the essentially identical

Figure 2-6. Building 17 "Hot" Machine Shop

Building 16, thus forming an "H-shaped" complex (Figure 2-7), but these latter two structures were not included the project scope.

For approximately 30 years Building 17 housed a "Hot" Machine Shop which was used to fabricate or to modify items which were radioactive in themselves or were components of radioactive systems. With the transfer of this work to other site locations, the facility had become excess to present needs. All of the shop's machinery was removed and the building left empty except for several years when a support service group occupied the balcony. Heat, light, power, water, and other utilities all remained in an operating condition. Also, most of the exhaust-ventilation ductwork, which transmitted air to the treatment systems in Buildings 37, 38, and 41, was still in place. The physical condition of the structure was also fairly good, and the roof did not leak except around some of the interior roof drains.

2.5.2 Radiological Condition

There was widespread radioactive contamination of various areas in this building. Uranium fires had occurred on several occasions which had spread airborne activity throughout the facility, and even though cleanup had been performed, it was expected that many horizontal surfaces high over head, as well as the ceilings, were still contaminated. Beta-gamma exposures rates of .01 to 5 mR/h had been measured in various locations, and smears yielding up to 36,000 dpm/100 cm² beta-gamma and 8,000 dpm/100 cm² alpha of removable activity were being observed. Natural and normal uranium and natural

Figure 2-7. Floor Plan of Buildings 16 and 17

thorium were the principle contaminants, but some cesium-137 and cobalt-60 were also detected.

2.6 BUILDING 34 - INDUSTRIAL WASTE TREATMENT PLANT

2.6.1 Facility Description

Building 34 (Figure 2-8) contained an industrial waste treatment plant which processed slightly radioactive fluids produced during the operation of the air-cleaning facility in Building 37 as well as radiologically contaminated solutions generated by various "hot" machine shop operations and metal treating baths. The structure (Figure 2-9) was approximately 17-feet x 18-feet x 10-feet high and had a full 10-foot deep basement with poured concrete walls and floors. The portion above ground was concrete block with a concrete roof. Abutting the exterior walls of the basement on the building's north and west sides were three open in-the-ground concrete tanks with capacities of 2,000, 3,000, and 7,000 gallons, respectively. These tanks received the contaminated waste solutions mentioned above, and held them until their treatment was complete. The plant's process equipment such as pumps, mixers, chemical-addition tanks, filters, etc., as well as the process piping remained in the building. The underground pipes which carried the contaminated wastes to the open concrete tanks from Buildings 16, 19, and 37 also remained in place. The facility had been out of use since 1978, and all heat, light, power, and water were shut off and cut in 1983. The outdoor tanks continually accumulated water from rain and snow and from in-leakage

Figure 2-8. Building 34 Industrial Waste Treatment Plant

Figure 2-9. Building 34 Floor Plan

to the underground sewer pipes serving the various buildings. Also, water leaked from the tanks into the basement on various occasions causing it to fill to a level equal to that in the outside tanks. At times, this amounted to about seven feet. However, samples of the water were always significantly below discharge levels so the liquid could be pumped directly to the sewer system.

2.6.2 Radiological Condition

The basement level of the plant was the principle location of the residual radioactivity. The insides of the process equipment and piping were contaminated to some degree with mainly uranium, and ranged between 1,000 and 10,000 dpm/100 cm² beta-gamma. Some of the influent sewer lines were also contaminated as well as the walls and bottoms of the concrete tanks. Soil in the immediate area of the tanks and the blacktop driveway in front of the building had been surveyed and certain areas were found to have elevated levels of radioactivity.

2.7 BUILDING 22 - NUCLEAR RESEARCH LABORATORY

2.7.1 Physical Description and Condition

Building 22 (Figure 2-10) originally consisted of two 40 foot wide by 120 foot long corrugated metal "Quonset" structures joined by a 60 foot long by 40 foot wide waist section toward the front of the building. Later, a poured concrete addition, 60 feet wide by 60 feet

Figure 2-10. Building 22 Nuclear Research Laboratory

long and 24 feet high was constructed to fill the gap behind the connecting unit. The maximum height of the overall structure was 24 feet. The building served a variety of uses from a paint shop to a ceramics and metallurgy lab to an "Atoms for Peace" teaching facility, and finally as a workshop and nuclear science laboratory for Argonne's educational programs. Its final configuration (Figure 2-11) consisted of numerous small offices and laboratories on the first floor and several mechanical equipment rooms on the two mezzanines above. Hoods, which served the various labs, were exhausted through HEPA filter systems that were on that upper level. A concrete tube storage vault was located in the southeast portion of A-Wing. Most of the laboratory hoods still remained, bench tops and cabinets were in place and various obsolete lab-type equipment and glassware were left in various locations. Also, a large volume of obsolete reports, publications, records, etc., remained scattered throughout the facility. Heat, power, lights, and water were still intact as the building was not vacated until 1984, and D&D started in early 1985 before those utilities could be cut.

2.7.2 Radiological Condition

Fixed, low-level, spotty radioactive contamination was detected in a number of places including floors, bench tops, etc., and loose radioactive contaminants were located in several laboratory hoods and gloveboxes. The tube storage vault, however, was found clean. In view of the fact that work, involving thorium and uranium, was performed in the building during the past, and at one time Wing A

Figure 2-11. Building 22 Floor Plan

housed a fuel reprocessing operation, it was expected that radioactive contaminants could exist in many places which were inaccessible.

Suspect areas included: under room partitions, floor tile, carpet, etc.; within sink and floor drains, exhaust ductwork, filter housings and stacks; and in the closed area between the room ceilings and the main roof of the structure. Most of the lab furniture and equipment was clean, but had to be removed so as not to become contaminated during the D&D activities.

3.0 DECOMMISSIONING OBJECTIVES AND WORK SCOPE

3.1 PROJECT OBJECTIVES

The objectives of this project were as follows:

1. To decontaminate and decommission Buildings 16F, 17, 22, 34, 37, 38, and 41 located on the Argonne Illinois Site in the East Area.
2. To remove any radioactive contaminated Soil associated with these East Area Facilities.
3. To minimize the volume of radioactive waste which must be packaged and sent offsite for burial.
4. To release the decontaminated buildings for demolition by conventional means.

5. To accomplish the foregoing in a manner that maximized worker safety and assured protection of the Laboratory employees and property as well as the general public and the environment.

3.2 WORK SCOPE

The scope of work for this project was as follows. Each step was applied, where appropriate, to each facility as it was decontaminated and decommissioned.

1. Removed from the facility all loose items of equipment, apparatus, furniture, and other materials that were left behind, or which had accumulated while the building was idle after which a general cleanup of the entire area was performed to eliminate debris and dust. Health physics monitoring of these activities was done as necessary to determine appropriate disposition.
2. Performed a radiation survey of the facility, equipment, components, and associated systems to identify and characterize the nature and extent of the existing radioactive contamination.
3. Disassembled all contaminated equipment and associated systems, size reduced components as necessary, and packaged them for disposal. Noncontaminated portions were segregated out, as practical, to minimize radioactive waste.

4. Dismantled facility, as needed, so that both exposed and concealed surfaces of all walls, ceilings, and floors were accessible for health physics monitoring.
5. Decontaminated, as necessary, all areas found to be radioactive during the facility survey.
6. Resurveyed decontaminated areas to assure that cleanup was satisfactory.
7. Located, excavated, and packaged for disposal all contaminated soil found in the vicinity of the facility.
8. Released decontaminated building for conventional demolition.
(No demolition was included within the scope of this project.)

4.0 WORK PERFORMED

4.1 PROJECT MANAGEMENT AND ENGINEERING

Overall responsibility for this project rested with Waste Management Operations (WMO) of the Plant Facilities and Services Division (PFS) at ANL. A WMO staff member with considerable past D&D experience was appointed Project Manager and charged with the planning, coordination, management, field engineering, budget preparation, cost control, scheduling, reporting, and the day-to-day direction of all aspects of the project. The Health Physics (HP) section of Occupational Health

and Safety Department (OHS) in the Support Services Division (SSD) directed the Radiological Control Program which included: furnishing personnel for the pre, interim and post-D&D radiation surveys; determining when the cleanup criteria had been satisfied; making the final determination as to the disposition of all waste materials generated (salvage, landfill, or radioactive disposal); ascertaining the nuclear composition and concentration of the radioactive waste; and handling the many other aspects of Health Physics. The OHS/HP Health Physicist and the PFS/WMO Project Manager worked closely and cooperated with each other extensively to assure that the work was done efficiently and in a cost-effective manner while at the same time maintaining the certainty that all radioactive materials were identified and removed from the facilities. Further details of the Health Physics Program are discussed in Section 7. Assistance by other Laboratory groups was provided, as necessary or as needed, in the areas of safety, industrial hygiene, fire protection, plant maintenance, procurement, transportation and rigging, and grounds. Since the effort was very similar to decommissioning work performed in the past, previously developed procedures and techniques were employed throughout.

