RECEIVED
OCT 13 1999
CSTI

Decontamination and Decommissioning of the
Argonne Thermal Source Reactor
at Argonne National Laboratory-East
Project Final Report

Decontamination and Decommissioning Program

Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Operated by The University of Chicago,
under Contract W-31-109-ENG-38, for the
United States Department of Energy

Argonne National Laboratory

Argonne National Laboratory, with facilities in the states of Illinois and Idaho, is owned by the United States Government, and operated by the University of Chicago under the provisions of a contract with the Department of Energy.

This final project report is a product of Argonne's Technology Development Division, Decontamination and Decommissioning Program. For information on the division's activities, contact:

Director, Technology Development Division
Argonne National Laboratory
Argonne, Illinois 60439-4814
Telephone (630) 252-3293

Disclaimer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Available to DOE and DOE contractors from the Office
of Scientific and Technical Information, P.O. Box 62,
Oak Ridge, TN 37831; prices available from (423) 576-8401.

Available to the public from the National Technical
Information Service, U.S. Department of Commerce,
5285 Port Royal Road, Springfield, VA 22161.

Decontamination and Decommissioning of the
Argonne Thermal Source Reactor
at Argonne National Laboratory-East
Project Final Report

Charles Fellhauer
Julie Mathiesen*
Gregory Garlock*

Decontamination and Decommissioning Program
Technology Development Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

December 1998

Work sponsored by United States Department of Energy,
Office of Environmental Management

*Mathiesen and Garlock are affiliated with MOTA Corporation, Columbia SC

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

TABLE OF CONTENTS

	<u>Page</u>
1.0 EXECUTIVE SUMMARY	1
2.0 PROJECT OBJECTIVE	2
3.0 FACILITY HISTORY AND DESCRIPTION	2
3.1 ATSR Reactor Facility History	2
3.2 Site Description	3
3.3 Facility Description	5
3.3.1 General	5
3.3.2 Reactor Assembly	5
3.3.3 Reactor Water Systems	5
3.3.4 Shielding	9
3.3.5 Reactor Air System	9
3.3.6 Graphite Pile	9
3.3.7 Snell Block	9
3.3.8 Control Room	9
4.0 OVERVIEW OF THE ATSR D&D PROJECT	10
4.1 General	10
4.2 Major Tasks	10
5.0 ATSR D&D PROJECT PLANNING AND ENGINEERING	12
5.1 Project Organization	
5.1.1 United States Department of Energy	12
5.1.2 Argonne National Laboratory-East	12
5.1.3 D&D Field Work	12
5.1.4 Project Oversight	12
5.1.5 Organizational Relationships	13
5.2 Project Engineering	15
5.2.1 Quality Assurance	15
5.2.2 Project Control	17
5.2.3 Project Data	17
5.2.4 Training	17
5.2.5 Health and Safety	18
5.2.5.1 Environment, Safety, and Health Policy	18
5.2.5.2 Planning and Review	18

	<u>Page</u>
5.2.5.3 Radiation Safety	19
5.2.5.4 Industrial Hygiene	19
5.2.5.5 Industrial Safety	19
5.2.5.6 Fire Protection and Security	19
5.3 Conduct of Operations	20
5.4 Site Characterization	20
5.4.1 Radiological Contaminants	20
5.4.2 Hazardous Materials	20
5.4.3 Mixed Waste	22
5.5 Alternatives Assessment	22
6.0 DECONTAMINATION AND DISASSEMBLY OPERATIONS	23
6.1 General	23
6.2 Pre-Subcontractor Preparation and Characterization	23
6.2.1 Project Preparations	23
6.2.2 Facility Characterization	24
6.3 Subcontractor Mobilization	24
6.3.1 Contract Award	24
6.3.2 Mobilization	24
6.3.3 Set-Up	25
6.3.4 Pre-Work Bioassay and Whole Body Count	25
6.3.5 Baseline Radiological Surveys	25
6.4 Decommissioning Activities	25
6.4.1 Lead-Based Paint Removal	25
6.4.2 Activated Lead Removal	25
6.4.3 Activated Graphite Removal	27
6.4.4 Reactor Assembly Removal	27
6.4.4.1 Shielding Removal	27
6.4.4.2 Reactor and Shield Tank Removal	27
6.4.5 Miscellaneous Equipment Removal	27
6.4.5.1 Electrical System Removal	27
6.4.5.2 Reactor Piping and Valves Removal	27
6.4.5.3 Snell Block Table Removal	29
6.4.5.4 ATSR Graphite Pile Table Removal	29
6.4.5.5 CP-1 Graphite Pile Table Removal	29
6.4.5.6 Concrete Shield Blocks Removal	29
6.4.5.7 Oils, Sludge, Miscellaneous Materials Removal	29
6.4.5.8 Cadmium Removal	29
6.4.5.9 Steel Floor Tracks Removal	31

	<u>Page</u>
6.4.5.10 Dump Tank Removal	31
6.4.5.11 Fuel Storage Pit	31
6.4.6 Fume Hood Removal	31
6.5 Close-Out Operations	34
6.5.1 Decontaminate and Wipe Down Surfaces	34
6.5.2 Perform Final Survey	34
6.5.3 Demobilize Site	34
6.5.4 Prepare Final Report	34
7.0 POST-DECOMMISSIONING RADIOLOGICAL SURVEY	35
7.1 Final Survey Objectives	35
7.1.1 Release Survey Conditions	35
7.1.2 Unrestricted Release Criteria	35
7.1.3 Volume Activity of Building Materials	36
7.1.4 Coated Surfaces	36
7.2 Final Survey Approach	36
7.2.1 Definitions	36
7.2.2 Potential Contaminants	38
7.2.3 General Survey Plan	38
7.2.3.1 Survey Area Classifications	38
7.2.3.2 Scope of Surveys	40
7.3 Reference Grid System	40
7.4 Survey Instrumentation	40
7.4.1 Instrument Selection	40
7.4.2 Background Determinations	40
7.4.3 Daily Instrument Function Test and Quality Assurance	41
7.5 Survey Methodology	41
7.5.1 Surface Scan	41
7.5.2 Direct Measurement	41
7.5.3 Removable Contamination Measurements	41
7.5.4 Exposure Rate Measurements	42
7.5.5 Special Measurements and Sampling	42
7.5.5.1 Paint Samples	42
7.5.5.2 Electrical Boxes	42
7.5.5.3 Soil Samples	42
7.5.5.4 Drain Surfaces and Penetrations	42
7.6 Interpretation of Survey Results	42
7.7 Final Survey Results	42
7.8 Independent Verification Survey	43

	<u>Page</u>
7.9 Post D&D Hazardous Material Condition	43
8.0 HEALTH AND SAFETY	43
8.1 Industrial Health and Safety	43
8.2 Radiation Protection	44
8.3 Project Exposure Summary	44
9.0 WASTE MANAGEMENT	45
9.1 Waste Types	45
9.2 Waste Volumes	46
9.3 Waste Packaging	46
9.4 Waste Transport	46
10.0 COST AND SCHEDULE	49
10.1 ATSR D&D Project Cost	49
10.2 ATSR D&D Project Schedule	49
11.0 FINAL FACILITY CONDITION	49
12.0 CONCLUSIONS, RECOMMENDATIONS, AND LESSONS LEARNED	54
12.1 General Problems Encountered and Lessons Learned	54
12.2 Management Issues	
12.3 Noteworthy Practices	54
12.3.1 Frequent Safety Inspections	54
12.3.2 Incorporation of Lessons Learned	54
13.0 ACRONYM AND ABBREVIATION LISTING	55

LIST OF FIGURES

	<u>Page</u>
Figure 3.1 ANL-E Site Map	4
Figure 3.2 ATSR Facility Floor Plan	6
Figure 3.3 ATSR Facility Layout	7
Figure 3.4 Cutaway of the Argonne Thermal Source Reactor	8
 Figure 5.1 ATSR D&D Project Responsibility Chart	 13
Figure 5.2 Relationship of ATSR D&D Project to Argonne National Laboratory-East	 14
Figure 5.3 Relationship of ATSR D&D Project to Subcontractors	15
 Figure 6.1 ATSR D&D Project Work Breakdown Structure	 23
Figure 6.2 ATSR Control Room E-101 After Lead-Based Paint Removal and Repainting	 26
Figure 6.3 Pallets of Lead Prior to Packaging as Mixed Waste (the ATSR shield tank can be seen in the background)	 26
Figure 6.4 Technicians Packaging CP-1 Graphite into a B-25 Waste Container	28
Figure 6.5 ATSR Prior to the Start of Removal Operations	28
Figure 6.6 Technicians Size-Reducing ATSR	28
Figure 6.7 Snell Block Table Prior to Size Reduction and Packaging	30
Figure 6.8 Concrete Shield Blocks Prior to Removal and Packaging (the ATSR graphite pile can also be seen on the left side of the shield blocks)	 30
Figure 6.9 Steel Floor Tracks Prior to Removal	32
Figure 6.10 The Reactor Dump Tank and Associated Piping Can be Seen Prior to Removal	 32
Figure 6.11 Technician in the Fuel Storage Pit Preparing for Material Removal	33
Figure 6.12 Shows the Fume Hood in E-101 Prior to Removal and Packaging Operations	 33
 Figure 10.1 ATSR D&D Project Schedule	 50
 Figure 11.1 ATSR Control Room Area in E-101	 51
Figure 11.2 Reactor Room Area (E-111) Looking Northeast	51
Figure 11.3 Reactor Room Area (E-111) Looking West	52
Figure 11.4 Dump Tank Pit	52
Figure 11.5 Fuel Storage Pit	53
Figure 11.6 Cesium Spill Area in Room E-102	53

LIST OF TABLES

	<u>Page</u>
Table 5.1	Nuclides Found During Characterization and Performance of D&D Operations 21
Table 5.2	Types and Locations of Hazardous Materials 22
Table 5.3	Types and Locations of Mixed Waste 22
Table 7.1	Survey Area Identification and Classification 39
Table 9.1	Waste Removed from the ATSR Reactor Facility 46
Table 9.2A	ATSR Low-Level Radioactive Waste Tracking Table 47
Table 9.2B	ATSR Mixed Waste Tracking Table 48
Table 9.2C	ATSR Chemical Waste Tracking Table 48

1.0 EXECUTIVE SUMMARY

The decontamination and decommissioning (D&D) of the Argonne Thermal Source Reactor (ATSR) at Argonne National Laboratory-East (ANL-E) was completed in October 1998. Descriptions and evaluations of the activities performed and analyses of the results obtained during the ATSR D&D Project are provided in this Final Report. The following information is included:

- Objective of the ATSR D&D Project
- History of the ATSR Reactor facility
- Description of the ANL-E site and the ATSR Reactor facility
- Overview of the D&D activities performed
- Description of the project planning and engineering
- Summary of the final status of the ATSR Reactor facility based upon the final survey results
- Description of the health and safety aspects of the project, including personnel exposure and OSHA reporting
- Summary of the waste minimization techniques utilized and total waste generated by the project
- Summary of the final cost and schedule for the ATSR D&D Project

This final report was written in accordance with requirements outlined in the ANL-E D&D Project Planning Guidance Manual and the ANL-E D&D Program Management Plan. It covers the entire ATSR D&D Project, from initiation of planning and characterization activities to final project closeout. The final survey was completed in October 1998, and an Independent Verification Survey (IVS) was performed in December 1998. After the IVS, the ATSR Reactor facility was released for unrestricted use. The ATSR Reactor facility was transferred from the U.S. Department of Energy (DOE) EM-40 roster to ANL-E surplus facilities.