Prior to the start of the actual D&D work an Action Description Memorandum (ADM) (Reference 1) was prepared to satisfy the National Environmental Policy Act (NEPA). In addition, a Project Plan (Reference 2) was issued which described how the work would be done, what the estimated costs would be, the time needed to complete the job, and various other aspects of the project. This was later revised to reflect the inclusion of Building 22.

4.2 SITE PREPARATION

Only one facility, Building 37, required any preparation prior to the D&D work. This consisted of constructing a new interior stairway up to the second level by the ANL in-house carpenters. The old stairs had been removed a number of years earlier, at the request of Health Physics, as a means of preventing the first floor occupants from direct access to the contaminated equipment above. The opening in the floor on the upper story was sealed off with plywood (see Figure 2-2) which provided complete isolation between the two levels. On the exterior of the building (see Figure 2-1), a temporary stairway had been built, up to the sliding cargo doors which were lockable, so routine surveillance of the air treatment equipment could be performed. These outside stairs were torn down as soon as the new interior one was installed, as it was through the upper cargo door that most waste had to be removed from the building. In addition, power for lights and the convenience outlets was restored on the second floor by plant maintenance shortly after the area was occupied.

4.3 DECOMMISSIONING OPERATIONS

All work relative to the D&D of the East Area Facilities was executed by ANL employees who had previously performed similar operations. A four-man team of Waste Management Operations mechanics, supervised by a Foreman and directed by the Project Manager, carried out the

physical effort. They were supplemented and given guidance by one or two Health Physics Technicians under the direction of a Chief Technician and a Staff Health Physicist. Specifics of the operations involved for each facility are outlined in the paragraphs which follow and in the order in which they were performed.

4.3.1 Building 37

The D&D of this facility proved to be the biggest challenge of all those included within the project. It contained the most contaminated equipment, in the form of air-cleaning machinery, generated the largest amount of radioactive debris (not soil), and took the longest to complete. After a general cleanup of the first floor, which contained a great deal of abandoned and useless materials left by the previous occupants, this area was set up as the project's base of operations and was utilized as such for the next two-and-a-half years. Tools, equipment, supplies, etc., left over from the decommissioning of the Building 350 gloveboxes were moved into the facility. A health physics radiological assay lab, a workshop, a lunchroom and an office were established and the crew utilized locker and washrooms that were nearby. Once these worker accommodations were set-up, D&D efforts began on the second level. They started with a thorough housecleaning accompanied by the appropriate HP survey to remove all of the loose items, debris, dirt, etc., which were present or had accumulated over the years of disuse. Piping, conduit, electrical gear, and other appendages on the exterior of the Rotoclones and precipitators and elsewhere in the facility were next

removed and since no contamination was detected, disposal took place at the on-site landfill or in the ANL scrap yard.

Work was then initiated on the air treatment equipment itself (Figure 4-1). The general procedure was to start on the discharge end by disconnecting the air outlet from the exhaust stack, since this was the cleanest side of the system, and then begin to dismantle the sheet-metal housing which enclosed the filters and the Electro-Cells (Figure 4-2). After completing the precipitator, the Rotoclone was dismantled by unbolting motors, fans, and other removable items. The goal of these activities was to expose or gain access to all interior and concealed surfaces. Each step was preceded and followed by radiation surveys to detect those portions which were contaminated. As the radiological condition of each air-cleaning device and its components became known, disposition as to radioactive, landfill, or salvage was determined in accordance with the specified criteria. (See Section 7-3 for the criteria which was used and how it was applied.)

Decontamination was attempted when some measure of success could be expected, but items such as filters and their housings, the Electro-Cells and their stands, baffle plates, and rusty Rotoclone surfaces seldom could be cleaned, so after one or two failures such effort was abandoned. Galvanized sheet metal, on the other hand, was cleaned up fairly often. Since all of these devices were quite large, size reduction of contaminated units or components was necessary to fit shipping containers. This was coupled with separating contaminated

Figure 4-1. Rotoclones/Precipitators in Building 37 Before D&D

Figure 4-2. Dismantling of Rotoclones/Precipitators in Building 37

portions from those which were not "hot" and was accomplished by sawing, shearing, nibbling, or flame cutting, depending on the nature of the material and its radioactive condition.

Dismantling of the air-cleaning equipment started in mid-April and continued until the end of September 1983. During that time, all nine precipitators and eleven Rotoclones were disassembled and disposed of in accordance with the criteria. The degree of contamination varied on each, from none in "G" and "H", to some portions for "A", "C", "D", and "M" and to almost all for "B", "E", "F", "J", "K", and "L". In every case the primary contaminant was uranium but "B", "K", and "J" also contained some thorium.

A further area of effort connected with each precipitator was the need to break up the raised cement pad under each unit (Figure 4-2, upper photo). This concrete base, which was actually the floor inside the precipitator housing, resisted all decontamination efforts and was therefore jackhammered or chiseled out. In many cases this debris showed higher radioactive readings than did the unit with which it was associated. In addition, each Rotoclone was positioned over a rectangular curbed area which contained and directed wash water, as it flowed from the bottom of the scrubber, to the drain in the center. These curbs, and sometimes portions of the floor, also had to be removed due to contamination. Overall, the dismantling of the air cleaners and the concrete removal required some 2650 man-hours and produced about 3600 cubic feet of radioactive waste.

After completing the preceding, work was shifted to removal of the inlet air ducts for each unit (Figure 4-3). Some of these extended back into the buildings in which they originated, while others had been partially or completely removed over the years as they became unnecessary. At this same time the exhausts stacks, extending up to the ceiling, were also taken down, but the portion passing through the roof was allowed to remain so that rain and snow would not enter the building. All ducts were sectioned by sawing into manageable-sized pieces, surveyed and disposed of in accordance with the criteria. Those exhaust stack sections, which were found contaminated, were all successfully decontaminated but some of the inlet ducts could not be cleaned and had to be cut up for disposal as radioactive waste. These activities required about 600 man-hours and generated some 300 cubic feet of radioactive waste.

Once all of the equipment, ductwork, and curbing had been removed from the second floor, surveys and decontamination of the interior of the structure itself was undertaken. The distance from the floor to the roof measured between 20 and 30 feet in height so the greatest portion of this work was performed on ladders, scaffolding or lift platforms. Most of the top sides of the horizontal surfaces were found to be contaminated with low, but above criteria, levels of radioactivity and required vacuuming and wiping before they could be considered clean. Since working conditions were very difficult, and a great deal of area had to be covered, this operation was very time consuming. It required approximately 1650 man-hours and was not completed until early January 1984.

Figure 4-3. Rotoclone Inlet Air Ducts Between Buildings 17 and 37

Included in the above effort was the removal of 44 floor drains that collected water from the various stages of the air-cleaning process and conveyed it to a sewer system that terminated at the Building 34 Industrial Waste Treatment Plant. All of these drains were contaminated and had to be jackhammered out of the floor. They were connected to piping which ran along the ceiling of the first level and these lines also required removal and disposal as radioactive waste. In all, this phase of work consumed 600 man-hours and produced 300 cubic feet of radioactive waste.

Upon completion of the work on the second-story (Figure 4-4) cleanup of the first floor vault rooms and covered walkway was instigated (Figure 4-5). The vault room proved relatively easy to decommission. Surveys showed that the shelving which remained was contaminated and could not be decontaminated as the activity had been painted over on several occasions. Therefore it was all disassembled, size reduced, and packaged as radioactive waste. The walls, ceilings, floors, and light fixtures were all wiped down and surveys then indicated the rooms met the established criteria.

Construction of Building 37 had evidently taken place after the covered walkway was built, as the second floor concrete slab extended out over the corridor roof creating about a three-and-a-half foot high crawl space between the two. Drain lines from the equipment above were present in this space and they had obviously leaked, contaminating the walkway roof, ceiling, and sidewalls. Because of

Figure 4-4. Second Floor of Building 37 After D&D

Figure 4-5. Covered Walkway and Vaults at Building 37

the low-head room in this area and the fact that the roof was made up of tongue and groove wooden boards, felt paper, tar, and gravel, a good deal of effort was spent tearing it out as it was almost totally contaminated over its 90-foot length. In addition, various walkway sections of ceiling under the roof and parts of the side walls had to be removed due to the radioactive liquid having soaked into the wood and plasterboard. Overall D&D effort on the first level was completed in early March 1984, required about 650 man-hours and generated about 400 cubic feet of radioactive waste.

The last task associated with the D&D of this facility consisted of the radiological survey of the ground around the exterior of the building. This was conducted in June of 1984 and did not find any conditions which required cleanup.

4.3.2 Building 16F

The decommissioning of this nuclear materials storage vault presented no particular problems and was carried out in the same manner as was the one in Building 37. The shelving in the vault also had painted-over radioactive contamination which made decontamination impractical so it was size reduced and packaged for disposal. The HEPA exhaust system, ductwork, and the workroom hood were all below criteria and, except for the duct, were saved for future use. All walls, ceilings, conduit, light fixtures, electrical switch gear, etc., were wiped down and the floors were scrubbed (Figure 4-6). A floor crack was found contaminated and, upon jackhammering out the concrete, the soil

Figure 4-6. Vault Work Room in Building 16F After D&D

beneath also showed some radioactivity. Removal of about two feet of dirt was necessary before the area was considered clean (Figure 4-7). Final surveys of the interior of the facility indicated that it met the criteria. Some "hot" soil however was detected when the exterior monitoring was done and this was picked up by hand shoveling. In all, about 400 man-hours were utilized for the D&D and 340 cubic feet of radioactive waste including 40 cubic feet of soil was generated. The work took place in February and March of 1984.

4.3.3 Building 41

The Pangborn Dust Collector was somewhat of a surprise, as upon opening it (Figure 4-8), no radioactivity was found inside and it was therefore sent to the on-site landfill. Ductwork leading to the unit was first taken down and then with the aid of a crane for support, the legs were cut off (Figure 4-9 and Figure 4-10). After laying the entire device on its side so that the top cover could be easily removed (Figure 4-11), surveys were conducted on all interior surfaces and when they showed no contamination the unit was released for burial. Soil underneath the dust collector was ascertained to contain uranium but it was possibly from the same source as the contaminated soil found adjacent to Buildings 17 and 38 (see Section 4.3.4), all of which was cleaned up in the Fall of 1984 after the decon of 38 was complete. Some 275 man-hours were expended on the D&D of this facility and 300 cubic feet of soil was considered to be attributable to the unit. Work was started in late April and completed in May 1984.

Figure 4-7. Vaults in Building 16F After D&D

Figure 4-8. Pangborn Dust Collector Opened Up for Radiological Surveys

Figure 4-9. Removal of Inlet Air Ducts to Pangborn

Figure 4-10. Pangborn Being Removed From Its Support

Figure 4-11. Preparing Pangborn For Radiological Surveys

4.3.4 Building 38

Since Fan House #2, Building 38 was very similar to Building 37 except for the size and the number of air filtration units (Figure 4-12), work in this facility followed the same approach as it did at Fan House #1 and for that reason only the differences will be detailed in this report.

Whereas Building 37 sent all process water via a sewer line to the Building 34 Industrial Waste Treatment Plant, this facility had two retention tanks on the first floor in which the liquid was collected and held until its disposition could be determined (Figure 4-13). Both tanks were found to be contaminated, so each had to be size-reduced to fit standard packaging (Figure 4-14). These tanks were cut apart first, the drainlines from above were taken down, the inlet air ducts on the exterior of the building were sectioned and removed and the concrete floor was decontaminated before proceeding to the second floor (Figure 4-15).

Radiation surveys of the dismantling operations on the upper level (Figure 4-16) determined that Rotoclone/Precipitron "N" and Precipitron "Q" were totally contaminated while Rotoclone/Precipitron "P" was mostly clean. Concrete curbing and bases, floor drains, discharge water piping, inlet air ducts and exhaust stacks for the respective units followed that same pattern. Interior monitoring of the structure resulted in identifying many portions of the sheet-metal

BUILDING 38

ROTOCLONES

SECOND FLOOR

GROUND FLOOR

Figure 4-12. Floor Plan of Building 38

Figure 4-13. Building 38 First Floor Prior to D&D

Figure 4-14. Dismantling the Retention Tanks at Building 38

Figure 4-15. Air Inlet Ducts to Building 38

Figure 4-16. Dismantling Rotoclones/Precipitators at Building 38

walls and roof which were contaminated. Since they had been coated with a tar-like material, decontamination was ineffective and so these sections had to be cut out in pieces (Figure 4-17 and Figure 4-18). In all, these activities inside the building required about 2100 man-hours and generated 1340 cubic feet of radioactive waste. They were performed during the period of mid-April through September of 1984.

Monitoring of the soil under the Pangborn Dust Collector led to finding a rather large area of contamination on the ground bounded by the east side of Building 38, the north side of Building 17, and the south side of a service road which ran along the north side of Building 38 and the radioactive material extended eastward somewhat beyond the east side of the dust collector. In all, it covered about 2000 square feet of area with the greatest concentration next to Building 38. A backhoe was used on three separate occasions to skim off three to four inch layers of dirt and place the material into shipping containers (Figure 4-19). After the third time, assay results showed that the activity had been satisfactorily removed. This operation required about 500 man-hours and resulted in nearly 4800 cubic feet of radioactive waste. Since it was in the vicinity of three separate project facilities, each was allocated a portion of that volume.

4.3.5 Building 17

The decommissioning of the "Hot" Machine Shop was originally scheduled to be initiated after completing Building 38. However, when work finished in Building 37 and 16F in early March 1984, it was still too

Figure 4-17. Decontamination of the Building 38 Structure

Figure 4-18. Decontamination of the Floors in Building 38

Figure 4-19. Soil Removal in the Vicinity of Buildings 38 and 41

cold to begin outdoors on Building 41, or inside the unheated Building 38. Therefore, about seven weeks of effort was performed in Building 17. This consisted of a general cleanup, the removal of the interior exhaust ductwork that went to the air-cleaning units in Building 38, a thorough scrubbing of all floors to eliminate the need for shoe covers, and the stripping of non-skid floor covering in the room used to machine graphite (Figure 4-20). By mid-April, the weather had improved sufficiently that work was stopped in Building 17 and shifted back to the original schedule.

Resumption of D&D in Building 17 took place in October 1984. This facility consisted of eight rooms that were about 30 feet by 30 feet each, which were used for such operations as grinding, welding, graphite machining, and other specialties, a 50 foot by 100 foot main shop area, and a 30 foot by 100 foot balcony that had offices, a lunchroom, and lavatory (Figure 4-21). Since there was no equipment remaining in the entire facility, decommissioning activity was simply one of finding the radioactivity and removing it. This was accomplished by dismantling each room so that all surfaces could be thoroughly monitored for radioactivity. This required removal of floor coverings (paint, tile, carpet, etc.); wall coverings, light fixtures, and room partitions up to about three feet from the floor; and any conduit, pipe, ductwork, etc. that interfered with or obstructed the surveying (Figure 4-22). All removed materials were checked for activity and then disposed of either as radioactive waste or sent to the landfill for burial as specified by the established criteria. After a room had been prepared, the remaining wall and

Figure 4-20. Initial Floor Decontamination in Building 17

7

MAIN FLOOR PLAN - BUILDING 17

Figure 4-21

2

Figure 4-22. Dismantling Building 17

ceiling surfaces were surveyed with appropriate instruments, checked for loose activity, further decontaminated as necessary, and finally marked as clean so there was no doubt about their status. The concrete floors which were routinely scrubbed to control loose contamination, but were known to need considerable further decontamination, were left until last so that the depressions and unevenness resulting from the decon effort did not create a safety hazard for the workers or interfere with the use of rolling equipment.