All accessible areas of the ATSR Reactor facility were decontaminated to meet free-release requirements as specified in the ANL-E Environment, Safety and Health Manual. Contaminated or activated equipment, piping, and concrete were removed and packaged for disposal; radiologically clean equipment was removed for recycle or reuse by ANL-E.

Total exposure to project personnel was 0.0 person-rem (0.0 mSv) compared to the original ALARA ("As Low As Reasonably Achievable") estimate of 0.313 person-mrem (3.13 mSv). The total cost of the project was approximately \$614,000, compared to the baseline cost of \$332,225. A total of 1,160 ft³ (32.8 m³) of low-level radioactive waste weighing 95,507 lb (43,314 kg) was packaged for off-site disposal at a DOE-approved low-level waste repository with a total activity of 49.2 mCi (1.82 GBq). An additional 96 ft³ (2.7 m³) of mixed waste weighing 21,662 lb (9,824 kg) was packaged for treatment/storage.

2.0 PROJECT OBJECTIVE

The ATSR D&D Project was directed toward the following goals:

- Removal of radioactive and hazardous materials associated with the ATSR Reactor facility
- Decontamination of the ATSR Reactor facility to unrestricted use levels
- Documentation of all project activities affecting quality (i.e., waste packaging, instrument calibration, audit results, and personnel exposure)

These goals had been set in order to eliminate the radiological and hazardous safety concerns inherent in the ATSR Reactor facility and to allow, upon completion of the project, unescorted and unmonitored access to the area. The reactor aluminum, reactor lead, graphite piles in room E-111, and the contaminated concrete in room E-102 were the primary areas of concern. NES, Incorporated (Danbury CT) characterized the ATSR Reactor facility from January to March 1998. The characterization identified a total of thirteen radionuclides, with a total activity of 64.84 mCi (2.4 GBq). The primary radionuclides of concern were Co⁶⁰, Eu¹⁵², Cs¹³⁷, and U²³⁸. No additional radionuclides were identified during the D&D of the facility. The highest dose rates observed during the project were associated with the reactor tank and shield tank. Contact radiation levels of 30 mrem/hr (0.3 mSv/hr) were measured on reactor internals during dismantlement of the reactor. A level of 3 mrem/hr (0.03 mSv/hr) was observed in a small area (hot spot) in room E-102. DOE Order 5480.2A establishes the maximum whole body exposure for occupational workers at 5 rem/yr (50 mSv/yr); the administrative limit at ANL-E is 1 rem/yr (10 mSv/yr).

3.0 FACILITY HISTORY AND DESCRIPTION

3.1 ATSR Reactor Facility History

The ATSR was one of several early "zero power" reactors (ZPRs) developed and operated from 1950 to 1989 within the Building 314, 315, 316 complex at ANL-E. The ZPRs were operated at zero power to assess the performance of various reactor core configurations. The genealogy of the ATSR dates back to Argonne's first zero-power reactor, ZPR-I, which provided basic physics studies for

naval reactors. The ZPR-I core and vessel were modified in 1953 to allow leakage of neutrons from the core to drive fast-spectrum exponential assemblies. Since this was the fourth Argonne zero-power experiment, the reactor was renamed ZPR-IV. In 1960, after completion of the exponential experiments, the reactor was moved to its present location in Building 316 and several modifications were made that included replacement of the core tank and modifications to the control rod and safety rod systems. To indicate that the reactor was used primarily as a source of neutrons, it was renamed the Argonne Thermal Source Reactor.

The reactor was in use until sometime in the late 1980s (possibly 1988), at which time it was finally shut down. The last of its fuel was removed in December 1992 and sent to the Savannah River Plant near Aiken SC.

3.2 Site Description

The ATSR Reactor facility was located in Building 316 on the ANL-E site, a 1,275 acre (5.16 km²) reservation in DuPage County, Illinois, operated by the University of Chicago under contract with the U.S. Department of Energy. Approximately 4,000 people work at the ANL-E site. The majority of the reservation is forested and landscaped with only 200 acres (0.81 km²) currently dedicated to operational facilities. The Laboratory is approximately 22 miles (35.4 km) southwest of Chicago and 25 miles (40.3 km) west of Lake Michigan at the closest point. Access is available from State Highway 83, county roads, Northgate Road, and Cass Avenue, all of which have access to Interstate 55. The reservation is surrounded by the 2,040 acre (8.26 km²) Waterfall Glen Forest Preserve, a greenbelt forest preserve managed by the DuPage County Forest Preserve District. The areas south and west of the site are primarily rural, with more heavily populated areas to the north and east. The Des Plaines River, Illinois Waterway, and the Chicago Sanitary and Ship Canal are all located about 1 mile (1.6 km) from the southern boundary of the site.

The majority of the work described in this report was performed in room E-111 of Building 316 (see Figure 3.1). The D&D subcontractor, MOTA Corporation (Columbia SC), maintained project offices, crew facilities, and equipment storage in temporary offices in Buildings 207 and 362, and in Building 316, near the ATSR Reactor facility. A D&D project office staffed by the ATSR field engineer was maintained in Building 207.

The decontamination and disassembly of this facility was funded by the DOE Office of the Assistant Secretary for Environmental Management, specifically EM-40 (Environmental Restoration), in order to allow its reuse by other DOE programs.

ARGONNE NATIONAL LABORATORY

Figure 3.1 ANL-E Site Map

3.3 Facility Description

3.3.1 General

The ATSR Reactor facility (see Figures 3.2 and 3.3) was fueled with highly enriched (93.5%) U^{235} , was light-water moderated, and capable of operating at 10 kW for sustained periods. The reactor facility was located in rooms E-101 (control room), E-102 (hallway), and E-111 (reactor room) in the southeast corner of Building 316. Normal access to the facility was through door "A" in room E-102, just south of room E-101. An emergency exit (door "B") was located in the northeast corner of E-111. A shielded freight door (door "C") was also located on the south wall of room E-111. The wall between the control room and the reactor room consisted of a 3-ft (0.91-m) thick concrete and masonry wall, while the remaining three walls and the roof had 2 ft (0.61 m) of concrete added to the original structure.

The ATSR was comprised of a shield tank, which contained the core tank. The shield tank was shielded on three sides with water and lead during reactor operation. The unshielded side was called the leakage face, and it allowed neutrons to escape the reactor for experimental purposes. The core tank contained the ATSR core assembly.

After modifications in 1960, ATSR was used as the source of a broad range of neutron flux shapes and intensities for irradiating materials and testing neutron detector performance. Irradiation could take place in the central access hole (highest fluxes), in the graphite pile at the leakage face (thermal fluxes), or in a depleted uranium "Snell" block (fast reactor-like fluxes). The graphite pile and the Snell block were located external to the ATSR.

3.3.2 Reactor Assembly

The entire reactor assembly (see Figure 3.4) was contained inside a 6 ft x 5 ft x 8 ft (1.83 m x 1.52 m x 2.44 m) shield tank. The shield tank contained the core tank, primary shielding, dump line, and start-up source tube. The 19.75 in x 25.5 in x 25.5 in (0.5 m x 0.65 m x 0.65 m) core tank contained the fuel elements in an aluminum core matrix, as well as the control and safety rods. The control rod and safety rod drive motors were mounted on top of the shield tank. The core tank was internally mounted at the unshielded east wall (the leakage face) of the shield tank.

3.3.3 Reactor Water Systems

Two separate water systems served the shield tank and core tank. The shield water recirculation system pumped shield water through filters and an ion exchange column to maintain water purity. The core water system provided moderator to the core during reactor operation. In the event of a scram, the air-actuated primary dump valve and secondary dump valve would open and dump the core water (moderator) to the dump tank. The system also included filters and an ion-exchanger to maintain water purity. The dump tank, located in a pit in the northwest corner of the reactor room, was large enough to hold all of the primary coolant (core water).

Figure 3.2 ATSR Facility Floor Plan

Figure 3.3 ATSR Facility Layout

Figure 3.4 Cutaway of the Argonne Thermal Source Reactor

3.3.4 Shielding

Shielding around the core was provided on three sides and the bottom by 6.2 in (15.7 cm) of core water, 6 in (15.3 cm) of lead, and another 18 in (45.7 cm) of shield tank water. The top of the core was shielded by Benelex placed in the upper shield tank. Due to the limited amount of neutron shielding around the core tank, a large amount of neutron scattering occurred in the reactor room. Additional portable shielding, consisting of concrete blocks and sheets of Benelex, was utilized as required.

3.3.5 Reactor Air System

The reactor air system was used to actuate the primary dump valve and insert the start-up source. Building air was supplied to the dump valve to close it. In the event of a scram or loss of air, the valve would be spring-actuated open. The americium-beryllium start-up source was positioned on the end of an air cylinder, which was controlled from the control room.

3.3.6 Graphite Pile

In order to obtain thermalized fluxes of neutrons for research purposes, a large pile [(7.5 ft x 5.4 ft x 5.8 ft) (2.29 m x 1.65 m x 1.77 m)] of graphite was constructed on a rail-mounted cart. The graphite pile could be positioned at the leakage face of the reactor by moving the cart. The pile contained access holes and entry ports for insertion of samples or instrumentation.