Work proceeded along these lines with little problem and few surprises. By the end of December 1984, everything except the decontamination of the concrete floors was complete. As a result of conversations with other DOE contractors involved in SFMP decommissioning, ANL became aware of the scabbling technique for removal of surface contamination on concrete. Procurement arrangements were made in early December 1984 to purchase such a machine and upon arrival in January it was used extensively on the Building 17 floors (Figure 4-23). Approximately 4000 square feet, or 30% of the shop area, required treatment and in all cases the survey results were below the established release criteria.

Decontamination of concrete surfaces using chemical solutions is often unsuccessful and may even cause the radioactivity to penetrate further into the treated area. An air operated commercially available scabbling machine readily removes from 1/8 to 1/4 inch of surface concrete which is usually sufficient to decontaminate most floors. The unit employs a reciprocating piston to drive a tungsten-carbide

Figure 4-23. Floor Decontamination by Scabbling in Building 17

bit with protruding pointed pins. The rapid up and down motion combined with the weight of the machine causes the concrete to chip or spall. Dust is controlled by keeping the floor wet, and the fine gravel-like debris can be collected in buckets or a wheelbarrow using a broom and a shovel. After scabbling, the floor is again sprayed with water and a wet-vacuum is used to remove the rinse solution along with any remaining residues. The five bit unit obtained for this operation makes a cut that is 11" wide and requires 125 cfm of 85 psi air at the tool. It is model U5 manufactured by the MacDonald Tool Corporation and cost \$4,500. Smaller and larger models are available with working widths from 6" to 19". Bits which require replacement after about 100 hours of use cost \$80 each. The operation of the scabbler is not labor intensive. A two-man crew can generally decontaminate about 400 square feet of floor in an eight hour day if only one pass is required. Waste generation is minimal as one day's operation produces only five to eight cubic feet of solids and about 25 gallons of liquid. If that same area of floor were broken up with jack hammers, some 70 to 200 cubic feet of concrete debris would result, depending on the thickness of the slab (2" to 6"). This process does not severely damage the floor. Even though the treated surface is rough, it does not impede rolling equipment or create a walking hazard for personnel. It also provides an excellent base over which to apply a new concrete topping. The scabbler needs a significant volume of air for proper operation which means a dedicated compressor may be required. Also, the operation is noisy and workers must be provided with ear protection. The machine cannot get closer than about six inches to walls and other up-right obstacles so devices

such as jackhammers or hand-held scabblers must be used for those inaccessible areas. Overall however, scabbling is a superior and cost effective way to decontaminate concrete surfaces.

By the end of January 1985, the D&D work in Building 17 was completed except for some exterior surveys that had to wait for warm weather. Those were finished in June and other than shoveling up a small amount of black top and soil adjacent to the east doorway, no additional effort was required. The entire decommissioning required some 3200 man-hours of effort and generated, exclusive of soil, about 1200 cubic feet of radioactive waste. Soil volume was approximately 700 cubic feet from the work described in Section 4.3.4.

4.3.6 Building 34

The D&D of the Industrial Waste Treatment Plant started with the cleanup of the outdoor tanks. Water, which had accumulated, was pumped out and since an analysis showed it was below the established discharge level, disposal to the sewer was permissible. However the sludge that had settled on the bottom of the tanks was above the release level so it was pumped into drums and trucked to the Laboratory Waste Processing Facility where it was converted to a solid by evaporation. Tank equipment such as mixers, heaters and the associated electrical gear, ductwork, piping, and other components were next removed (Figure 4-24) and disposed of in accordance with the criteria. Most of these items were not contaminated.

Figure 4-24. Building 34 Outdoor Tanks and Equipment

The interior of the tanks had been covered with a coating which was meant to protect the concrete from becoming contaminated but over the years it had failed in many spots. Since it was felt necessary to actually monitor the bare concrete, this epoxy-like material had to be scraped off. Survey results then showed that the interior walls were acceptable but the tank bottoms required further decontamination. This was accomplished by scabbling and chipping with a jackhammer (Figure 4-25).

After the interior of the outdoor tanks had been successfully decontaminated (Figure 4-26), work on dismantling the equipment inside the building was undertaken. On the ground floor panel boards, tanks, controls, a sink, electrical gear, piping, etc., (Figure 4-27) were all removed, surveyed and disposed of as appropriate. Since this floor served mainly as a point of control for the liquid processing very few items were contaminated. Quite the reverse was true on the below-ground service floor which contained the pumps, filters, piping valves, etc., that actually came in contact with the radioactive solutions (Figure 4-28). Most of these components were "hot" and, because of their severely corroded condition, they could not be decontaminated. Instead they were size reduced as necessary and packaged for offsite shipment.

Once these removal operations were completed, the building surfaces underwent radiological surveys. No contamination was found on the floors, walls, or ceilings at ground level (Figure 4-29), but the entire floor of the basement required scabbling and chipping. Also,

Figure 4-25. Decontamination of Building 34 Outdoor Tanks

Figure 4-26. Building 34 Outdoor Tanks After Decontamination

Figure 4-27. Building 34 Ground Floor Prior to D&D

Figure 4-28. Building 34 Service Floor Prior to D&D

Figure 4-29. Building 34 Ground Floor After D&D

the pump pedestals had to be taken out and the sump hole required considerable effort. Walls and ceilings were scraped of all loose paint prior to monitoring. After these operations were finished the service floor (Figure 4-30) was found to meet the terms of the release criteria.

The foregoing work was started in mid-April and completed by the end of May 1985. It required about 700 man-hours and generated some 500 cubic feet of radioactive waste.

This, however, did not conclude the job. Because it was not known if the tanks had ever leaked, surveys of their exteriors were needed. A backhoe was utilized to dig out the soil immediately next to each tank wall so that both the adjoining soil and the walls could be checked for radioactivity. This operation also served to locate the influent lines to the tanks from the other buildings. Upon locating the first tank inlet pipe, which was only a few feet underground, it was decided to follow it back to where it had originated in a nearby building that had been torn down two years earlier. This pipe run was only about 40 feet long but as excavation approached the end, soil underneath was found contaminated (Figure 4-31) and this lead to the discovery of a rather large area of additional "hot" soil beyond the termination of the line. After removal and packaging about 1000 cubic feet of dirt, work was halted because it appeared that further enlargement of the hole (Figure 4-32) would prohibit the backhoe from being able to resume digging next to the tank walls as the machine would be unable to get close enough to reach.

Figure 4-30. Building 34 Service Floor After D&D

Figure 4-31. Excavating Sewer Pipe and Contaminated Soil Near Building 34

Figure 4-32. Further Excavation of Contaminated Soil Near Building 34

Excavation adjacent to the tanks was once again undertaken and carried out to completion over the next two weeks (Figure 4-33). Another area of radioactive soil next to one of the tanks was revealed and a portion of the concrete wall of one tank also showed considerable contamination. Once the tank and portions of the building basement walls had been exposed, excavation of the contaminated soil found earlier was resumed, and continued until all was dug out (Figure 4-34). Since sufficient shipping containers were not immediately available, the "hot" soil recovered from all but the first few days of operations was placed in a pile for packaging at a later date (Figure 4-35).

The remaining sewers serving Building 34 were next dug out (Figure 4-36). These lines were all made up of three-foot lengths of vitreous tile rather than cast iron as the others had been and many broke during removal. In all about 300 feet of various diameter pipe was removed of which less than 50% was contaminated and no radioactivity was found in any of the soil.

After all digging work was completed, the exteriors of the tanks were decontaminated by scabbling, contaminated blacktop at the front of the building was taken up and the "hot" soil was packaged and prepared for shipment. Also, assistance was provided during demolition (Figure 4-37) which was not included within the scope of the project but instead was arranged and paid for by ANL Facilities Engineering. At that time additional concrete from the tank bottoms, the basement floor of the

Figure 4-33. Excavating Around the Outdoor Tanks at Building 34

Figure 4-34. Area Around Building 34 After Completing Soil Excavation

Figure 4-35. Packaging Building 34 Contaminated Soil

Figure 4-36. Building 34 Sewer Line Removal

Figure 4-37. Building 34 Demolition

building, and an adjacent steam pit was found contaminated. These pieces were placed in a separate laydown area by the demo contractor and then broken up and packaged by the D&D crew (Figure 4-38). No contaminated soil was detected under the building, the tanks or the steam pit, and the area was later filled and graded (Figure 4-39).

Work on the exterior of the facility started in June and finished in October of 1985. Overall this second phase required about 2000 man-hours of effort and generated 500 cubic feet of contaminated pipe, concrete and other similar debris. In addition almost 7800 cubic feet of soil was packaged as radioactive waste.

4.3.7 Building 22

Decommissioning of Building 22, which was accepted by SFMP in November 1984, was scheduled to start after the completion of Building 34 or about October of 1985. However, since Building 17 was finished in January of 1985 and the weather was not favorable to initiate activities at 34, D&D was instead begun at 22. The effort here was similar to that in 17, in that it consisted mainly of surveying all surfaces and decontaminating any which were found to be radioactive. Throughout the course of the work very little activity was found but in order to reach the underside of the Quonset roof, virtually all of the walls and ceilings of the more recently constructed offices and labs had to be taken down (Figure 4-40). In addition, it was necessary to scabble various floor areas which had been painted to fix the radioactivity which had been found years back (Figure 4-41).

Figure 4-38. Building 34 Contaminated Concrete Located During Demolition

Figure 4-39. Former Location of Building 34

Figure 4-40. Dismantling Interior of Building 22

Figure 4-41. Floor Scabbling in Building 22

Also, floor boards in the fan loft had to be removed and some HEPA filtered exhaust systems (Figure 4-42) along with the hoods they serviced were dismantled, size reduced and packaged for disposal as radioactive waste. After demolition of the building (Figure 4-43) sewer lines under the slab were dug up, and along with the soil were checked for radioactivity but none was found (Figure 4-44).

This work was accomplished between the periods of February to April, and September to November, of 1985 with the break due to effort being diverted to Building 34 during the good weather months. A total of almost 3000 man-hours was required and 600 cubic feet of waste was generated.

4.4 WASTE DISPOSAL

All waste material generated during the span of this project was classified as "Radioactively Contaminated" or "Clean" in accordance with the criteria discussed in Section 7-3. Materials determined to be "Clean" were salvaged for reuse, disposed of as scrap or placed in the ANL onsite landfill. Radioactively contaminated solid waste, all of which was low-level nontransuranic (non-TRU), was further classified as to combustible or noncombustible. Liquid waste, which amounted to only about 300 gallons and came primarily from the Building 34 collection tanks, was converted to solid using existing ANL systems and equipment.

Figure 4-42. D&D of the Building 22 Fan Lofts

Figure 4-43. Demolition of Building 22

Figure 4-44. Sewer Line Removal at Building 22

The radioactive solid waste was packaged in conformity with the Department of Transportation (DOT) regulations for low-specific activity (LSA) material and met the requirements of Radioactive Waste Management Complex (RWMC) operated by EG&G Idaho (EG&G) at the Idaho National Engineering Laboratory (INEL) which accepted it for burial. The shipping container used for the radioactive waste was the standard ANL M-3A bin (Figure 4-35). The M-3A bins are made of 12-gauge steel reinforced with angle iron and nominally measure 4 feet by 5 feet by 6 feet in height. A cover made of the same material and equipped with an integral gasket is fastened to the bin with eight bolts. The bin has a gross load limit of 9,000 pounds and meets DOT requirements for LSA waste.

The RWMC requires that all nontransuranic waste be double contained and this was accomplished by the use of a wooden liner (Figure 4-32) or plastic sheeting (Figure 4-35). Also some soil was placed in M-3A bins which were only 4 feet high as they were left from a previous SFMP project. East Area D&D waste was shipped in combination with low level material generated by other ANL activities and transported to the Idaho site on "Sole Use" tractor-trailer trucks on a routine basis. Since there were no hazardous chemical wastes involved with this project, disposal of such was never an issue.

4.5 POST DECOMMISSIONING SURVEY

The Health Physics Program (Section 7) discusses the various survey aspects utilized for this project and describes what was considered a

post-decommissioning survey. In addition, OHS-HP provided a letter for the DOE Chicago Operations Office (DOE-CH) which indicated that from a radiological standpoint, the buildings could be demolished. DOE-CH, with the General Services Administration's concurrence, then issued formal approval back to the Laboratory authorizing that demolition could take place.

5.0 COST AND SCHEDULE

The D&D of the ANL East Area Facilities was finished nine months ahead of schedule, and came in \$574,000 under budget, or \$719,000 under the original estimate. Total project cost was \$1,881,000 versus the authorized budget of \$2,455,000 or the original estimate of \$2,600,000. The work was performed during the period of March 1983 through December 1985, a total of 33 months, as compared to a scheduled completion of September 1986, or an elapsed time of 42 months. In addition, one extra facility was added to the project (Building 22) without requiring additional funding or extending the overall schedule. A milestone and cost schedule by years for the project is graphically presented in Figure 5-1. In addition, Table 5-1 provides a breakdown of the actual work periods, man-hours expended, and the costs incurred for each facility, as well as the planned schedule, man-hours anticipated, and estimated costs.

6.0 WASTE VOLUMES GENERATED

The project generated 18,760 cubic feet of solid low-level non-

FIGURE 5-1

EAST AREA D&D PROJECT
MILESTONE AND COST SCHEDULE
(IN THOUSANDS OF DOLLARS)

Task	FY-1983 Quarters 1:2:3:4	FY-1984 Quarters 1:2:3:4	FY-1985 Quarters 1:2:3:4	FY-1986 Quarters 1:2:3:4	FY-1987 Quarters 1:2:3:4	Actual Cost					Total	Cost Estimate
						FY-83	FY-84	FY-85	FY-86	FY-87		
1. Building 37 D&D	▽△	▽△▲				377	161				538	550
2. Building 16F D&D		▽△▲					30				30	60
3. Building 41 D&D		▽△▲					22				22	60
4. Building 38 D&D		▽△▲	▽△▲				164	30			194	300
5. Building 17 D&D		▽△▲	▽△▲	▽△▲			95	207			302	610
6. Building 34 D&D			▽△▲	▽△▲				239	161		400	340
7. Building 22 D&D			▽△▲	▽△▲	▽△▲			253	107		360	680
8. Final Report					△×△					35	35	—
												2600
Total Cost						377	472	729	268	35	1881	—
Authorized Budget						332	485	795	808	35	2455	—

△ Planned Work Start

▲ Estimated Completion

▽ Actual Work Start

▼ Actual Completion

TABLE 5-1
EAST AREA D&D PROJECT
MANHOUR AND COST SUMMARY

	Building Number							Total
	37	16F	41	38	17	34	22	
<u>Work Schedule</u>								
June 1983 Plan								
Start	4/83	5/84	5/84	7/84	1/85	10/85	(1)	
Complete	9/84	9/84	9/84	3/85	12/85	9/86	(1)	
December 1984 Plan(2)								
Start		Work Already		4/84	3/84	7/85	10/85	
Complete		Completed		3/85	6/85	12/85	9/86	
Actual								
Start	3/83	2/84	4/84	4/84	3/84(3)	5/85	2/85(4)	
Complete	6/84	5/84	5/84	11/84	5/85	10/85	11/85	
<u>Craft Manhours</u>								
Estimate	5400	800	800	3600	5500	2600	5600	24,300
Actual	5554	393	275	2512	3174	2663	2971	17,542
Over (Under)	154	(407)	(525)	(1088)	(2326)	63	(2629)	(6,758)
<u>Costs - \$000</u>								
Craft Labor	238	16	11	94	135	142	159	795
Health Physics	68	3	2	30	47	60	64	274
Waste Disposal	43	3	3	24	23	63	7	166
Administration	34	1	1	6	24	26	34	126
Materials & Supplies	25	1	0	1	4	14	10	55
Misc. Services	26	0	1	1	11	16	15	70
Final Report	--	--	--	--	--	--	--	28
Subtotal	434	24	18	156	244	321	289	1,514
Overhead Tax	104	6	4	38	58	79	71	367
Grand Total	538	30	22	194	302	400	360	1,881
Estimate	550	60	60	300	610	340	680	2,600

(1) Not included in origin scope of project.

(2) Plan revised to include Building 22.

(3) Work started in Building 17 on March 1, 1984, was halted on April 30, 1984, and resumed on October 1, 1984.