3.3.7 Snell Block

The Snell block was used to obtain fast-reactor-like fluxes of neutrons for research purposes. The Snell block was also mounted on a rail-mounted cart and could be positioned next to the leakage face of the reactor. The Snell block had been removed prior to and was not part of the ATSR D&D project. However, the table that held the Snell block had remained and was removed as part of D&D activities.

3.3.8 Control Room

The reactor room consoles were located in Room E-101, directly west of the reactor room. The majority of the consoles and controls had been removed prior to and were not part of the ATSR D&D project.

4.0 OVERVIEW OF THE ATSR D&D PROJECT

4.1 General

The ATSR D&D Project began in December 1997 with the approval of funding for characterization, document preparation, and environmental assessment. That scope of work consisted of preparation of internal documents, e.g., Characterization Plan, Project Management Plan, Quality Assurance Plan, Auditable Safety Analysis, Environmental Assessment, Waste Management Plan, and appropriate procurement documents. Document preparation under this scope of work was performed from December 1997 through July 1998. From January through March 1998, a characterization of the ATSR Reactor facility was performed and a report prepared by NES, Incorporated. The actual D&D work was scheduled to be completed in September 1998.

In April 1998, it was determined that the ATSR may have historical significance, as it was a contributing component of the Building 314, 315, 316 complex. DOE recently had determined that the complex was eligible for listing on the National Register of Historic Places due to its importance in the development of nuclear reactor technology. The potential historical significance required the preparation of an environmental assessment (EA), which occurred during the months of May and June 1998. The EA was finalized and a Finding of No Significant Impact issued on July 15, 1998.

Also in April, the Argonne project manager requested a cost estimate from Argonne's Waste Management Operations (WMO) to conduct the actual D&D work. In May 1998, the manager of WMO informed the ATSR project manager that he did not have available resources to conduct the ATSR D&D work.

Given the lack of available resources within the Laboratory, a contract was awarded to MOTA Corporation in July 1998 to perform the D&D work. On-site mobilization occurred in July 1998, two months behind schedule, and facility D&D was completed in October 1998 only two weeks behind schedule.

4.2 Major Tasks

The major tasks performed during the D&D of the ATSR Reactor facility were conducted in three phases. The specific tasks are described in detail in Section 6.0.

Phase One - D&D Activities

Remove and Package Lead-Based Paint

Remove and Package Activated Lead

Remove and Package Activated Graphite Piles

Remove and Package Reactor Assembly
Open Shield Tank, Remove and Package Shielding
Size Reduce and Package Reactor and Shield Tank Assembly

Remove and Package Miscellaneous Equipment
Electrically Isolate, Lock Out/Tag Out (LO/TO), and Remove All Electrical Components
Survey All Miscellaneous Materials for "Free Release"
Disassemble, Size Reduce, and Package Reactor Piping and Valves
Disassemble, Size Reduce, and Package Snell Block Table
Disassemble, Size Reduce, and Package ATSR Graphite Pile Table
Disassemble, Size Reduce, and Package CP-1 Graphite Table
Remove and Package Concrete Shield Blocks
Collect and Containerize All Oils
Collect and Containerize All Cadmium
Remove, Size Reduce, and Package Steel Floor Tracks
Remove, Size Reduce, and Package Dump Tank and Associated Systems
Remove and Package Equipment/Material from Fuel Storage Pit

Remove and Package Contaminated Fume Hood

Identify Any Residual Radioactivity and Decontaminate Areas

Perform 100% Wipe Down of All Surfaces to Facilitate Final Survey

Phase Two - Final Status Survey and Project Close-Out

Perform Final Status Survey of ATSR Facility

Demobilize Site

Prepare and Submit Project Report and Final Survey Report

Phase Three - Surveillance and Maintenance

Perform routine surveillance and maintenance tasks during Phases One and Two. Work to be performed is described in the "Surveillance and Maintenance Plan for the Decontamination and Decommissioning of the Argonne Thermal Source Reactor."

5.0 ATSR D&D PROJECT PLANNING AND ENGINEERING

5.1 Project Organization

The ATSR D&D Project had a specific management structure in which the administrative, programmatic, and technical responsibilities, including management controls and reporting systems for the performance of the project, were well defined. The various organizations involved in this project and their responsibilities are described below. A project responsibility chart is provided in Figure 5.1.

5.1.1 United States Department of Energy

Overall responsibility for accomplishment of the ATSR Reactor facility D&D project resided with the Secretary of Energy. Responsibility flowed from the Secretary through the Office of the Assistant Secretary for Environmental Management (DOE-EM) to DOE Chicago Operations (DOE-CH) and to the DOE Argonne Group (DOE-ARG).

5.1.2 Argonne National Laboratory-East

The Decontamination and Decommissioning Program of the Technology Development Division (TD) Environmental Remediation Program was assigned the lead for the D&D of the ATSR Reactor facility, which included direction, management, and control of all phases of work. A project manager was assigned and given full line authority and responsibility for the hands-on management of the project. The project manager was responsible for the consistent application of project controls, developed through a risk assessment, to ensure acceptable performance and successful completion of the ATSR Reactor facility D&D.

5.1.3 D&D Field Work

A contract to perform D&D field work was awarded to MOTA Corporation. To accomplish their assigned scope of work, they provided D&D technicians, DOE-certified health physics technicians, health and safety oversight personnel, and management personnel. To fulfill contract requirements, they complied with a project-specific Environment, Safety and Health Plan and provided bi-weekly reports which detailed the work accomplished, cost of work performed, and issues or concerns regarding the project.

5.1.4 Project Oversight

Project oversight was provided by personnel from various ANL-E organizations, e.g., Environment, Safety and Health (ESH), Plant Facilities and Services (PFS), and the Technology Development Division.

Figure 5.1 ATSR D&D Project Responsibility Chart

5.1.5 Organizational Relationships

Figure 5.2 shows the organizational relationship of the ATSR D&D Project to ANL-E and to the laboratory support services. Figure 5.3 shows the organizational relationship between the ANL-E D&D Program and the subcontractors. The ANL-E project manager had full responsibility for all subcontracting activities.

Figure 5.2 Relationship of ATSR D&D Project to Argonne National Laboratory-East

Figure 5.3 Relationship of ATSR D&D Project to Subcontractors

5.2 Project Engineering

5.2.1 Quality Assurance

The project Quality Assurance (QA) Plan prescribed the requirements for achieving a satisfactory level of quality in the performance of project activities. These requirements were based upon existing codes, standards, and practices found in the current issues of ANSI/ASME NQA-1, DOE Order 5700.6C, the ANL-E QA Implementation Guide, and the ANL-E QA Planning Guide. The following project D&D activities were covered by the project QA Plan:

- Segregating of radioactive and non-radioactive waste
- Packaging of radioactive, hazardous, and mixed waste
- Determining curie and radionuclide content of waste packages
- Calibrating instruments to NIST-traceable standards
- Inspecting and certifying lifting equipment
- Inspecting waste packages
- Maintaining sample chain-of-custody compliance
- Auditing of the QA Plan

Quality Assurance responsibilities for all project management personnel were defined by the project QA Plan. The project manager was assigned overall responsibility for the execution of the project QA Plan. Assistance in carrying out specific QA requirements was provided by the Quality Assurance Representatives (QARs) from TD, ESH, and the Environmental Management Operations (EMO) divisions, and by personnel from the ESH and EMO divisions. The Office of ESH/QA Oversight provided an audit and verification function. Specific requirements carried out by each office are discussed below.

The ESH/Health Physics Manager was responsible for oversight of the sampling, sample analysis, standards, instrument calibration, radiation safety, radiation monitoring, and final radiation survey of the facility conducted by the D&D subcontractor.

The ESH Manager was responsible for providing project oversight of subcontractor safety and health practices during performance of the D&D field work, and for reviewing and approving the subcontractor's plans and procedures to ensure compliance with federal, state, and laboratory rules and regulations.

The Waste Management Operations (WMO) Manager was responsible for providing training and oversight of the subcontractor's waste packaging activities and for providing disposal of the radioactive waste generated during project D&D activities.

The QARs for EMO, ESH, and TD had joint responsibility for review and approval of the project QA Plan. They assisted the project manager in implementing the QA Plan and served as an interface with the Office of Environment, Safety and Health/Quality Assurance (ESH/QA) Oversight.

Environment, Safety and Health/Quality Assurance Oversight was responsible for auditing the project to verify compliance with the QA Plan and to determine the Plan's effectiveness. The Office reviewed the QA Plan prior to issuance and provided guidance and consultation to Divisional QARs. It also served as third party independent review of all project QA-related issues.

5.2.2 Project Control

The ATSR D&D project manager had prime control and overall responsibility for the project. Details of project activities were documented on daily project log sheets. In addition, progress was reported to DOE through weekly and monthly progress reports. All reports and records were reviewed by the project manager to identify any deficiencies. Weekly meetings were held with project personnel to discuss work performed and the upcoming work schedule, and to identify any issues or problems. Periodic project status review meetings were held with TD management and with DOE representatives.

5.2.3 Project Data

Data generated by D&D activities, e.g., survey results, instrument calibrations, sample analyses, personnel radiation, and toxic material exposures, have been retained as a permanent record of the project. ANL-E management staff reviewed the data to assure that all operations were in compliance with QA Plan specifications. Periodic QA audits of the data were performed to verify accuracy and compliance.

5.2.4 Training

All project personnel involved with the ATSR D&D Project were required by ANL-E policy to meet minimum training requirements, as identified below:

For all personnel requiring unescorted access to the ATSR Reactor facility:

- ANL-E Contractor Safety Orientation
- ANL-E Radiological Worker II
- OSHA 40-hour Hazardous Waste Site Operations
- Building 316 and ATSR Facility Orientation
- Conduct of Operations Training
- ANL-E Quality Assurance Plan Training

For personnel assigned as Health and Safety Manager:

- OSHA Hazard Recognition for Construction

For personnel who perform health physics-related functions:

- Previously qualified as a Radiological Controls Technician at a DOE site

For personnel who performed radioactive waste packaging, inspection, or labeling functions:

- Complete ANL-E Radioactive Waste Generator Training

For personnel who operated fork lifts and/or the 3-ton (2.7 MT) crane:

- ANL-E ESH approved fork lift operation training
- ANL-E ESH approved crane operation training and provide documentation of previous crane operating experience

Additional job-specific training requirements for individuals involved in those operations:

- Lead hazards training
- Working near asbestos training
- Confined space training
- Specialized training for various equipment and tools

5.2.5 Health and Safety

The project manager was responsible for implementing the ANL-E Health and Safety requirements for the project to ensure compliance with existing directives on environment, safety, and health issues. The actions implemented are discussed below.

5.2.5.1 *Environment, Safety, and Health Policy*

All project activities were performed in a manner that ensured protection of the environment, and the health and safety of the general public and workers. All project personnel had the authority and responsibility to stop work if an unsafe condition or activity was observed. The project manager was the only individual at the project level with authority to restart work after an unsafe condition or activity had been identified and corrected. All work was performed in accordance with the ANL-E ESH Manual, the ATSR D&D Auditable Safety Analysis, and the project-specific Environment, Safety and Health Plan.

5.2.5.2 *Planning and Review*

A Planning and Review Committee consisting of technical, operating, and safety personnel was appointed by the project manager in order to provide a mechanism for independent review of the plans and procedures utilized in the D&D effort. This committee reviewed proposed plans and procedures, and resolved differences that arose regarding methods of operation. It also served as an internal safety evaluation committee which made recommendations to the ATSR D&D project

manager. The ATSR D&D project manager held final approval authority for all plans and procedures.

5.2.5.3 *Radiation Safety*

Radiation safety at the ATSR D&D Project was the responsibility of MOTA health physics personnel. The ANL-E ESH Manual and the MOTA ATSR D&D project-specific Radiological Controls Plan served as guides for implementing the project's radiation safety program. Approximately 120 hours of health physics oversight of the project was provided by ANL-E ESH/HP personnel. This included review of subcontractor health physics plans and procedures, audits of project data [i.e., surveys, Radiological Work Permits (RWPs), and personnel exposure reports], and performance of periodic radiological surveys of areas and materials to verify subcontractor survey results. All project plans and procedures were developed and implemented using the ALARA principle.

5.2.5.4 *Industrial Hygiene*

MOTA held responsibility for the sampling and management of hazardous substances at the project site in accordance with OSHA and ANL-E regulations. ANL-E ESH Industrial Hygiene (IH) furnished technical guidance on toxic materials handling (lead and cadmium) and reviewed sample results obtained by MOTA to ensure compliance with ANL-E and OSHA requirements.

5.2.5.5 *Industrial Safety*

MOTA held responsibility for all industrial safety aspects of the project and was required to comply with rules and regulations as stated by OSHA and in the ANL-E ESH Manual, and the project-specific Environment, Safety and Health Plan. ANL-E ESH safety engineering personnel, and the project manager and staff continuously observed subcontractor operations. The project Surveillance and Maintenance Plan required weekly safety inspections and comprehensive monthly safety inspections performed by project management, safety engineering, and the subcontractor to identify existing or potential safety hazards. Daily project meetings, weekly toolbox meetings, and monthly safety meetings were used to keep project personnel aware of potential or existing personnel hazards and accident prevention techniques.

5.2.5.6 *Fire Protection and Security*

Project fire protection services and safety guidance were provided by the ANL-E Fire Department. Fire Marshals made periodic tours of the work site to assess fire potential and fire protection, and to advise project management on potential fire safety improvements. Physical security was provided by the ANL-E security force.

5.3 Conduct of Operations

The ATSR D&D Project was performed in accordance with guidelines established in the ANL-E D&D Conduct of Operations Manual. The eight elements utilized by the project are:

- Operations organization and administration
- Communications
- Investigation of abnormal event(s)
- Control of systems and equipment status
- Log-keeping
- Postings
- Labeling
- Operations essential to ensure safe and timely progress of the D&D project

5.4 Site Characterization

During January, February, and March of 1998, NES, Incorporated performed a detailed characterization of the ATSR Reactor facility. The characterization revealed the presence of thirteen different radionuclides in the facility. The total radioactive material inventory was approximately 64.84 mCi (2.4 GBq), resulting in a DOE facility classification of "Other Industrial Facilities." Four hazardous materials were also identified as being present: asbestos, cadmium, lead (both solid items and lead-based paint), and oils. The asbestos present in the facility was in a condition that did not warrant removal and, therefore, was not removed during D&D activities. No additional hazardous materials and mixed waste were identified during the performance of D&D operations.

5.4.1 Radiological Contaminants

Table 5.1 identifies nuclides found during the characterization and performance of D&D operations at the ATSR Reactor facility.

5.4.2 Hazardous Materials

Table 5.2 identifies the types and locations of hazardous materials found during the characterization and performance of D&D operations.

Table 5.1 Nuclides Found During Characterization and Performance of D&D Operations

Isotope*	Maximum Concentration	Area Found	Remarks
Co ⁶⁰	721 pCi/g (26.7 Bq/g)	Reactor aluminum, steel rail, shield blocks	Activation Product
Cs ¹³⁷	53,013 pCi/g (1963.44 Bq/g)	E-102 Hot Spot, graphite piles, E-102 paint, E-101 fume hood paint	Fission Product
Eu ¹⁵²	37.3 pCi/g (1.38 Bq/g)	Graphite piles, shield blocks	Activation Product
Eu ¹⁵⁴	3,058 pCi/g (113.26 Bq/g)	Metal coupon**, reactor lead, shield blocks	Activation Product
U ²³⁵	1,574 pCi/g (58.3 Bq/g)	Metal coupon**, E-101 duct smear, E-101 hood paint, CP-1 graphite pile	Includes associated decay products not listed (see U ²³⁵ decay chain)
U ^{233/234}	440 pCi/100 cm ² (16.3 Bq/100 cm ²)	E-101 Duct smear, reactor smear	U ²³⁴ is a Uranium decay product
U ²³⁸	445,807 pCi/g*** (16,511 Bq/g)	Metal coupon**, reactor lead, reactor smear, E-101 duct smear	Includes associated decay products not listed (see U ²³⁵ decay chain)
Ce ¹⁴¹	11 pCi/g (0.41 Bq/g)	E-101 hood paint	Activation Product
Zr ⁹⁷	1,180 pCi/g (43.7 Bq/g)	Metal coupon**, reactor lead	Activation Product
Nb ⁹⁵	1,429 pCi/g (52.93 Bq/g)	Metal coupon**, reactor lead	Decay product of activation or fission product parent
C ¹⁴	60 pCi/g (2.22 Bq/g)	Reactor lead, graphite piles	Activation Product
H ³	5.8 pCi/g (0.21 Bq/g)	Graphite piles, reactor lead	Activation Product
Sr ⁹⁰	5.9 pCi/g (0.22 Bq/g)	ATSR graphite pile	Fission Product****

* Naturally occurring nuclides are not listed in this table.

** The metal coupon was discovered inside the ATSR facility. The coupon was sent to an off-site laboratory for analysis and was not returned to the project. Results for this coupon are listed but not part of the radioactive inventory during the D&D of ATSR. The maximum concentration listed was found on the metal coupon. Concentrations found on the other items were substantially lower.

*** These U²³⁸ values were derived from Pa²³⁴ gamma spec. results. Pa²³⁴ is assumed to be in secular equilibrium with U²³⁸.

**** According to ANL release limits, beta-gamma emitters include mixed fission products, one of which is Sr⁹⁰.

Table 5.2 Types and Locations of Hazardous Materials

Hazardous Substance	Location(s) Found	Remarks
Asbestos	Asbestos containing materials comprised primarily of pipe lagging and floor tiles in rooms E-101 and E-111	Left in place; condition of material does not pose a safety hazard
Lead	Flaking lead-based paint in room E-101	Flaking paint was stripped from the walls the residue transferred to WMO for disposal
Cadmium	Room E-111	Surveyed for free release
Oils & Grease	Rooms E-101 and E-111	Sampled and transferred to WMO for disposal
Paint remover	Room E-111	Sampled and transferred to WMO for disposal

5.4.3 Mixed Waste

Table 5.3 identifies the types and locations of mixed waste found during the characterization and performance of D&D operations.

Table 5.3 Types and Locations of Mixed Waste

Mixed Waste	Location(s) Found	Remarks
Lead	Room E-111	Activated and contaminated lead items were packaged as mixed waste and transferred to WMO for treatment and/or disposal

5.5 Alternatives Assessment

After shutdown of the ATSR Reactor facility in the late 1980s, a facility options review was conducted by DOE. The extremely high cost of bringing the ATSR Reactor facility up to current code and safety requirements coupled with the lack of continuing research in that area resulted in a determination to declare the facility surplus to DOE's needs. In 1993, the facility was placed on the DOE EM-40 D&D roster.

6.0 DECONTAMINATION AND DISASSEMBLY OPERATIONS

6.1 General

MOTA divided the project into three phases. Each phase was further divided into major subtasks, and then work packages. The ATSR D&D Project work breakdown structure (WBS) is shown in Figure 6.1. A detailed description of each phase of the ATSR D&D Project is provided below.

Figure 6.1 ATSR D&D Project Work Breakdown Structure

6.2 Pre-Subcontractor Preparation and Characterization

6.2.1 Project Preparations

In December 1997, planning for the ATSR D&D Project began. These activities consisted of preparing a facility characterization plan, a detailed cost/schedule plan, an EA of the D&D activities, and other required plans and procedures for the D&D work.

6.2.2 Facility Characterization

During January, February, and March of 1998, NES Incorporated performed a radiological and hazardous materials characterization of the ATSR Reactor facility. This characterization served as the basis for preparing the project's Health and Safety Plan (HASP) and Auditable Safety Analysis (ASA) and for the air discharge permit application. Identified in the characterization were thirteen radioisotopes (predominately Co⁶⁰, Cs¹³⁷, Eu¹⁵², and U²³⁸), areas coated with lead-based paint, approximately 20,000 lb (7,460 kg) of activated and contaminated lead, and 30 lb (11.2 kg) of cadmium.