(4) Work started in Building 22 on February 1, 1985, was halted on April 30, 1985, and resumed on September 1, 1985.

transuranic waste in contrast to an estimate of 30,000 cubic feet. All of it was packaged in the standard ANL-M3A bin and was sent to the Radioactive Waste Management Complex operated by EG&G Idaho at the Idaho National Engineering Laboratory for burial. A total of 172 bins were required, of which nine (1,080 cubic feet) were filled with combustible material, 64 (7,640 cubic feet) had non-combustible debris, and 99 (10,040 cubic feet) contained soil. Table 6-1 presents a summary of the waste volume and weight generated from each facility, and the amount of radioactivity associated with that waste. Overall, the project generated .438 curies of activity (mostly uranium) compared to an estimate of less than two curies. The majority of this was found in the soil.

7.0 HEALTH PHYSICS PROGRAM

7.1 OBJECTIVES

The objectives of the Health Physics Program included:

1. Assuring that the D&D activities were in compliance with the radiation protection standards in DOE Order 5480.1A (Reference 3) and other pertinent DOE directives, and the ANL Health and Safety Manual (Reference 4), with due regard for ALARA.
2. Evaluating proposed work procedures and strategies by means of safety reviews and proposing desirable modifications to minimize

TABLE 6-1
EAST AREA D&D PROJECT
SUMMARY OF WASTE GENERATED

	Building Number							
	37	16F	41	38	17	34	22	Total
<u>RADIOACTIVE WASTE</u>								
<u>Volume - ft³</u>								
Debris	4320	300	0	1340	1200	960	600	8720
Soil	0	40	280	1240	720	7760	0	10040
Total	4320	340	280	2580	1920	8720	600	18760
Original Estimate	7000	2000	2000	3000	10000	6000	5000	35000
<u>Weight - tons</u>								
Debris	59	7	0	20	15	26	9	136
Soil	0	1	10	41	25	250	0	327
Total	59	8	10	61	40	276	9	463
<u>Radioactivity-mCi</u>								
Debris ²³⁸ U	2.56	0.11	0	4.74	0.25	6.41	0.25	14.32
Debris ²³⁴ U	2.56	0.11	0	4.74	0.25	6.41	0.25	14.32
Debris ²³⁵ U	0.11	0.05	0	0.24	0.01	0.14	0.01	0.56
Debris ²³² Th	0.03	0.04	0	0.02	0	0	0	0.09
Debris ²²⁸ Ac	0.03	0.04	0	0.02	0	0	0	0.09
Soil ²³⁸ U	0	.001	9.43	28.71	0.06	163.58	0	201.78
Soil ²³⁴ U	0	.001	9.43	28.71	0.06	163.58	0	201.78
Soil ²³⁴ U	0	0	0.59	1.81	0	3.29	0	5.69
Total ²³⁸ U	2.56	0.11	9.43	33.45	0.31	169.99	0.25	216.10
Total ²³⁴ U	2.56	0.11	9.43	33.45	0.31	169.99	0.25	216.10
Total ²³⁵ U	0.11	0.05	0.59	2.05	0.01	3.43	0.01	6.25
Total ²³² Th	0.03	0.04	0	0.02	0	0	0	0.09
Total ²²⁸ Ac	0.03	0.04	0	0.02	0	0	0	0.09
Grand Total	5.29	0.35	19.45	68.99	0.63	343.41	0.51	438.63
<u>NON-RADIOACTIVE WASTE</u>								
<u>Volume - ft³</u>	5700	1100	1300	3000	5700	800	2800	25400

personnel exposures and the potential for spread of contamination.

3. Performing radiation surveys of equipment, ductwork, building surfaces, materials and soil to evaluate and document the radiological condition prior to any D&D effort.
4. Carrying out follow-up surveys of items, equipment, and building areas after decontamination procedures to certify and document the radiological condition of these, prior to release for demolition.
5. Acquiring samples for gamma spectrometry to identify and evaluate the potential radionuclide content. Following assay, to estimate the concentration of relevant radionuclides in the decommissioning waste to determine its disposition either as low specific activity (LSA) material, or for release, either as unrestricted or conditional.

7.2 PROCEDURE REVIEW

The Staff Health Physicist participated in the review of all procedures relating to the D&D of the facilities. This review was conducted to assure that appropriate consideration was given to all safety aspects. From time to time, the review required the input of other safety professionals of the OHS Department, such as in the assessment of potential asbestos hazards. Final agreement on the

method of proceeding was attained between the Staff Health Physicist and the Project Manager before a new procedure was incorporated.

1.3 SURVEY STRATEGY/RELEASE CRITERIA

Initial surveys of the areas disclosed that the main concern with respect to health physics activities was the presence of isolated contaminated items, furniture, equipment and areas in the facilities. In some cases, such as the machine shop, which had been designated as a shoe cover area, the floor contamination was more general (about 30% of the floor area). For the Building 37 Rotoclone area, the concrete pads indicated higher levels of contamination than other equipment associated with the Rotoclones and precipitator equipment. In general, contamination levels in the seven facilities ranged from low to moderately high (up to 10^5 dpm/100 cm²) and the external radiation fields which were encountered were not significant from an exposure standpoint (less than 5 mR/h generally). During the characterization survey, a number of general samples for gamma spectrometry were collected. The main radionuclides identified were uranium and thorium, although some samples indicated ⁶⁰Co and ¹³⁷Cs also.

Following identification of items, equipment and/or areas with radioactive contamination above the acceptable levels in Table 7-1, an attempt to decontaminate these materials was made, if practical. Following any decontamination activity, additional surveys were performed prior to a decision regarding the disposition of the

Table 7-1
Acceptable Surface Contamination Levels^(a)

Radionuclides ²	Allowable Total Residual Surface Contamination (dpm/100 cm ²) ¹		
	Average ^{3, 4}	Maximum ^{4, 5}	Removable ^{4, 6}
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β - γ	15,000 β - γ	1,000 β - γ

¹ As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

² Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

³ Measurements of average contamination should not be averaged over an area of more than 1 m². For objects of less surface area, the average should be derived for each such subject.

⁴ The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

⁵ The maximum contamination level applies to an area of not more than 100 cm².

⁶ The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm² is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

(a) Adapted from "DOE Guidelines for Residual Radioactivity at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites. Rev. 1, July 1985."

material. If decontamination attempts appeared to be ineffective or cost prohibitive, the article was disposed of as radioactive waste. If successful decontamination was accomplished, the material was disposed of as salvage or to the ANL landfill. In the case of contaminated areas of buildings, resurvey of the area was performed prior to the release of the building or facility for demolition. In some cases, such as the removal of floor drains or exhaust ventilation stacks, it was necessary for health physics personnel to provide standby coverage as the demolition contractor removed the items. WMO personnel were also on hand to collect and remove any contaminated items. Final surveys of the soil around floor drains were then made at this time.

The approach used for the surveying of items, equipment, and structures was to assess the contamination level on all accessible surfaces, with respect to the limits given in Table 7-1. This required both instrument and smear surveys to determine removable and "fixed" contamination levels. In the event that an item had interior surfaces which were totally inaccessible, so that assessment for possible contamination was not feasible, the item was disposed of as radioactive waste. Exceptions to this procedure were made for certain known enclosed systems, such as conduit, piping, radiators, etc., which were surveyed on exterior surfaces only and compared to the acceptable levels on that basis.

When an item could be surveyed on all surfaces, and the instrument survey indicated levels below the applicable criterion in Table 7-1

for total contamination, the item was dry smeared and the smear paper was counted to determine removable contamination. If the results indicated less than the Table value, the item was released for unrestricted use. The survey results and item description were documented on survey record sheets prior to release to salvage or disposal to the landfill.

For an item with survey results above the acceptable values, even after decontamination attempts, a sample was taken for analysis in order to identify the radionuclide and determine the activity concentration. Such items were placed in a disposal bin, and a record made of the volume of radioactive waste in addition to recording the information regarding survey results, concentration, and radionuclide content.

For structural members, such as walls and floors, the same procedure was used. When the total area to be surveyed was larger than 1 m^2 , the area was broken up into sectors of 1 m^2 to comply with the averaging procedure in Table 7-1. If none of the surveyed areas of 100 cm^2 within a given sector indicated levels above the maximum values for the appropriate radionuclide, the results of the surveys were averaged over the entire 1 m^2 sector. If the averaging procedure yielded a value less than the average value limit in Table 7-1, that sector was considered acceptable. The sector was then marked, generally with spray paint (yellow), to indicate that it was surveyed and met the criterion.