6.3 Subcontractor Mobilization

6.3.1 Contract Award

In July 1998, a contract for the D&D of the ATSR Reactor facility was awarded to MOTA Corporation. Prior to the start of on-site work, contract documents were finalized, and plans and procedures were provided for review and approval by ANL-E. After approval was granted, a preconstruction safety meeting was held at ANL-E on July 23, 1998. This meeting provided MOTA management personnel an opportunity to meet with representatives from various groups at ANL-E involved in D&D operations. Personnel from Industrial Hygiene, Safety Engineering, Fire Protection, and Building Maintenance reviewed required notifications, permits and, inspections. Health Physics discussed their oversight role as it related to the project. The Building 316 Manager reviewed requirements for building occupancy, vehicle parking, emergency response, and emergency shelter assignments. Security personnel reviewed procedures for site access, deliveries, visitor access, and ANL-E traffic regulations. Plant Facilities and Services discussed the process for obtaining assistance with systems and structures which are inside the subcontractor's work area but outside the subcontractor's scope of work. The Procurement Official reviewed procedures for submitting change orders.

6.3.2 Mobilization

MOTA personnel arrived at ANL-E on July 20, 1998, for a one-week, on-site training and orientation session. All subcontractor personnel were required to complete the following training: ANL-E Contractor Safety Orientation, Building 316 ATSR Facility Orientation, ANL-E Radiation Worker II training, OSHA 40-hour Hazardous Waste Site Operations training, ANL-E Radioactive Waste Generator training, and ANL-E Lead Hazards and Control training. In addition, all personnel who performed health physics-related functions were required to be DOE-qualified Radiation Control Technicians (RCTs).

6.3.3 Set-Up

In parallel with training and orientation activities, MOTA set up project offices, crew facilities and equipment storage in Building 207 and in Room E-101 of Building 316.

6.3.4 Pre-Work Bioassay and Whole Body Count

During the one-week training and orientation session, each person working on the ATSR D&D project was required to submit urine and fecal samples for bioassay and either provide documentation of an exit whole body count from their last assignment or undergo a whole body count at ANL-E.

6.3.5 Baseline Radiological Surveys

MOTA health physics personnel performed fixed and loose radiological surveys of the ATSR Reactor facility to verify its radiological status prior to beginning D&D activities. General access Radiological Work Permits (RWPs) were generated based on the results of these surveys.

6.4 Decommissioning Activities

On-site D&D activities began on July 29, 1998. The following task descriptions are based on the project schedule (see Figure 10.2) for ease of presentation. Actual start and completion dates for each task are noted.

6.4.1 Lead-Based Paint Removal

During the March 1998 ATSR Reactor Facility characterization, loose-flaking, lead-based paint was identified in E-101 (control room). To eliminate the loose-lead hazard involved with this condition, the lead-based paint was removed. To strip away the paint, Peel Away™ paint remover was applied to walls. The paint residue was collected on paper and rags, and packaged as hazardous waste. All waste was transferred to WMO for final disposition. Following paint removal, the walls were repainted with latex paint to prevent any additional flaking inside the facility. This work was started on August 3, 1998 and completed on August 6, 1998. The walls of E-101 after completing paint removal operations are shown in Figures 6.2.

6.4.2 Activated Lead Removal

Approximately 20,000 lb (96 ft³) [7,460 kg (2.69 m³)] of activated and contaminated lead were present inside the ATSR facility. The lead was packaged into B-12 metal bins and transferred to WMO for storage as mixed waste. This work was performed on August 22, 1998. Figure 6.3 shows pallets of lead prior to removal and packaging at ATSR.

Figure 6.2 ATSR Control Room E-101 After Lead-Based Paint Removal and Repainting
(ANL Neg. 24571K, Frame 6A)

Figure 6.3 Pallets of Lead Prior to Packaging as Mixed Waste (the ATSR shield tank can be seen in the background).
(ANL Neg. 24571K, Frame 15A)

6.4.3 Activated Graphite Removal

Two piles of graphite were located in E-111, the ATSR graphite pile and the CP-1 graphite pile. These piles were unstacked and packaged into waste containers for disposal as low-level radioactive waste. This work was performed between August 12 and August 21, 1998. Figure 6.4 shows technicians packaging graphite from the CP-1 graphite pile.

6.4.4 Reactor Assembly Removal

Figures 6.5 and 6.6 show the reactor prior to and during removal operations.

6.4.4.1 *Shielding Removal*

Surrounding the core tank was 6 in (25.24 cm) of lead shielding. The shield tank covers were removed, and the lead block shielding was removed from around the core tank and packaged as mixed waste. This work was started on August 21 and completed on August 22, 1998.

6.4.4.2 *Reactor and Shield Tank Removal*

This activity involved the disassembly, size reduction, and packaging as low-level radioactive waste, the reactor internals, core tank, and shield tank.. These operations were started on August 10 and completed on September 10, 1998.

6.4.5 Miscellaneous Equipment Removal

6.4.5.1 *Electrical System Removal*

Electrical system isolation consisted of performing lockout/tagout (LO/TO) of circuits feeding power to equipment and components scheduled for removal. A two-part LO/TO process was used to ensure that both project personnel and building maintenance personnel had knowledge regarding the electrical status of the facility. Project personnel identified circuits that were required to be de-energized and requested building maintenance to de-energize and LO/TO them. After completing LO/TO, building maintenance personnel verified the circuits were de-energized. Project personnel then installed their own LO/TOs and again verified that the circuits were de-energized. All LO/TO operations were performed in accordance with the ANL-E ESH Manual. Electrical isolation was started on August 20, 1998 and continued throughout the entire project.

6.4.5.2 *Reactor Piping and Valves Removal*

Reactor piping and valves that connected the reactor and the dump tank were disconnected, size reduced, and packaged for disposal as low-level radioactive waste. This work was performed between August 17 and August 18, 1998.

Figure 6.4 Technicians Packaging CP-1 Graphite into a B-25 Waste Container
(ANL Neg. 24572K, Frame 29A)

Figure 6.5 ATSR Prior to the Start of
Removal Operations
(ANL Neg. 23988K, Frame 1)

Figure 6.6 Technician Size-Reducing
ATSR
(ANL Neg. 24637K, Frame 19A)

6.4.5.3 *Snell Block Table Removal*

The Snell block table was dismantled, size reduced, and packaged for disposal as low-level radioactive waste. This work was performed on September 10, 1998. Figure 6.7 shows the Snell block table prior to disassembly.

6.4.5.4 *ATSR Graphite Pile Table Removal*

After the ATSR graphite pile was packaged, the table that supported this pile was size reduced and packaged as low-level radioactive waste. This work was performed on September 10, 1998.

6.4.5.5 *CP-1 Graphite Pile Table Removal*

After the CP-1 graphite pile was packaged, the table was size reduced and packaged as low-level radioactive waste. This work was performed on September 14, 1998.

6.4.5.6 *Concrete Shield Blocks Removal*

Twenty activated concrete shield blocks were removed and packaged as low-level radioactive waste. This work required a lift plan and special rigging due to the absence of the original lifting and rigging equipment. This work was performed between September 8 and September 9, 1998. Figure 6.8 shows the concrete shield blocks prior to removal and packaging.

6.4.5.7 *Oils, Sludge, Miscellaneous Materials Removal*

Small motors and gear boxes contained grease and oils which required removal from that equipment prior to packaging. The oils and grease was collected into a single container, sampled for radioactive and hazardous (lead & PCB) constituents, and turned over to WMO for treatment and disposal. This work was performed throughout the project.

6.4.5.8 *Cadmium Removal*

Several sheets [about 30 lb (11.2 kg)] of cadmium were discovered in the ATSR facility. The sheets were surveyed for "free release" and transferred to Argonne's Intense Pulsed Neutron Source (IPNS) for reuse.

Figure 6.7 Snell Block Table Prior to Size Reduction and Packaging
(ANL Neg. 23988K, Frame 29)

Figure 6.8 Concrete Shield Blocks Prior to Removal and Packaging
(the ATSR graphite pile can also be seen on the left side of the shield blocks)
(ANL Neg. 23988K, Frame 33)

6.4.5.9 *Steel Floor Tracks Removal*

The steel floor tracks for the ATSR and Snell block tables were removed, size reduced, and packaged as low-level radioactive waste. This work was performed between August 10 and September 15, 1998. Figure 6.9 shows the floor tracks prior to removal.

6.4.5.10 *Dump Tank Removal*

The dump tank, located in a floor pit just north of the reactor, was rigged and lifted from the floor pit, size reduced, and packaged as low-level radioactive waste. This work was performed between September 12 and September 14, 1998. Figure 6.10 shows the dump tank prior to removal.

6.4.5.11 *Fuel Storage Pit*

The fuel storage pit contained a large quantity of miscellaneous equipment and material. The pit was emptied, and the material packaged as low-level radioactive waste. This work was performed between September 8 and September 9, 1998. Figure 6.11 shows the fuel storage pit prior to clean-out.

6.4.6 *Fume Hood Removal*

The fume hood, located in Room E-101, was disconnected from existing services (air, electrical, HEPA ventilation), relocated to a contamination control area inside E-111, and size reduced and packaged as low-level radioactive waste. This work was performed on September 12, 1998. Figure 6.12 shows the fume hood prior to removal.

Figure 6.9 Steel Floor Tracks Prior to Removal
(ANL Neg. 23988K, Frame 30)

Figure 6.10 The Reactor Dump Tank and Associated Piping Can Be Seen Prior to Removal
(ANL Neg. 23988K, Frame 12)

Figure 6.11 Fuel Storage Pit Being prepared for Material Removal
(ANL Neg. 23988K, Frame 26)

Figure 6.12 Shows the Fume Hood in E-101 Prior to Removal and Packaging Operations
(ANL Neg. 23988K, Frame 5)

6.5 Close-Out Operations

6.5.1 Decontaminate and Wipe Down Surfaces

At the completion of all D&D activities and prior to starting the final status survey, the facility was wiped down with damp rags. This work was performed from October 1 to October 5, 1998.

6.5.2 Perform Final Survey

A final status radiological survey was performed on the ATSR Reactor facility at the completion of the D&D phase of work. The survey was performed in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM/NUREG 1575), the Manual for Conducting Radiological Surveys in Support of License Termination (NUREG/CR-5849), and the approved final survey plan. Details of the final status survey are provided in Section 7.0. Gridding for the final status survey started on September 21, 1998, and the survey was completed on October 15, 1998.

In conjunction with the final status survey, paint and soil samples were collected and analyzed for residual activity. Refer to Section 7.0 and to the detailed Final Status Survey Report for the D&D of the Argonne Thermal Source Reactor that was prepared by ANL-E TD/D&D group for additional information.

6.5.3 Demobilize Site

Upon completion of the final survey, the contractor demobilized from the site. Demobilization consisted of archiving all records and data, packaging and shipping equipment and supplies, and disbanding the project staff. Demobilization was completed on October 16, 1998.

6.5.4 Prepare Final Report

The final project activity consisted of preparation of this final report. This report incorporates information and data from several documents i.e., the ATSR Characterization Report (April 1998) and the Final Project Report and Final Status Survey Report. The final report was submitted to DOE before the milestone date of December 23, 1998.

7.0 POST-DECOMMISSIONING RADIOLOGICAL SURVEY

7.1 Final Survey Objectives

The purpose of the final status survey was to demonstrate that the radiological conditions at the ATSR Reactor facility satisfied the unrestricted release guidelines presented in the following documents:

- ANL-E Environment, Safety and Health Manual
- Radiological Protection Program, MOTA document PL-ATSR-100
- NUREG 1575 (MARSSIM)
- NUREG/CR-5849, Manual for Conducting Radiological Surveys in Support of License Termination
- MOTA's Final Status Survey Plan HP-ATSR-200

7.1.1 Release Survey Conditions

The following specific conditions were established for the release survey:

- Average surface contamination levels for each survey unit were within the authorized guideline values.
- Small areas of elevated activity (hot spots) were limited in size to less than 100 cm² and could not exceed three times the allowable guideline value for the entire survey area. The presence of an elevated area also could not result in the average for the entire 1 m² survey area exceeding allowable guideline values.
- A reasonable effort was demonstrated to clean up removable activity; any remaining removable activity did not exceed the guideline value.
- Exposure rates in accessible and normally occupied locations were in accordance with the guideline values.

7.1.2 Unrestricted Release Criteria

Based on the contaminants present at the ATSR Reactor facility, the release criteria specified for the project were as follows:

Beta-Gamma Contamination

- 5,000 dpm (83 Bq)/100 cm², beta-gamma fixed and removable (total) contamination, averaged over 1 m²;

- 15,000 dpm (250 Bq)/100 cm², maximum beta-gamma fixed and removable (total) contamination over 100 cm²; and
- 1,000 dpm(17 Bq)/100 cm², removable beta-gamma contamination.

Alpha Contamination

- 5,000 dpm (83 Bq)/100 cm², alpha fixed and removable (total) contamination, averaged over 1 m²;
- 15,000 dpm (250 Bq)/100 cm², maximum alpha fixed and removable (total) contamination over 100 cm², and
- 1,000 dpm (17 Bq)/100 cm², removable alpha contamination.

The absence of detectable activation products will satisfy the release criteria for volumetric residual radioactive material produced from neutron flux.

Exposure Rates

- Exposure rates in occupiable locations are less than 10 μ R/hr (1.0×10^{-2} mSv/hr), and are due to residual radioactivity. Exposure levels were measured at 1 meter from floor/lower wall surfaces and averaged over floor areas of <10 m². The maximum exposure rate at 1 meter was not to exceed 20 μ R/hr (2.0×10^{-2} mSv/hr) above background.

For purposes of final survey release status, all “unrestricted release” guideline values are referred to as Derived Concentration Guideline Levels (DCGL’s).

7.1.3 Volume Activity of Building Materials

Reasonable effort was made to identify and remove all activated structural material. Where activation still exists, the residual exposure rates result in doses less than 15 mrem/yr (150 μ Sv/yr) for a 2,000-hour occupancy.

7.1.4 Coated Surfaces

Reasonable efforts were made to identify and remove contaminated paint or coatings on the ATSR Reactor facility interior surfaces.

7.2 Final Survey Approach

7.2.1 Definitions

The following definitions were applied in the final survey:

- *Biased or Judgment Survey* - a survey performed at locations likely to contain residual contamination. Locations are selected using professional judgment based on unusual appearance, location relative to known contaminated areas, general supplemental information, etc.
- *Characterization Survey* - a survey that includes facility or site sampling, monitoring, and analysis activities to determine the nature and extent of contamination. Characterization surveys provide the basis for acquiring technical information necessary to develop, analyze, and select appropriate cleanup techniques.
- *Final Status Survey* - the final status survey of the area demonstrating that it meets the established release criteria.
- *Grid* - a system of intersecting lines referenced to a fixed site location or bench mark. The grid lines are arranged in a perpendicular pattern, dividing the survey area into squares of equal area.
- *Impacted Area* - any area that is not classified as *non-impacted*. Impacted areas are those areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels.
- *Lower Wall* - the portion of the wall that extends from the floor to a height of 2 m above the floor.
- *Non-Impacted Area* - areas where there is no possibility (extremely low probability) of residual contamination. Non-impacted areas may be used as background reference areas.
- *Release Criterion or Release Limit* - a regulatory limit expressed in terms of dose or risk. Release limits generally cannot be measured directly. An analysis of various exposure pathways and scenarios is used to convert dose or risk into a radionuclide-specific concentration. The radionuclide-specific concentration that corresponds to a specific release limit is the *derived concentration guideline level* (DCGL) for that radionuclide. $DCGL_w$ is the concentration level for residual radioactivity that is uniformly present above background. The $DCGL_{emc}$ applies to small, isolated areas of elevated radioactivity.

DCGLs can be obtained from responsible regulatory agency guidance, which is based upon modeling using default input parameters, or they can be derived using site-specific parameters. The DCGLs used in the ATSR Reactor facility final status survey were essentially adapted from the Nuclear Regulatory Commission, Regulatory Guide 1.86.

- *Survey Area* - an easily identifiable area selected for radiological evaluation, which may be divided into smaller units as necessary.
- *Survey Location* - the survey data point within a grid square or in an ungridded area.
- *Survey Package* - the portfolio for a specific area being surveyed. Each survey package contains the details for surveillance, including sample locations, types of measurements, sample point selection criteria, background determinations, maps, diagrams and the results and analyses of all data collected.
- *Survey Unit* - a division of a survey area that is expected to have similar contamination and deposition patterns (e.g., floors, lower walls, horizontal surfaces). The maximum survey unit size is approximately 100 m² for impacted areas classified as Class I and 1,000 m² for Class II areas. There are no size limitations on survey units for Class III areas. No survey unit shall include different class areas.

7.2.2 Potential Contaminants

Table 5.1 lists the nuclides identified during the characterization of the ATSR facility conducted prior to D&D operations. Based on knowledge of site operations and the results of the characterization survey performed in early 1998, the primary radionuclides of concern were considered to be Co⁶⁰, Eu¹⁵², Cs¹³⁷, and U²³⁸. The levels of contamination found during the characterization survey and during D&D operations at the facility were generally less than unrestricted release guideline levels except for a Cs¹³⁷ “spill” in Room E-102, and activated shield blocks, reactor, and graphite piles in Room E-111.

7.2.3 General Survey Plan

7.2.3.1 *Survey Area Classifications*

Classifying a survey unit determines the level of survey effort for that unit, based upon the potential for contamination. Areas are initially classified as impacted or non-impacted, using historical information and characterization results. Non-impacted areas have no reasonable potential for residual radioactive contamination and require no further evidence to demonstrate compliance with release criteria.

Impacted areas are areas that have some potential for residual radioactive contamination and can be subdivided into three classes:

- Class 1 Area: Areas that have or had, prior to remediation, a potential for radioactive contamination or known contamination, in excess of the DCGL_w.

- Class 2 Area: Areas that have or had, prior to remediation, a potential for or known contamination, but are not expected to exceed the $DCGL_w$.
- Class 3 Area: Impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_w$, based upon operating history and previous radiological surveys.

Class 1 areas have the greatest potential for contamination and, therefore, receive the highest degree of survey effort, followed by Class 2 and then Class 3 areas. The final survey plan for the ATSR facility was designed using this classification system. Room E-101 (the former control room) did not have contamination above the guideline values. As stated in 7.2.2, room E-102 met the release criteria with the exception of a Cs^{137} "spill" located in the center area near the south wall. This spill required the removal of ~ eight inches of concrete and underling soil from a 3-ft² (0.28-m²) area on the floor and south wall. Room E-111 also met the release criteria with the exception of beta contamination due to activation of the shield blocks, reactor, and graphite piles.

Based on available characterization data, and considering that D&D activities could potentially impact the radiological status of the facility, the facility was classified as follows: The floor of room E-111, the floor pits in room E-111, and the lower walls of room E-111 comprised three separate Class 1 areas. In rooms E-101 and E-102, the lower walls were combined with the floor areas to comprise two separate Class 1 survey units. This resulted in a total of five Class 1 areas, each approximately 100 m². The upper walls and ceiling of rooms E-101 and E-102 were designated one Class 3 area, as were the upper walls and ceiling of room E-111, for a total of two Class 3 areas. The ATSR survey units are summarized in Table 7.1.

Table 7.1 Survey Area Identification and Classification

Area Identification (Room)	Area Classification
E-111 Floor	Class 1
E-111 Lower Walls	Class 1
E-111 Floor Pits	Class 1
E-111 Upper Walls & Ceiling	Class 3
E-101 Floor & Lower Walls	Class 1
E-102 Floor & Lower Walls	Class 1
E-101 & E-102 Upper Walls and Ceilings	Class 3

7.2.3.2 *Scope of Surveys*

- 7.2.3.2.1 Each area was divided into functionally similar survey units of floor-lower walls (<2 m above the floor surface), upper walls (>2 m above the floor surface) and ceilings.
- 7.2.3.2.2 Where a wall, floor or ceiling exhibited a discontinuity, it was categorized and surveyed as two different survey units.
- 7.2.3.2.3 The survey units were marked into 1 m² grids as specified in Section 7.3 of this document.

7.3 Reference Grid System

A grid system was used to reference the location of samples and measurements within the ATSR Reactor facility. Survey units containing affected areas were divided into 1 m² intervals (grids). The grid pattern used alphabetical coordinates along the east-west axis and numerical coordinates along the north-south axis. All ceiling and overhead grids were referenced using the existing floor coordinate subsystem. Maps were prepared of each survey unit showing grid numbers and locations. Measurements taken in unaffected areas were referenced using prominent building features and grid numbers from nearby affected areas. The location of each survey point in an unaffected area was marked with a permanent marker and noted on the appropriate survey map.