For areas found to be contaminated above the levels in the table, the area was marked with spray paint (purple) to indicate that it did not meet the criterion. If decontamination efforts proved unfruitful, the area was chipped, or cut out, and placed into a bin. Samples of what was removed were retained for gamma spectrometry analysis to determine radionuclide content and concentration. The volume of the disposed material was documented, along with the survey results, the radioassay data, and determination of the radioactivity concentration. In addition to a regular survey of wall and floor surfaces, surveys were performed for migrated activity on the inside of walls, at junctions of walls and floors, and under floor plates.

For those cases in which decontamination could be effected, the area was given a final resurvey to determine that the criterion had been met.

Soil samples, taken from areas which showed elevated survey instrument readings, or soil from around contaminated drains, were analyzed for radionuclide content and concentration by means of gamma spectrometry. The samples (100 g) were prepared for counting in a sealed petri dish to insure a standard geometry. A survey instrument reading was then made on the top and bottom of the dish to indicate the relative uniformity of the sample concentration. For greatly differing survey readings, the sample was counted on both sides and the activity determinations were averaged. A number of sample concentrations were determined and these were averaged to arrive at the average soil concentration for the given radionuclides.

The dominant contaminant identified in soil was uranium. Based upon results obtained in the pathway analysis for the D&D of the New Brunswick Laboratory (Reference 5), the external exposure pathway dose rate from contaminated soil was found to be the limiting parameter for uranium. In order to be conservative, the lower value of the total body dose rate conversion factor for natural uranium, found in Table 4 of Reference 5, was used, instead of the value for normal uranium. If one does not use correction factors for occupancy and for shielding by structures, the dose rate factor is 0.221 pCi/g-soil per mrem/y. On the basis of a 100 mrem/y limit to members of the public, the residual soil contamination level must be no more than 22 pCi/g-soil. A rounded-off value of 20 pCi/g-soil was used as the soil concentration limit for this project.

7.4 SURVEY INSTRUMENTS

A number of survey instruments were used to estimate activity levels or radiation fields. In addition, some of these instruments were used to complement the spectral analysis obtained from radioactive samples.

The Eberline PRM-5-3 (on the left in Figure 7-1) utilizes a thin (2 mm thick) Sodium Iodide (NaI) crystal which is efficient for detecting low energy photon radiation. It was used as a scanning instrument for locating contamination because of its sensitivity for photon radiation. The instrument is supplied with a rate meter and a single channel analyzer. It operates in three gross modes; at thresholds

Figure 7-1. Eberline PRM-5-3 and PAC-4G-3 Survey Instruments

equal to 17 keV, 60 keV, and 186 keV, respectively. It may also be operated in the pulse height analysis mode for the photon energies listed. This latter feature is useful when ^{235}U (185.7 keV) is the contaminant of interest, as was sometimes the case for this project. On the right in Figure 7-1, is the Eberline gas flow proportional counter, the PAC 4G-3; the main instrument used to estimate surface activity levels. The instrument utilizes a propane gas bottle to supply the counting gas for the probe which has a 100 cm^2 active probe area. The probe window is thin (0.85 mg/cm^2 aluminized mylar) to allow alpha to enter the chamber and be detected. The instrument can be used to detect alpha, beta, and gamma surface contamination and can be used to delineate the alpha from the beta-gamma contamination levels. By using known source activities of a given alpha or beta-gamma emitter, the instrument can be calibrated to accurately determine the surface activity levels for a given radionuclide.

The instrument on the left side of Figure 7-2 is the Victoreen Panoramic, an air-ionization chamber instrument suitable for estimating the exposure rate due to a gamma radiation field. Exposure rate readings with an ion chamber at a known distance from a volume source can be used in conjunction with spectral data of the radionuclide content to estimate the radionuclide concentration in the volume source. For the radiation fields encountered during this project, the accuracy which can be attained with an ion chamber device was not really needed. For this reason, the instrument on the right side of Figure 7-2, the Eberline PRM-7, called a micro-R meter, was more useful. The detector in the PRM-7 is a 25 mm by 25 mm NaI

Figure 7-2. Victoreen Panoramic and Eberline PRM-7 Micro-R Survey Instruments

crystal connected to a rate meter. Generally, the severe energy dependence of the response makes this instrument more useful as an indicator of the relative magnitude of the radiation field and its variation over the object dimensions. However, for the radiation fields encountered during this project, mainly less than 5 mR/h, the accuracy of the readings is reasonably adequate.

7.5 PERSONNEL PROTECTION

Normal ANL protective clothing was worn by all personnel involved in D&D operations. Specialized protective clothing was supplied whenever the degree of hazard encountered required such clothing. This clothing consisted of disposable paper coveralls, air-supplied hoods, shoe covers and gloves. The Staff Health Physicist had the responsibility for specifying the required protective clothing commensurate with the degree of hazard. Shoe covers were provided for work in areas which presented a potential for tracking of contamination. Gloves were required to be worn for protection against contamination when dismantling operations involved contaminated, or potentially contaminated, items. Full-face piece respirators or powered air-purifying respirators were used during dismantling operations in which there was a potential for generating particulate airborne radioactivity. Their use was restricted to situations in which one can reasonably expect the airborne concentration to be less than 50 times the applicable concentration guide for the radionuclide of interest. When higher concentrations were encountered, supplied-air respiratory devices had to be used.

All personnel involved in D&D operations were surveyed prior to breaks, lunch, and at the termination of their work shifts. Any dismantling procedure required a complete survey prior to the start of the operation. If a complete survey could not be accomplished by the HP technician, standby monitoring was provided during the dismantling to insure that no material was released for unrestricted use without appropriate surveying and documentation.

.6 CONTAMINATION CONTROL

Contamination control was accomplished through these measures:

1. Surveys to detect and define areas of contamination, with prompt follow-up to decontaminate or remove and dispose of as radioactive waste,
2. Surveys of personnel, equipment, and materials prior to release from the site,
3. Use of protective clothing and other protective equipment which could be disposed of as radioactive waste if they became contaminated,
4. Monitoring of air during a specific D&D procedure for indications of loss of control indicated by airborne activity,

5. Wetting of dusty surfaces and vacuuming with a HEPA-filtered vacuum to reduce dispersal of material,
6. Use of filtered local exhaust ventilation, or filtered temporary enclosures to contain activity which is readily dispersible.

No major contamination incidents occurred over the duration of this project. In general, the low-contamination levels encountered and their localized areal extent precluded the possibility of any large release of contamination during the D&D operations. In addition, no airborne releases were noted on the filter paper samples taken during the D&D procedures.

7.7 PERSONNEL DOSIMETRY

Film badges and dosimeters were worn by all personnel directly involved with D&D operations, as well as by the Health Physics technicians monitoring the operations. Approximately 15 different individuals were used during the period of the project, although not all were directly involved in the dismantling operations. Film badge results indicated an estimated average monthly exposure of about 10 mrem. The maximum individual monthly exposure recorded was 20 mrem. A total of about 1.8 person-rem is estimated at the total exposure for the entire operation as compared to a forecasted dose commitment of three person-rem.

Bioassay samples were submitted periodically by all personnel who participated in the operations. Results indicated no intakes were occurring. This supports the air sample data which also indicated that no airborne releases took place during the D&D operations.

7.8 DOCUMENTATION

Results of all radiation surveys, air sampling data, survey instrument and assaying equipment calibrations; radionuclide identification and concentration results for waste bin containers; radionuclide spectral data for various samples, along with information and data concerning the bin contents have been documented and archived by Health Physics. Survey results were recorded on ANL/HP survey record sheets and air sample results were recorded on air sample data sheets. A log was used to record items being put into waste bins. The data included identification of the item, total contaminated surface area, or total contaminated volume, if relevant, representative survey readings, and the initials of the individual making the entry. In addition, HP personnel kept a log book for recording survey data on various items which were either disposed of as radioactive waste, or were found to meet the criteria of Table 7-1 and were released to salvage or to the ANL landfill.

Documentation with respect to assay samples includes teletype printout of spectral data in regions of interest and cassette tape recordings of the entire spectrum. In addition, writeups of the analysis of counting data, assay instrument setup parameters, calibration data for

sources and calculations of geometry correction factors for certain types of volume samples which were analyzed are on file.