7.4 Survey Instrumentation

7.4.1 Instrument Selection

To provide a detection sensitivity of approximately 25% or less of the approved release criteria for total and removable radioactivity measurements, the most appropriate combination of instrumentation, background count time, field count time, and survey technique were considered. All instruments were required to be calibrated to NIST-traceable standards. Efficiencies were determined on-site using laboratory standards that were also NIST-traceable. Daily source and background checks were made throughout the survey work to ensure accurate readings.

7.4.2 Background Determinations

Background determinations were made by taking measurements at locations on or near the site which had been unaffected by site operations. Instrument reference response readings to levels of naturally occurring background radiation in non-radiological areas were determined for exposure rates and contamination levels. Readings for gross alpha and beta contamination activity for removable contamination were not determined for these reference response levels.

7.4.3 Daily Instrument Function Test and Quality Assurance

Each instrument used during the final survey was tested a minimum of once each day prior to use, and the results of each test were recorded on an instrument test sheet. The instrument test comprised background readings, source checks to determine instrument efficiency, and periodic response checks to ensure proper functioning. All test results were recorded and reviewed by the Radiological Controls Supervisor, and all records were made part of the final survey package.

7.5 Survey Methodology

7.5.1 Surface Scan

Surface scans were used to identify any locations having residual surface activity. The type and extent of the surface scan performed was dependent upon the following:

- *Class 1 areas* - scan 100% of the surface.
- *Class 2 areas* - scan the area in the vicinity of each point measurement.
- *Class 3 areas* - up to 25% of the surface.

Building interior surfaces were scanned for beta-gamma and alpha activity. As a rule, the most sensitive instrument available was used for scanning unless restricted by the physical surface of the area or portability of the instrument.

7.5.2 Direct Measurements

Direct measurements were taken in selected areas:

- *Class 1 areas (high probability)* - A minimum of thirty static measurements were taken for total alpha contamination within each class 1 survey unit.
- *Class 2 areas (upper walls and ceilings)* - A minimum of thirty static measurements were taken for total alpha and beta-gamma contamination in each class 2 survey unit.

7.5.3 Removable Contamination Measurements

One 100 cm² wipe for removable contamination was taken at each static point measurement. All wipes were analyzed for both alpha and beta-gamma activity.

7.5.4 Exposure Rate Measurements

Gamma exposure rate measurements were taken 1 m from the surface. Measurements were uniformly spaced according to the following criteria:

- *Class 1 survey units* - one measurement per 4 m² of floor area.

7.5.5 Special Measurements and Sampling

7.5.5.1 *Paint Samples*

Twenty paint samples, i.e., 100 cm² paint scrapings, were taken from the painted surfaces inside the ATSR facility.

7.5.5.2 *Electrical Boxes*

Electrical boxes were opened and direct measurements taken for total beta and alpha surface contamination. In addition, several boxes from each area were smeared for loose alpha and beta-gamma contamination.

7.5.5.3 *Soil Samples*

One soil sample was taken from the dirt below the area of the Cesium-137 spill in E-102.

7.5.5.4 *Drain Surfaces and Penetrations*

All drain surfaces and penetrations were scanned for alpha and beta contamination, and samples were taken where feasible. These samples were analyzed for gross alpha and beta-gamma contamination.

7.6 Interpretation of Survey Results

Data conversions and evaluations were performed following guidance provided in NUREG 1575, MARSSIM, NUREG/CR-5849 and the ATSR D&D Project Final Status Survey Plan.

7.7 Final Survey Results

All accessible areas within ATSR met the ANL-E release criteria.

7.8 Independent Verification Survey

During December 1998, ORISE performed an IVS of ATSR to verify the results of the contractor's final verification survey.

7.9 Post D&D Hazardous Material Condition

All hazardous materials were removed from the ATSR facility and transferred to the appropriate ANL-E division for reuse or disposal, with the exception of asbestos-containing materials that will be removed at a future date.

8.0 HEALTH AND SAFETY

8.1 Industrial Health and Safety

It is the policy of ANL-E to protect the safety and health of employees, subcontractors, members of the general public and the environment by taking all reasonable precautions during the performance of a D&D project. Strict compliance with all applicable environmental, safety and health regulations and requirements, including DOE reporting requirements, is essential. During the duration of the ATSR D&D Project, safety took precedence over production. A principal objective of the project was to complete the D&D of the ATSR Reactor facility in a timely manner while maintaining the highest standards for safety and health. The project-specific Environment, Safety and Health Plan provided the guidance necessary to perform all work in a safe manner.

A pre-job hazard evaluation was performed which identified as many of the known potential hazards as possible. Some of the hazards identified were operation of heavy equipment, lifting and rigging, noise, falling objects, eye hazards, radiation exposure, pinch points, confined space entry work, fire hazards, electrical shocks, heat stress, and exposure to hazardous chemicals. A hazard communication program was implemented which kept workers informed and aware of potential hazards. Frequent inspections by ANL-E Safety Engineering personnel, as well as ANL-E and subcontractor oversight personnel, were performed to ensure employee awareness and compliance with established safety regulations.

During the course of the project, MOTA employees worked a total of 6,100 hours at the ATSR D&D Project site with no lost work days for the entire project.

The excellent safety performance at the ATSR D&D project was due to the commitment of ANL-E project staff and MOTA employees to perform their jobs in a safe and professional manner. Daily toolbox meetings and weekly safety meetings provided the necessary forum for keeping the project staff appraised of potential hazards and unusual situations. Training, including periodic refresher courses, provided the necessary operational and safety information to allow project staff to perform their jobs in accordance with required standards.

8.2 Radiation Protection

The presence of radioactive materials presented a radiological hazard to the workers, general public and the environment. The ATSR D&D Project Radiological Protection Plan provided the necessary guidance with which to perform work in a radiologically safe manner. The ALARA (As Low As Reasonably Achievable) philosophy was used throughout the project. Only trained, essential personnel were used during the performance of the project. ALARA reviews were made prior to the start of on-site work and prior to the start of each segment of work that involved personnel exposure.

Engineering controls, such as HEPA ventilation and contamination containments, were used whenever possible to limit personnel exposure. Personnel protective equipment was also used to limit worker exposure to loose and airborne contamination. Signs and barriers were posted to keep unauthorized personnel from entering radiation and/or contamination areas and to inform workers about entry requirements and radiological conditions inside the area. To prevent the spread of contamination, all equipment, tools and personnel leaving a controlled area were monitored for radioactive contamination at the exit point.

Radiological Work Permits (RWP) were utilized for all phases of work. The RWP specified the radiological conditions in the area, and requirements for safety and protective equipment, personnel monitoring equipment, and sampling. All individuals working in the ATSR facility was required to read, understand, and sign the specific RWP under which they were working. Radiation exposure was monitored with thermoluminescent dosimeters (TLDs), bioassay analyses, and whole body counting.

Specialized radiation protection was utilized. Continuous air monitors (CAM) were placed near work areas which sounded an alarm if high airborne radioactivity existed. Grab samplers and lapel samplers were placed in a worker's breathing zone to track personnel exposure to airborne activity. Respiratory protection was required when exposure to airborne levels of 10% derived airborne concentration (DAC) or higher was expected.

There were **no** personnel contaminations or over exposures throughout the ATSR D&D Project.

8.3 Project Exposure Summary

A project dose estimate made prior to the start of on-site activities was used to determine project staffing and tracking of actual-to-planned project exposure. The ANL-E administrative limit of 1.0 rem (10 mSv) per individual per year was adopted as the project administrative limit. No individual exceeded the ANL-E administrative limit during the project. Total project exposure was estimated to be 0.313 person rem (3.13 mSv). Actual exposure for the project was 0.0 person rem (0.0 mSv).

9.0 WASTE MANAGEMENT

9.1 Waste Types

Material removed from the ATSR Reactor facility was separated into five categories: low-level radioactive waste, mixed waste, hazardous waste, recoverable material and clean scrap.

- Low-level radioactive waste was packaged and transferred to WMO for shipment to a licensed off-site disposal facility.
- Mixed waste (material that contained both hazardous or characteristic-hazardous materials combined with radioactive materials) was packaged and transferred to WMO for further processing and/or storage at ANL-E.
- Hazardous waste (small quantities oil & grease, lead based paint) was packaged and disposed of at a licensed facility or processed at ANL-E.
- Recoverable material (clean lead) was transferred to the ANL-E lead bank or transferred to WMO for future use at other ANL-E projects.
- Clean scrap (equipment and materials removed from the ATSR facility) was transferred to ANL for sorting and disposition.

MOTA was responsible for packaging waste in accordance with ANL-E, DOE-Hanford and Department of Transportation (DOT) regulations. Disposition of all materials was the responsibility of ANL-E.

9.2 Waste Volumes

A summary of waste and recoverable materials removed during the ATSR D&D Project is shown in Table 9.1. Waste volumes are shown graphically in Figure 9.1, and waste volume details are provided in Tables 9.2a, 9.2b, and 9.2c.

Table 9.1 Waste Removed From the ATSR Reactor Facility

Type of Material	Volume ft ³ (m ³)	Weight lb. (kg)	Activity mCi (MBq)
Low-Level Radioactive Waste	1,160 (32.48)	95,490 (43,314)	49.2 (1820)
Mixed Waste	96 (2.69)	12,526 (5,682)	22.8 (844)
Hazardous Materials	7.5 (0.21)	N.A.	N/A

9.3 Waste Packaging

Waste packaging operations conformed with ANL's Waste Handling Procedures Manual, U.S. Department of Transportation (49CFR) regulations and requirements of the designated disposal site.

- *Low-level and mixed waste* - MOTA-supplied B-25 and B-12 metal boxes, 17H 55-gal (208.18 l) drums were loaded, sealed and transferred to WMO final disposition.
- *Clean scrap* - were transferred to ANL-E for disposition
- *Hazardous Waste* - small quantities of liquid hazardous waste (oil and grease) were packaged into appropriate containers and transferred to WMO for disposition.

9.4 Waste Transport

Transportation of project waste was the responsibility of WMO. Waste packages were prepared for shipment by MOTA and delivered to WMO for final disposition.