7.9 ASSAY PROCEDURES

Changes in the waste disposal regulations have necessitated improved identification of the radionuclide content and more reasonable estimates of the activity concentration for materials designated for disposal, reuse, or release to other organizations. Since some of this material is odd-shaped, irregularly contaminated and in the form of volume sources of differing material and density, quantitative estimates from survey data alone are virtually impossible. The use of gamma spectrometry equipment allows the identification of the radionuclides in the sample and also the determination of the relative contribution of each to the total activity. The equipment used for gamma spectral measurements is shown in Figure 7-3. An 8192 channel analyzer with a teletype printout and a cassette recorder was used to obtain spectral data resulting from interactions in a high purity portable germanium detector, that was connected to a storage Dewar, sitting in a lead cave. The cave was partially open for easy access to the detector which could be detached from the storage Dewar and used for measurements out in the field, for a period of up to four hours. Figure 7-4 illustrates the detector being used to view the residue in a floor drain. The portability feature was very useful at facilities where one could not get a sample of the contaminant from a large immobile object.

Figure 7-3. Multi-channel Analyzer System for Assaying Samples

Figure 7-4. Assaying a Floor Drain

The basis for generating concentration estimates for volume sources is the point source efficiency concept. The efficiency versus photon energy for a number of standard sources can be measured at a given distance or distances from the crystal face. The average efficiency over some volume source can then be obtained by integrating the point source efficiency over the volume of the source and dividing the result by the source volume. However, in going from a point source efficiency to a volume source efficiency, certain factors need to be considered:

1. Self absorption - A correction must be made for the attenuation occurring in the source material, waste matrix, container, etc.
2. Non-uniform activity distribution - Generally, a reading with a survey meter on each side of the object will give a relative indication of the evenness of the distribution. If the difference in readings is significant, one can count the sample on each side and use the average result.
3. Geometry - One may need several geometric models to cover all the potential shapes of samples, such as disk, slab, sphere, cylinder, etc.
4. Multiple radionuclides - If several radionuclides are present in the sample, and each has several photons, the analysis will be further complicated.

Corrections for absorption in the source were based upon the expression:

$$ABS = \frac{1 - e^{-\mu x}}{\mu x} \quad 7.1$$

in which μ is the attenuation coefficient for the given medium (cm^{-1}), and x is the thickness in the medium (cm). For a medium in which μ is unknown; for example, insulation of mastic-coated sheet metal, the transmission through a sample can be determined and an effective μx can be computed.

For the case of multiple radionuclides in a sample, one can find the ratio of activities in the sample. That is, assume a sample contains two radionuclides. Since the sample has the same geometry during counting, the relative contribution to the total activity can be determined for each radionuclide. This assumes that for a given geometry, the ratio of the efficiencies for two different photons will be about the same regardless of the geometry. Thus, one can determine the ratio of efficiencies for the case of a point source and this ratio should prevail for the case of a different geometry. So, for a volume source, the efficiency is

$$\begin{aligned} \text{eff} &= \frac{\text{CTS. IN PEAK}}{\text{photons emitted which leave the source}} \\ &= \frac{N_p}{(ABS) n_\gamma (Act) \text{time}} \quad 7.2 \end{aligned}$$

in which n_γ is the fraction of times that a photon of a given energy is emitted and Act is the activity of the emitter ($\frac{\text{disintegrations}}{\text{time}}$). One may rewrite this as

$$(\text{Act})_i = \frac{N_{pi}}{(\text{ABS})_i n_{\gamma i} (\text{eff})_i \text{time}} \quad 7.3$$

for an individual radionuclide i , of gamma abundance $n_{\gamma i}$, absorption factor of $(\text{ABS})_i$, and photopeak efficiency $(\text{eff})_i$, and for the case of two radionuclides,

$$\frac{(\text{Act})_i}{(\text{Act})_j} = \frac{N_{pi} [(\text{ABS})_j n_{\gamma j} \text{eff}]_j}{N_{pj} [(\text{ABS})_i n_{\gamma i} \text{eff}]_i} = (\text{constant}) \frac{N_{pi}}{N_{pj}} \quad 7.4$$

In the above, the ratio $\text{eff}_j/\text{eff}_i$ is assumed to be the same regardless of the geometry, provided one correctly accounts for the difference in absorption. Thus, the activity ratio for an undetermined geometry can be related to the activity ratio for a known geometry, such as for point sources.

In order to determine the value of the activity for a given radionuclide, when a number of radionuclides are contributing, one needs to know the geometry of the sample-detector configuration, or the total activity which is involved. For surface contamination, one can determine the total activity with survey instruments, so that survey results, in conjunction with spectral data, can be used to arrive at the activity of each of the components.

For volume sources, it is necessary to compute the geometry factor for the sample-detector configuration, or, alternatively, use a calibration standard which closely approximates the geometry of the situation. For the assay of soil samples, the latter method was generally used. Figure 7-5 shows a series of calibration disks which approximate a soil sample contained in a sealed petri dish. By running calibration spectra on these standards, the efficiency for the given radionuclide represented by the standard could be determined for the specified geometry. Then, soil samples containing natural uranium, normal uranium, enriched uranium or natural thorium could be directly compared to the efficiencies obtained for the disks. That is, the counting data N_{pi} for each of the sources is related to the $(Act)_i$ by equation 7.3.

For the case of natural uranium and natural thorium, the sensitivity of the gamma spectrometry method for the determination of low levels of activity concentration (10-20 pCi/g) is poor. In order to certify that soil contamination limits for uranium were less than 20 pCi/g, backup samples were sent for radiochemical analysis.

8.0 FINAL CONDITION OF FACILITIES

All of the facilities included in the project were successfully decontaminated so they could be released for conventional demolition. Several contaminated exhaust air stacks could not be readily or safely removed during the D&D from Buildings 22, 37, and 38, so at the time the contractor was tearing the structures down, the

Figure 7-5. Calibration Disks for Multi-Channel Analyzer

stacks were removed with a clambucket on a crane (Figure 8-1), and turned over to the decommissioning crew for disposal. In addition, the crew worked with the contractor during the removal of all concrete floors so that sewers under the slabs could be recovered for radiological survey and suitable disposal. Some portions of those drainlines were contaminated and became part of the radioactive waste. Soil was also checked at that same time, but none was found to be active.

Part of the floor slab for Building 17, and all of the slab and some concrete superstructure for Building 37 remain to be removed (Figure 8-2) because of the concern over nearby utilities that are still in use. However, responsibility for the sewers under those slabs has been accepted by the Laboratory in general, and will be handled during the demolition of the last two buildings which still exist in the immediate vicinity. After they are down, the entire area will be graded and landscaped. This is expected to occur in late 1987. Views of the area as it currently appears (3/87) are shown in Figure 8-3 and on the front cover.

9.0 LESSONS LEARNED

1. Surface decontamination of concrete proved to be a difficult task early in the project, but as a result of discussions with other DOE contractors engaged in similar work, ANL was made aware of the scabbling technique, which, when employed, saved many hours of work, and greatly reduced radioactive waste volumes.

Figure 8-1. Recovery of Contaminated Exhaust Stacks

Figure 8-2. Site Conditions After Demolition -
South and West Views

Figure 8-3. Site Conditions After Demolition - Northwest View

2. Use of existing radiological historical data for a facility, as a basis of estimating D&D costs, may account for these estimates being higher than actual costs since such records tend to give the impression that contamination is likely to be more widespread than is really the case.
3. Quantifying waste as to the amount of radioactivity requires using both gamma spectrometry assay data and survey-instrument readings to arrive at a reasonable estimate of package contents.

10.0 REFERENCES

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ABBREVIATIONS AND ACRONYMS

ADM	Action Description Memorandum
ALARA	As Low as Reasonably Achievable
ANL	Argonne National Laboratory
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOE-CH	Department of Energy Chicago Operations Office
DOT	Department of Transportation
HEPA	High Efficiency Particulate Air (Filter)
HP	Health Physics
INEL	Idaho National Engineering Laboratory
LSA	Low Specific Activity (Waste)
NaI	Sodium Iodide
NEPA	National Environmental Policy Act of 1969
OHS	Occupational Health and Safety Department
PFS	Plant Facilities and Services Division
RWMC	Radioactive Waste Management Complex
SFMP	Surplus Facilities Management Program
SSD	Support Services Division
TRU	Transuranic (Waste)
WMO	Waste Management Operations

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