Table 9.2A ATSR Low-Level Radioactive Waste Tracking Table

Container PIN	Requisition No.	Container Type	Volume [(ft ³) (m ³)]	Total Activity [(mCi) (MBq)]	Date Sealed	Package Weight [(lb) (kg)]	Picked up by WMO	Contents
RW76104	980600284	B-25	96 (2.69)	8.27E-01 (306E-01)	18AUG98	7,948 (3,605)	17SEP98	Graphite, hardboard, steel, Tyvek, rubber, wood, and clay
RW76105	980600285	B-25	96 (2.69)	9.80E-01 (362.6E-01)	17AUG98	8,256 (3,745)	17SEP98	Plastic, wood, graphite, hardboard, and clay
RW76106	980600286	B-25	96 (2.69)	2.28E-01 (84.36E-01)	11AUG98	5,245 (2,379)	17SEP98	Metal, plastic, paper, rags, wood, rubber, graphite, clay, hardboard, concrete, Tyvek, and glass
RW76107	980600287	B-25	96 (2.69)	9.51E-01 (351.8E-01)	13AUG98	8,876 (4,026)	17SEP98	Metal, plastic, graphite, and hardboard
RW76108	980600288	55-gal (208.18 l)	7.5 (0.21)	3.98E-03 (147.3E-03)	15OCT98	262 (119)	17SEP98	Metal, plastic, paper, rags, and solidified liquid
RW76109	980600289	B-25	96 (2.69)	8.83E-01 (326.7E-01)	21AUG98	8,247 (3,741)	17SEP98	Metal, plastic, paper, rubber, graphite, hardboard, and clay
RW76110	980600290	B-25	96 (2.69)	9.38E-01 (347.1E-01)	22AUG98	8,693 (3,943)	17SEP98	Metal, plastic, paper, wood, rubber, graphite, and clay
RW76112	980600292	B-25	96 (2.69)	2.46E+01 (91.0E+1)	8SEP98	7,046 (3,196)	17SEP98	Metal, plastic, paper, wood, rubber, clay, concrete, hardboard, Tyvek
RW76113	980600293	B-25	96 (2.69)	8.93E-02 (330.4E-02)	10SEP98	9,495 (4,307)	17SEP98	Metal, hardboard, and concrete shield blocks
RW76114	980600294	B-25	96 (2.69)	4.18E-01 (154.6E-01)	10SEP98	9,239 (4,191)	17SEP98	Metal, graphite, concrete shield blocks, paraffin, and Tyvek
RW76116	980600296	B-25	96 (2.69)	2.50E-01 (92.5E-01)	14SEP98	9,456 (4,289)	17SEP98	Metal, plastic, rubber, clay, and Tyvek
RW76117	980600297	B-25	96 (2.69)	2.73E-01 (101.0E-01)	16SEP98	9,610 (4,359)		Metal, plastic, rags, wood, and clay
RW76118	980600298	B-25	96 (2.69)	1.88E+01 (69.6E+01)	15OCT98	3,117 (1,414)		Metal, plastic, rubber, clay, and concrete rubble
TOTALS			1,160 (32.48)	4.92E+01 (182.0E+01)		95,490 (43,314)		

Table 9.2B ATSR Mixed Waste Tracking Table

Container PIN	Requisition No.	Container Type	Volume [(ft ³) (m ³)]	Total Activity [(mCi) (MBq)]	Date Sealed	Package Weight [(lb) (kg)]	Picked up by WMO	Contents
RW76111	980600291	B-12	48 (1.34)	2.28E+01 (84.4E+01)	10SEP98	12,526 (5,682)	17SEP98	Lead and plastic (mixed waste)
RW76115	980600295	B-12	48 (1.34)	1.62E+01 (59.9E+1)	9SEP98	9,131 (4,142)	17SEP98	Lead and plastic (mixed waste)
TOTALS			96 (2.69)	3.90E+01 (144.3E+01)		21,658 (9.824)		

Table 9.2C ATSR Chemical Waste Tracking Table

Container PIN	Requisition No.	Container Type	Volume [(ft ³) (m ³)]	Total Activity [(mCi) (MBq)]	Date Sealed	Package Weight [(lb) (kg)]	Picked up by WMO	Contents
CW61487	N.A.	55-gal (208.18-l)	7.5 (0.21)	N.A.	28SEP98	N.A.		Lead-based paint residue
TOTAL			7.5 (0.21)					

10.0 COST AND SCHEDULE

10.1 ATSR D&D Project Cost

The ATSR Reactor D&D Project was funded by the U. S. Department of Energy Assistant Secretary for Environmental Management Office of Environmental Restoration (EM-40) and completed for a total cost of approximately \$614,000.

10.2 ATSR D&D Project Schedule

The ATSR Reactor D&D Project began in December 1998 and finished in October 1998, a total of 10 months. Actual on-site work started in July 1998 and was completed in October 1998. The ATSR D&D Project Schedule is shown in Figure 10.1

11.0 FINAL FACILITY CONDITION

MOTA completed all on-site D&D activities in mid-October, 1998. All areas met the free release criteria.

All systems and components associated with reactor operation have been removed. These included primary and secondary coolant systems, reactor helium systems, reactor water purification and water storage systems, ventilation systems, reactor control systems, the biological shield and the reactor.

Figures 11.1 - 11.6 depict the post D&D condition of the ATSR facility. Figure 11.1 is the ATSR Control Room area in E-101; Figure 11.2 is the Reactor Room Area (E-111) looking northeast; Figure 11.3 is the same room looking west. The dump tank pit and the fuel storage pit are shown in Figures 11.4 and 11.5. The cesium spill area in Room E-102 is shown in Figure 11.5.

Figure 10.1 ATSR D&D Project Schedule

Figure 11.1 ATSR Control Room Area in E-101
(ANL Neg. 24748K, Frame #9)

Figure 11.2 Reactor Room Area (E-111) Looking Northeast
(ANL Neg. 24748K, Frame 10)

Figure 11.3 Reactor Room Area (E-111) Looking West
(ANL Neg. 24748K, Frame 13)

Figure 11.4 Dump Tank Pit
(ANL Neg. 24748K, Frame 15)

Figure 11.5 Fuel Storage Pit
(ANL Neg. 24748K, Frame 16)

Figure 11.6 Cesium Spill Area in Room E-102
(ANL Neg. 24748K, Frame 7)

12.0 CONCLUSIONS, RECOMMENDATIONS, AND LESSONS LEARNED

The completion of the ATSR D&D project permitted the transfer of the ATSR Reactor facility from the U.S. Department of Energy EM-40 roster to ANL-E surplus facilities. The facility has been free-released for unrestricted use and made available for immediate reuse.

12.1 General Problems Encountered and Lessons Learned

The ATSR D&D project utilized the lessons learned from previous reactor D&D projects performed at the Laboratory and other similar facilities. No major problems or lessons learned were encountered during the work at ATSR

12.2 Management Issues

Only one management issue is worthy of note, the delay in project start-up due to the cultural resources issue identified in May of 1998. The determination of historical significance of the ATSR facility and resultant requirement for an Environmental Assessment was responsible for at least a 2-month delay in the start of field activities.

12.3 Noteworthy Practices

12.3.1 Frequent Safety Inspections

At the start and frequently throughout the project, formal safety inspections were conducted by the Project Manager, ANL-E ESH Safety Engineering and Health Physics, TD ESH/QA Officer and MOTA management to insure the project personnel were aware of the emphasis that ANL-E and MOTA placed on safety. This practice helped develop a safety first mind set with the project staff that resulted in a project with no recordable or loss time injuries, no contamination events and no overexposure events.

12.3.2 Incorporation of Lessons Learned

The incorporation of previous lessons learned and the utilization of experienced and qualified personnel resulted in a safe, error-free project.

13.0 ACRONYM AND ABBREVIATION LISTING

ALARA	As Low As Reasonably Achievable
ANL-E	Argonne National Laboratory-East (located in Argonne, Illinois USA)
ANSI	American National Standards Institute
ASA	Auditable Safety Analysis
ASME	American Association of Mechanical Engineers
ATSR	Argonne Thermal Source Reactor
Bq	Becquerel
cm	centimeter
CAM	continuous air monitor
CP-1	Chicago Pile-1
CT	Connecticut
D&D	Decontamination and Dismantlement (or Decontamination and Decommissioning)
DAC	derived airborne concentration
DCGL	Derived Concentration Guideline Levels
DOE	United States Department of Energy
DOE-ARG	United States Department of Energy Argonne Group
DOE-CH	United States Department of Energy Chicago Operations
DOE-EM	United States Department of Energy Environmental Management
dpm	disintegrations per minute
EA	Environmental Assessment
e.g.	for example
EM-40	United States Department of Energy, Assistant Secretary for Environmental Management, Office of Environmental Restoration
EMO	ANL-E Environmental Management Operations Division
ESH	ANL-E Environment, Safety and Health Division
ESH/HP	Environment, Safety and Health/Health Physics Group
ESH/QA	Environment, Safety and Health/Quality Assurance Oversight
ft	foot
g	gram
gal	gallon
GBq	Giga Becquerel
HASP	Health and Safety Plan
HEPA	High Efficiency Particulate Air

hr	hour
i.e.	that is
IH	Industrial Hygiene
in	inch
IPNS	Intense Pulsed Neutron Source
IVS	Independent Verification Survey
kg	kilogram
km	kilometer
kW	kilowatt
l	liter
lb	pound
LO/TO	Lock Out/Tag Out
m	meter
MBq	mega Becquerel
mBq	milli Becquerel
mCi	microcurie
min	minute
ml	milliliter
mR	milli Roentgen
mrem	millirem
mSv	milli Sievert
MT	metric ton
NIST	National Institute for Science and Technology
NQA	Nuclear Quality Assurance
OSHA	Occupational Safety and Health Administration
ORISE	Oak Ridge Institute for Science and Education
pCi	picocurie
PFS	ANL-E Plant Facilities and Services Division
QA	quality assurance
QAR	Quality Assurance Representative
rad	radiation absorbed dose
rem	Roentgen equivalent man
RCT	Radiation Control Technician

RFP	Request for Proposal
RWP	Radiological Work Permit
SC	South Carolina
sec	second
TD	Argonne National Laboratory Technology Development Division
TLD	thermoluminescent dosimeter
WBS	Work Breakdown Structure
WMO	ANL-E Waste Management Operations
yr	year
ZPR	Zero Power Reactor